Long-term Viscoerastic Relaxation and Spatially Inhomogeneous Viscosity Structure

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Activities of very low-frequency earthquakes after mega-thrust earthquakes can be related to afterslips (e.g., Baba et al., 2020 JGR) but estimation of the spatiotemporal distribution of afterslip is difficult. For instance, GNSS observation can detect the signal of crustal deformation by afterslip + viscoelastic relaxation and their simultaneousness makes it hard to separate those signals.

One method for the separation is to use very long-term data. Time constant of afterslip is relatively short compared to that of viscoelastic relaxation, so the data obtained long after the earthquake do not include the signal of afterslip. By estimating viscoelastic relaxation based on those data and removing its contribution in the whole time series, we can gain the data mainly reflecting afterslip. This concept is very simple and today most of researches attempting to separate afterslip and viscoelastic relaxation are more or less related to it. However, it has one unignorable problem, namely, spatial inhomogeneousness of viscosity structure.

Suito (2017 EPS) suggested that three dimentional rheological heterogeneity is necessary for interpreting viscoelastic relaxation caused by the 2011 Tohoku-Oki earthquake based on GNSS data including ocean bottom stations and also showed that the viscosity of oceanic mantle can be higher than that of mantle wedge. However, it is still unclear if similar phenomena can be observed in different earthquakes and in different places.

In this presentation, I report that spatial inhomogenous viscosity structure is decisively important to interpret GNSS + satellite gravimetry observation results about post-seismic phenomena of the 2004 Sumatra-Andaman earthquake, the 2006-2007 doublet Kuril earthquakes, the 2009 Samoa-Tonga earthquake, the 2010 Maule earthquake, the 2011 Tohoku-Oki earthquake, and the 2012 Indian-Ocean earthquake. I also show the viscosity structure can possibly be even more complex than expected.

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