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Long-term Changes in Coulomb Failure Function on inland faults in SW Japan due to plate motion and earthquakes

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There are many inland active faults in and around the Kinki region, such as Median Tectonic Line, Neodani, Atotsugawa, and Rokko-Awaji faults. The earthquakes on the faults are mainly generated by the east-west compression, known as Niigata-Kobe Tectonic Zone (NKTZ), which would come from the relative motion between Okhotsk and Amurian plates (Sagiya, 2004). However, because the activity of inland earthquakes increases in the period from 50 years before to 20 years after the occurrence of great interplate earthquakes along the Nankai Trough (Hori & Oike, 1996), earthquake generations on these faults are affected by the interplate earthquakes at the trough. To investigate this problem, Pollitz & Sacks (1997), Hyodo & Hirahara (2004), and Hirahara (2007) evaluated the viscoelastic effect of great interplate earthquakes and interseismic plate locking at the Philippine Sea (PHS) Plate subduction by examining Change in Coulomb Failure Function (dCFF). In these studies, the effect of steady subduction is ignored. However, it generates long-term (Myr scale) crustal deformation, which is obtained by the viscoelastic response function at infinite time (Matsu'ura & Sato, 1989). Hashimoto et al. (2008) explained free-air gravity anomaly in and around Japan by steady subduction of the PHS and Pacific (PAC) plates. We now add the effect of steady subduction and interaction between the inland earthquakes in evaluating stress change on the inland active faults. With this study we evaluate how stress change during the earthquake cycle affects the long-term stress accumulation on inland active faults. We investigate the validity of the model with comparing the historical record of inland earthquakes.

We employ quasi-static viscoelastic slip response functions for point sources in an elastic-viscoelastic stratified medium by Fukahata & Matsu'ura (2006). For the plate interface of PHS and PAC subduction, we use the structure by Hashimoto et al. (2004), because they put priority on minimization of roughness, which is important to calculate the effect of steady subduction. We set history of the interplate earthquakes at the Nankai Trough. The amount of slip is set by Time or Slip Predictable model (Shimazaki & Nakata, 1980). For the global plate motion, we use REVEL 2000 (Sella et al., 2002) based on the GPS data. The maximum compressive strain due to NKTZ east-west compression is set to be 1×10^{-7} strain/yr with the direction of N100E. For the collision of the Izu Arc, the relative plate motion between PHS and AMR plates are decreasing in the Izu and Suruga regions, after Heki & Miyazaki (2001). The geometries of inland faults are after HERP. The effective friction coefficient is set to be 0.3.

For the validity, we first calculated the long-term crustal deformation due to steady subduction of PAC and PHS plates, under the same condition in Hashimoto et al. (2008). The computed results are consistent with the previous work. We then changed the thickness of elastic lithosphere from 40 km to 35 km, which is appropriate for SW Japan. With the thickness the computed crustal uplift pattern is more similar to the observed free-air gravity anomaly than the result of Hashimoto et al. (2008). Thus thickness is set to be 35 km. We then calculated dCFF on the inland faults due to NKTZ east-west compression and steady plate subduction. The dCFF due to NKTZ east-west compression is positive and its value is several kPa/yr, for most active faults. The dCFF due to steady plate subduction are both positive and negative and its value is around several hundred Pa/yr. These results are consistent with that the inland earthquakes in this region are mainly generated by NKTZ east-west compression. Most earthquakes on the faults occur when dCFF is largest-ever, which is consistent with the concept of dCFF. In the presentation, we show the effect of interaction between inland earthquakes.

Keywords: subduction zone, numerical simulation, viscoelasticity, Coulomb failure function, steady plate subduction, inland earthquake