Afterslip, viscoelastic relaxation, poroelastic rebound: A possible mechanism in the sort and long term postseismic deformation following the 2011 Tohoku earthquake.

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Postseismic deformation of the Tohoku earthquake has been investigated by Ozawa et al. (2011), Wang et al. (2012), Diao et al. (2013), Sun et al. (2014), Perfettini and Avouac (2014), Shirzaei et al. (2014), Silverii et al. (2014), and Yamagiwa et al. (2015). Of these studies, Diao et al. (2013) investigated rheological model inferred from postseismic deformation of the Tohoku earthquake using 1.5 years GPS data following the mainshock. Because reliable investigation of the viscosity and its transient behavior require observation with longer time period, we build postseismic deformation model of the Tohoku earthquake using longer GPS data than that of used by previous studies and estimated the inferred rheological model. In addition, we also evaluate the possibility of the poroelastic relaxation signal due to the Tohoku earthquake.

We used observed surface deformation recorded by inland GEONET stations from 12 March 2011) to 12 October 2016 (~ 5.6 years). Afterslip model was inverted by assuming a homogeneous elastic half-space (Okada 1992). Viscoelastic relaxation due to coseismic stress change of the Tohoku earthquake is estimated using the Fortran code PSGRN/PSCMP (Wang et al. 2006). We estimated poroelastic relaxation following Gahalaut et al. (2008) and compared the result with observed ground water-level change to investigate relaxation time of poroelastic rebound.

Observed postseismic displacement for 5.6 following the mainshock show that deformation is characterized by seaward movement and is more broadly distributed than the coseismic displacement. Our model show an effective thickness of the elastic crust (*D*) and an asthenosphere viscosity (η) are 50 km and 5.6×10^18 Pa s, respectively. This result is consistent with most estimated viscosity in NE japan area (e.g., Rydelek and Sacks 1990; Suito and Hirahara 1999; Ueda et al. 2003; Hyodo and Hirahara 2003). Incorporating viscoelastic and poroelastic rebound in the early stage of postseismic deformation improve the agreement between predicted and observed displacement. It implies that postseismic deformation following the Tohoku earthquake is likely driven by multiple mechanism instead of single mechanism. Poroelastic relaxation is consistent with the ground water-level change during the first 140 days after the mainshock, suggesting that poroelastic rebound after the Tohoku earthquake have longer relaxation time than 60 days of poroelastic rebound following the 2000 South Iceland earthquake (Jonsson et al. 2003). Landward displacement of poroelastic rebound at offshore area indicate that this mechanism, along with viscoelastic relaxation, could have contributed to the postseismic deformation of the Tohoku earthquake.

Keywords: afterslip, viscoelastic relaxation, poroelastic rebound, GNSS, Postseismic deformation

