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Viscoelastic Model of 2004 Sumatra-Andaman Earthquake observed from near (AGNeSS) and far field GPS measurements

Gunawan Endra[1*], Takeshi Sagiya[1], Takeo Ito[1], Fumiaki Kimata[1], Takao Tabei[2], Didik Sugiyanto[3], Irwandi[3]

[1]Nagoya University, [2]Kochi University, [3]Syiah Kuala University

The 2004 Sumatra-Andaman (SA) earthquake occurred due to the subduction of the Indo-Australian plate beneath the Eurasian plate along the Sunda trench. Coseismic deformation of the 2004 SA earthquake was detected by Global Positioning System (GPS) over a wide area in the Southeast Asia. [i.e. Vigny et al., 2005: Subarya et al., 2006; Hashimoto et al., 2006]. In addition, postseismic deformation has been detected by GPS in the Andaman Islands [i.e. Paul et al., 2007; Gahalaut et al., 2008] and Thailand [Satirapod et al., 2008].

We have been operating a GPS network in northern Sumatra called AGNeSS (Aceh GPS Network for Sumatran Fault System) from 2005 and also detected significant postseismic signal. AGNeSS is a densification of the area for about 150 km by 150 km wide which located in the northern region of Sumatran fault. AGNeSS constituted of campaign and continues GPS sites. Totally, 20 campaign sites were obtained during our field observation. Meanwhile, our continuous GPS site, USKL, has been operated since March 2005.

Thus we try to model postseismic deformation combining all those available data. By assuming a coseismic fault model the 2004 SA and the 2005 Nias earthquakes [Einarsson et al., 2010], we predict postseismic viscoelastic relaxation and compare the model calculation with observation. We use PSGRN/PSCMP program developed by Wang et al. [2006]. We assume three-layered structure, a Burgers viscoelastic layer is intervened between the elastic suface layer and the Maxwell viscoelastic substratum. Here, we did not use Maxwell rheology since it can not match with GPS observation [Paul et al., 2007].

We assume that viscosity for Maxwell element is 10^19 Pa s. Our result shows that the viscosity for Kelvin element is 2x10^18 Pa s. Our rheology model is similar to those obtained by Hoechner et al. [2010] and Pollitz et al. [2008]. However, our current viscoelastic model here can not match the vertical deformation data in northern Sumatra. On the other hand, the model reproduces both the horizontal and the vertical GPS data in the Andaman Islands well [Hoechner et al., 2010].One possible reason is that other physical process such as an afterslip has may have significant contribution to the postseismic deformation. Our current estimate of the elastic layer thickness is 55 km. However, the best fit model for elastic depth in Andaman Islands is 40 km [Hoechner et al., 2010]. This result indicates that there is structure heterogeneity between north Sumatra and Andaman Islands.

Keywords: 2004 Sumatra-Andaman earthquake, GPS, viscoelastic deformation