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Transient Deformation Following the 2016 Kumamoto Earthquake: Towards Building a Rheological Model of Kyushu

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Postseismic studies of geodetic data following large earthquakes indicate a wide range of mechanisms contribute to the observed deformation and stress relaxation. Both on-fault afterslip and off-fault viscoelastic relaxation can contribute to the postseismic transient phase of the earthquake cycle. One problem with these (quasi-) dynamic models is that there is a wide range of parameter space to be investigated, with each parameter pair possessing their own tradeoffs. This becomes especially problematic when trying to model both on-fault and off-fault deformation simultaneously. Here, we draw insight from 18 months of postseismic geodetic observations following the 2016 Mw 7.0 Kumamoto earthquake by utilising a novel inversion technique.

We present a novel approach to invert for on-fault and off-fault deformation simultaneously using analytical Green's functions for distributed deformation at depth (Barbot, Moore and Lambert., 2016) and on-fault deformation (Okada 1985). Using these Green's functions, we jointly invert InSAR images and GEONET GPS time series following the Kumamoto earthquakes for afterslip and lower-crustal viscoelastic flow.

The calculated strain-rates in the lower crust are directly converted to effective viscosities and we investigate the implications of the effective viscosity structure within an outlier-sensitive Bayesian statistical framework to estimate in-situ parameters, such as temperature.

Following the work presented in Moore et. al. (2017) and using aspects presented in Qiang, Moore et. al. (2018) we extend the study over the 18 months following the earthquake sequence, investigating the 4D spatio-temporal evolution of the viscosity beneath and deformation within the island of Kyushu and draw comparisons with the inelastic strain distributions in Kyushu presented in Matsumoto et. al. (2016).

The postseismic deformation at Kumamoto brings new insights into the distribution of brittle and ductile crustal processes beneath Japan and we use this to infer lower crustal properties and move towards a rheological model for Kyushu.