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Change in stress field by the 2011 Tohoku-Oki earthquake and fault strength-stress loading process for inland earthquake

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A clear temporal change in stress field was observed after the 2011 Tohoku-Oki earthquake in the upper plate beneath the Pacific Ocean (Hasegawa et al., 2012). The principal stress directions were reversed for areas with static stress change greater than 5-15 MPa, which indicates that those areas in the upper plate beneath the Pacific Ocean had differential stress magnitudes less than 5-15 MPa before the earthquake. Significant rotations of the principal stress axes after the earthquake were also observed for some areas of the inland, far from the source area of the Tohoku-Oki earthquake, suggesting that stress magnitudes for those areas before the earthquake were as small as ˜1 MPa (Yoshida et al., 2012). If the stress magnitudes have such small values, we need to reconsider the stress loading model for inland earthquakes.

A recent study on stress field in the inland of NE Japan based on many focal mechanism data shows that the arc and back-arc are characterized by spatially uniform margin normal compression, but the fore-arc has different stress orientations (Yoshida et al., this meeting). The Kitakami and Abukuma mountain ranges in the north and south have ?1 axis oriented nearly N-S and vertical, respectively. This indicates that the margin normal compression in the arc and back-arc is not caused mainly by the coupling with the Pacific plate beneath the Pacific Ocean but perhaps by the convergence of the Eurasia plate from the back-arc side.

These observations indicate that differential stress magnitudes causing inland earthquakes are small and so fault strengths are weak as well. The weak faults are probably caused by overpressured fluids. We propose a new stress loading model for inland earthquakes based on these observations.

Keywords: Stress, fault strength, stress loading process, inland earthquake, crustal fluids, Tohoku-Oki earthquake