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Changes in Coulomb Failure Function on inland faults in southwest Japan due to subduction events along the Nankai Trough

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The earthquakes on inland active faults in the Kinki region are mainly generated by the east-west compressive stress probably due to the Pacific (PAC) plate subduction. However, because the activity of inland earthquakes increases in the period from 50 years before to 10 years after the occurrence of great interplate earthquakes along the Nankai trough (Hori & Oike, 1999), earthquake generations on these faults are affected by the interplate earthquakes due to the Philippine Sea (PHS) plate subduction. To evaluate the effects quantitatively, we calculate the stress change on the inland active faults in southwest Japan due to the PHS subduction events, such as interplate earthquake, locking, and steady plate subduction.

For this problem, Pollitz & Sacks (1997), Hyodo & Hirahara (2004), and Hirahara (2007) evaluated the viscoelastic effect of great interplate earthquakes at the PHS plate subduction by examining Change in Coulomb Failure Function, dCFF. In these studies, they calculated dCFF due to great earthquakes and locking, among the subduction events.

The long-term (Myr scale) crustal deformation is caused by the mechanical effect due to plate subduction and is obtained by the viscoelastic response function at infinite time (Matsu'ura & Sato, 1989). As for the stress accumulation due to steady plate subduction, Hashimoto & Matsu'ura (2006) explained east-west compression in northeast Japan by steady subduction of the PHS plate and the partial collision of the PAC plate.

Based on the studies, we calculate dCFF on the inland active faults due to the steady plate subduction, using the above-mentioned procedure by Matsu'ura & Sato (1989). We compute the slip response function in an elastic-viscoelastic stratified medium. We employ quasi-static viscoelastic slip response functions for point sources by Fukahata & Matsu'ura (2006). For the plate interface of PHS and PAC plates, we use the structure by Nakajima & Hasegawa (2007) and Nakajima et al. (2009). We set the history of the interplate earthquakes at the PHS plate subduction as the boundary condition; the occurrence time is from historical record and the amount of slip is from time or slip predictable model (Shimazaki & Nakata, 1980). We also consider the east-west compressive stress due to the Pacific plate subduction and the collision of the Izu volcanic arc.

The current result is as follows. First, we calculated the slip response function by the modeled PHS plate. To investigate the validity of the obtained slip response function, we calculated the crustal deformation due to the 1944 Tonankai and 1946 Nankai earthquakes by giving the slip distribution of the events and compared with the geodetic observation data (triangulation, leveling, and sea level data). The computed results are basically consistent with the observation data. Then, we calculated the long-term crustal deformation due to steady subduction of the PHS plate. The computed vertical deformation is generally consistent with the observation of free-air gravity anomaly by Sandwell & Smith (1997). Computing the long-term crustal deformation pattern with various plate thicknesses, we found the vertical deformation pattern considerably depends on the plate thickness. Next, we evaluated dCFF due to great interplate earthquake, locking, and steady subduction. The ratio of dCFF due to steady subduction to the dCFF evaluation varies with the faults, and the stress accumulation pattern also considerably depends on the plate thickness.

We can consider dCFF due to steady plate subduction is the long-term stress accumulation to generate inland earthquake. So, we can evaluate how stress change during the earthquake cycle affects the long-term stress accumulation on inland active faults. We here evaluate the occurrence possibility of each inland earthquake during each great earthquake cycle along the Nankai trough and compare the historical record of inland earthquakes.

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