応力場の時間変化に基づく御嶽火山のモニタリング
Monitoring eruption activity using temporal stress changes at Mount Ontake volcano

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On 27 September 2014, around 11:52 a.m. JST, Mt. Ontake volcano produced a hydrothermal eruption with a VEI value of 2. We examined temporal changes in the local stress field at Mt. Ontake over a period of 17 months (August 2014 to December 2015) with the 2014 eruption from focal mechanism solutions of 168 volcano-tectonic (VT) events (Terakawa et al., in press). In general, the local stress field around volcanoes represents the superposition of the regional stress field caused by plate motion and stress perturbation related to volcanic activity. The regional stress field does not change over periods of weeks to months, and so temporal stress changes over such time periods are attributed to volcanic activity.
We defined the angular difference between the observed slip vectors and theoretical slip vectors expected from the regional stress field as the misfit angle, based on the concept that seismic slip occurs in the direction of the resolved shear traction acting on a pre-existing fault. The misfit angles larger than the estimation errors of the regional stress field and focal mechanism solutions (>65°) mean that the local stress field was deviated from the regional stress field due to enhanced volcanic activity. The average misfit angles remarkably exceeded the threshold value (65°) two weeks before the eruption, but immediately after the eruption the values showed a marked decrease. The pre-eruption seismicity was dominated by normal faulting with ENE-WSW tension, indicating that the volcanic activity caused strong tension for the pre-eruption period. On the other hand, many reverse faulting with ESE-WNW compression for the post-eruption period corresponded to shrinkage of the volcanic edifice, controlled by the regional stress field.
The stress perturbation for the pre-eruption period suggests existence of dyke-type volcanic system beneath Mt. Ontake in which inflation is driven by magmatic/hydrothermal fluids propagating upwards in a vertical crack. This is consistent with the distribution of hypocenters of volcanic earthquakes relocated by a DD method (Kato et al., 2015), the alignment of craters from the 2014 eruption (GSI, 2014), and source mechanisms of VLP events prior to the 2007 and 2014 eruptions (Nakamichi et al., 2009, Maeda et al., 2015).
The time history of average misfit angles showed slight enhancements in November 2014, January-February 2015, June-July 2015, and October-December 2015. Especially, the final stage of the enhancement in June-July 2015 was synchronized with an unusual tiltmeter signal indicating summit upheaval. These observations suggest that some re-pressurization/de-pressurization processes repeated after the 2014 eruption. Temporal stress changes revealed in this study were well associated with physical processes at the active volcano. This indicates that the method has potential to contribute to eruption monitoring.

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