

The role of the lower crust in crustal deformation of the Japan island arc

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In the Japanese island arc, interplate locking along the subduction interface of the Pacific plate and the Philippine Sea plate has been considered as the main source of the crustal deformation. On the other hand, detailed analysis of crustal deformation before and after the 2011 Tohoku-oki earthquake has revealed existence of persistent deformation associated with the Niigata-Kobe Tectonic Zone, a major inland deformation zone (Meneses-Gutierrez and Sagiya, 2016), which is independent of the mechanical interaction at the subduction interface. This observation suggests that activity of inland deformation zones is driven by regional tectonic stress that has been built up over a geological time scale. In addition, a special structure that promotes localized deformation must exist in the lower crust associated with active deformation in the upper crust. Such an idea is supported by a numerical simulation study, in which shear localization occurs in the lower crust beneath an inland active fault even with a slow fault slip rate such as 1 mm/year. The nonlinear rheology is considered to be the most important cause of the shear localization (Zhang and Sagiya, submitted). Thus it is expected that localized deformation in the lower crust is pertinent to each active fault. Once such a structure is created in the lower crust, it in turn controls the deformation of the upper crust. Such an idea is supported by the fact that crustal deformation pattern around active faults is well explained by an elastic dislocation model with a locking depth of ~15km. Around the Atera fault and the Gofukuji fault, major left-lateral strike slip faults, observations with dense GNSS network show that the lower crustal shear localization beneath the active fault traces continue even during significant perturbation due to the 2011 Tohoku-oki earthquake (e.g. Kumagai et al., 2017). The idea also provides a physical basis for the block modeling of inland areas.

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