Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SVC45-14 Room:304 Time:May 28 12:00-12:15

Temporal changes in earthquake focal mechanism solutions following the 2014 eruption of the Mt. Ontake volcano

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On 27th September in 2014, the Mt. Ontake volcano caused phreatic eruption after an interval of 7 years. In order to understand physical processes associated with the phreatic eruption of the Mt. Ontake volcano, we investigated relationship between the tectonic field and focal mechanism solutions of VT microseismicity in the Ontake region.

We applied a method of stress inversion, termed the CMT data inversion method (Terakawa & Matsu'ura, 2008), to 550 focal mechanism solutions of seismic events (M >1), and estimates the tectonic stress field in the Ontake region. The stress pattern was characterized by strike-slip faulting with the maximum principal stress axis in the direction of WNW-ESE. On the other hand, we estimated focal mechanism solutions of about 70 VT events below the craters during September 2014 to January 2015 using S/P amplitude ratios as well as polarities of P wave first motion (Hardebeck & Shearer, 2003). We found that events before the eruption were mainly normal faulting with east-west tension, while those after the eruption were reverse faulting with east-west or north-sourth compression. The hypocentral depths became <1 km shallower after the eruption, but the epicentral locations were almost the same.

To measure cocnsistency of focal mechanism solutions with the regional stress pattern, we evaluated misfit angles between actual slip vectors and theoretical slip vectors expected from the regional stress pattern in the Ontake region, based on the idea that seismic slip occurs in the direction of the resolved shear traction acting on a pre-exsiting fault (Wallace, 1951; Bott, 1959). The events of reverse faulting after the eruption were well controlled by the regional stress field. They may be related with some physical processes of crustal contraction follwong the emission of vocanic products like debris, volcanic ashes and steam. However, the events of normal faulting before the eruption were inconcictent with the regional stress pattern, although these events may be linked with inflation of dike. This suggests that the local stress field at depths of 2-3 km below the craters would have temporally changed controlled by inflation, or that the stress field would be heterogenerous originated by vocanic processes. In any case, events of normal faulting just below the Mt. Ontake may show one of the signs of an increase in volcanic activity.

Keywords: volcano, eruption, VT earthquakes, focal mechanism, stress field