Reestimation of pore fluid pressure fields in the region with intensive swarm activity around Mt. Ontake volcano

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Overpressurized fluids in the Earth’ s crust have been increasingly implicated to play an important role to earthquake generation by decreasing fault strength (e.g., Hubert and Rubey, 1959). However, it is difficult to directly measure pore fluid pressures in the crust. The focal mechanism tomography (the FMT) is an inversion method to estimate 3-D pore fluid pressure fields by mapping focal mechanism solutions (fault strike, dip angle, and slip angle) of seismicity on the 3-D Mohr diagram for a given tectonic stress field (Terakawa et al., 2010). Validity and applicability of the method are demonstrated by analyzing seismicity induced by fluid injection experiments (where the history of fluid pressures is known) in the Basel Enhanced Geothermal System, Switzerland (Terakawa et al., 2012; Terakawa 2014). On the other hand, in applications of the method to natural earthquakes there was no way to validate results of pore fluid pressures (Terakawa et al., 2010; Terakawa et al., 2013).
In this study we reevaluated the 3-D pore fluid pressure field in the frank of Mt. Ontake in Terakawa et al. (2013). The previous study applied the FMT method to microseismic activity around Mt. Ontake, and estimated overpressureized fluid reservoirs with a peak of 100-150 MPa (with estimation errors of 20 MPa) at depths between 5 and 12 km in the southeast and east franks of the mountain, assuming a tectonic stress field with 10-20 km resolution inferred from events with M > 3 (Terakawa and Matsu’ ura, 2010). In this study we analyzed the same data set as that in Terakawa et al. (2013), assuming a regional stress field with 5 km resolution inferred from smaller events with M > 1 (Terakawa et al., 2016). The pore pressure field obtained in this study is consistent with the former one in the north frank of Mt. Ontake, but discrepancy is large in the southeast and east franks. The peak pore fluid pressure in this study is by > 30 MPa smaller than the former one. In the southeast and east franks difference of the two stress pattens assumed in the two analyses is the largest, although in the two stress patterns the maximum compressive principal stress axes are commonly in the direction of the northwest-southeast. The estimation errors in pore fluid pressures are attributed to both accuracy of the stress pattern and focal mechanism solutions. The level of the pore fluid pressures in the previous study may be overestimated. We reconsider the estimation errors of the stress patterns, and estimate appropriate pore pressure triggering swarm activity.

Keywords: pore fluid pressures, earthquake, stress field

