Viscoelastic lower crust and mantle relaxation following the 14-16 April 2016 Kumamoto, Japan, earthquake sequence

*Fred F Pollitz[1], Chuck Wicks[1], Tomokazu Kobayashi[2], Hiroshi Yarai[2], Bunichiro Shibazaki[3]

1. USGS Western Regional Offices Menlo Park, 2. Geospatial Information Authority, Tsukuba, Japan, 3. Building Research Institute, Tsukuba, Japan

The M_w 7.0 16 April 2016 Kumamoto, Japan, earthquake is the largest-intensity earthquake to strike Japan since the 2011 Tohoku earthquake, and it was preceded by a M_w 6.0 foreshock on 14 April. The 16 April event ruptured earth' s surface and involved predominantly right-lateral strike slip ranging from decimeters to several meters along a ENE-WNW trending fault of length ~80 km and width ~20 km. Crustal motions have been constrained during the pre-seismic, co-seismic, and post-seismic phases by Global Positioning System (GPS) data from GEONET and Interferometric Synthetic Aperture Radar (InSAR) data from ALOS. Relative to background (pre-seismic) motions, horizontal postseismic crustal motions during the first six months following the sequence exhibit a quadrant pattern centered on the fault that acts to restore right-lateral horizontal shear strain in the epicentral region. These motions are asymmetric about the fault, reaching ~5 cm/yr 50 km north of the fault and only 1-2 cm/yr 50 km south of the fault. This pattern is inconsistent with afterslip and is rather suggestive of viscoelastic lower crust and mantle relaxation driven by the coseismic stress changes, with relatively low viscosity northwest of the rupture zone. We explore 2.5D and 3D models of viscoelastic lower crust and mantle relaxation and afterslip to explain the postseismic motions. A preliminary 2.5D Burgers body model involves transient lower-crust/mantle viscosities of 3 $x10^{17}$ Pa s and 1.5$x10^{18}$ Pa s northwest and southeast of the rupture, respectively. This model replicates the first-order pattern of observed postseismic deformation. It is consistent with relatively high heat flow north of the local trace of the Median Tectonic Line, as well as low seismic-wave attenuation in the mantle beneath the volcanic gap of central Kyushu.

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