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Diversity in Triggering Mechanism for Seismic Events Following the 2011 off the Pacific Coast of Tohoku Earthquake

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Extensive aftershocks and triggered seismic events are ubiquitous following large earthquakes, but the controlling mechanisms are not yet understood. Focal mechanisms of these events can provide insight into physical triggering mechanisms because they reflect friction coefficient and pore fluid pressure on the fault as well as the tectonic stress pattern. In the present study we examined physical processes triggering seismic events following the 2011 off the Pacific Coast of Tohoku earthquake (Mw = 9.0) by examining focal mechanisms through CMT data inversion and changes in the Coulomb failure function (DCFF). In the shallow part (< 20 km) of the source region the tectonic stress pattern drastically changed from reverse-type with east-west compression to normal-type with east-west tension, while it doesn't change in the remaining region. We evaluated DCFF in the direction of resolved shear traction on the maximum shear plane of the present tectonic stress field. The direct causes triggering aftershocks of the 2011 Tohoku earthquake are increase of the magnitude of deviatoric stresses and decrease of the fault strength, which directly correspond to the two factors of the Coulomb failure function. The increase of seismicity rate in the region east to the Japan trench and central Honshu was mainly controlled by the former, which is caused by the static stress change due to the mainshock. The latter is more complicated, but one of the plausible physical processes is fluid diffusion excited by the mainshock. The temporal (apparent) stress rotation observed in the northernmost part of Nagano prefecture reflected temporal changes of statistical characteristics of focal mechanisms, caused by decrease of fault strength through increase of pore fluid pressures. The local excitation of seismicity rate in the northern Honshu also indicates that aftershocks in the region with negative DCFF may have been triggered by the same process.

Keywords: Aftershock/triggered seismic events, Stress, Pore fluid pressure, Change in Coulomb failure function