

Persistent and time-dependent crustal deformation in northern Fossa Magna and its tectonic implications

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In the northern Fossa Magna of the northern Nagano Prefecture, GNSS observations over last two decades identified a rapid E-W contraction around the northern Itoigawa-Shizuoka Tectonic Line (ISTL) and the Western Nagano Basin Fault (WNBF). After the 2011 Tohoku-oki earthquake, postseismic deformation with a large E-W extension occurred throughout northeast Japan. However, the northern Nagano area has been still under contraction, implying that the local contraction is a persistent deformation feature. Similar persistent deformation was identified in the Niigata area by Meneses-Gutierrez and Sagiya (2016) and around other active faults in central Japan. These observations illustrate that there exists persistent localized deformation in the lower crust beneath active faults, driven by the regional stress field. This localized deformation in the lower crust is the driving force for faults in the upper crust. The persistent local crustal deformation around active faults suggests that the long-term inland deformation and resultant inland seismic activity are steady over a longer time scale than that of an earthquake cycle at subduction zones. On the other hand, after the 2014 Northern Nagano Earthquake (Mw6.3) along the northern ISTL, an acceleration of contraction along the WNBF was identified. This observation implies that the northern ISTL and WNBF are not independent but mechanically interact each other, forming an active deformation system that accommodates regional deformation. Such a complicated behavior of the fault system implies that the long-term activity of each fault in the system is not steady but time-dependent. Such a time-dependence may be a cause of irregular activity of inland faults and such a possibility should be considered for evaluation of seismic hazard.

Keywords: inland earthquake, active fault, inelastic deformation, persistent crustal deformation, fault interaction