# Influence of pore fluid pressure on aftershock sequence of the 2016 Kumamoto earthquake

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Aftershock activity following a large earthquake is a well-known phenomenon, but physical mechanisms triggering aftershocks are not well understood. We quantitatively examined the effects of pore fluid pressure on the occurrence of aftershocks of the 2016 Kumamoto earthquake, based on an inversion analysis of pore fluid pressure and a numerical calculation of coseismic stress changes in the central part of the Kyushu island, Japan. We analyzed 2,282 earthquake focal mechanisms to estimate the 3-D pore fluid pressure field before the main shock, using the method of focal mechanism tomography. In order to evaluate the change in Coulomb failure function ($\Delta CFF$), we also calculated the coseismic stress changes caused by the main shock based on the dislocation theory. Then, we examined the seismicity rate changes, which is the ratio of events for three years after the main shock to that before the main shock, and compared it with the results of pore fluid pressure and the coseismic stress changes.

We found that the seismicity rate tended to increase and decrease in the regions with $\Delta CFF > 0$ and $\Delta CFF < 0$, respectively, indicating that the seismicity rate changes were roughly explained by the coseismic stress changes. In addition, the seismicity rate tended to increase more as the pore fluid pressure coefficient $C$, which is defined by the excess pore fluid pressure above hydrostatic normalized by the difference between the lithostatic and hydrostatic pressures, before the main shock was higher. This indicates that the pore fluid pressure before the main shock as well as $\Delta CFF$ controlled the seismicity rate change due to the main shock. We also found that 13 % of the aftershocks occurred in the regions with increases in seismicity rate changes and negative $\Delta CFF$ values. The increase in seismicity rate changes contrary to negative $\Delta CFF$ values was more remarkable in the regions where negative effects from $\Delta CFF$ were smaller and pore fluid pressure coefficients $C$ were higher. This suggests that negative effects from coseismic stress changes were compensated by increases in pore fluid pressure.

To confirm this scenario, we examined the average level of pore fluid pressure triggering events before and after the main shock, based on the temporal change in types of focal mechanisms relative to the tectonic stress pattern. At shallow depths around 5 km, pore fluid pressures triggering these aftershocks were by 5–12 MPa larger than those before the main shock. These estimates support that increases in pore fluid pressure caused by the main shock played an important role in triggering these aftershocks.

Keywords: pore fluid pressure, stress change, aftershock

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