東北沖地震間における東北日本弧の変形過程：垂直変動と水平歪
Deformation processes of island arc during the interseismic period of Tohoku-oki earthquake: Vertical movement and horizontal strains

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This study models the deformation of the crust and upper mantle of the northeastern Japan island arc during the interseismic period of the Tohoku-oki earthquake considering heterogeneous rheological structure. Nishimura (2012) investigated the crustal deformation of northeastern Japan based on geodetic data for the 120-year period preceding the 2011 Tohoku-oki earthquake. The results indicate north-south extension and east-west compression along the central axis of northeastern Japan. Vertical deformation data for a 100-year period indicates uplift in the backarc region but subsidence in the forearc region. Recently, Shibazaki et al. (2014) calculated the effective viscosity of the crust and upper mantle of the Japanese island arc based on the thermal structure obtained by dense geothermal observations using Hi-net boreholes (Matsumoto, 2007) and by Tanaka et al. (2004). They reproduced several elongated low-viscosity regions in the crust and upper mantle of the northeastern Japan arc, striking transverse to the arc, which correspond to hot fingers. We develop a finite element model of the viscoelastic deformation processes during the interseismic period considering heterogeneous viscosity structures. In order to model interseismic coupling, we give back-slip along the subduction plate boundary for 500 years. We investigate several cases by changing back-slip distribution to model interseismic deformation. To reproduce the uplift observed from the volcanic front to the backarc and the subsidence in the forearc, we need to consider back-slips at the deeper subduction plate interface. In this region, the back-slip rate decreases from 8 cm/yr at a depth of 40 km to 0 cm/yr at a depth of 90 km. Compared with the model with only elastic structures, the smaller amount of the deep back-slip is necessary for the model with the heterogeneous viscoelastic structure to reproduce the observed uplift. Strain rates during the interseismic period show east-west compression and north-south extension. Our results indicate that the heterogeneous rheological structure of the crust and upper mantle of the island arc and back-slip at the deeper region are necessary to reproduce the observed interseismic strain distribution and vertical deformation.

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