Static and Quasistatic stress changes due to Tohoku megathrust earthquake: Effects on Japanese volcanoes

Eisuke Fujita[1], Tomofumi Kozono[1], Hideki Ueda[1], Yuhki Kohno[1], Shoichi Yoshioka[2], Norio Toda[3], Aiko Kikuchi[3], Yoshiaki Ida[3]

[1]National Research Institute for Earth science and Disaster prevention, Japan, [2]Kobe University, Japan, [3]Advance Soft Corporation, Japan

E-mail: fujita@bosai.go.jp

An enormous crustal deformation due to the Mw9.0 megathurst Tohoku earthquake on Mar. 11, 2011, gave much perturbation on the regional tectonics and we have to pay attention to seismicity and volcanic activity. Volcanic eruption triggered by >M8 earthquakes have been widely reported in the world, and we have to estimate the eruption potential from the view of volcanic hazard mitigation. Shortly after the megathrust earthquake, i.e. within about three months, 20 volcanoes in Japan suggested abnormal seismicity, however, we have no eruptions by January, 2013 (about 22 months).

In this paper, we evaluate static and quasistatic stress change due to the enormous crustal deformation, affected on the magma plumbing system beneath Japanese volcanoes. FEM modeling is applied both for static and quasistatic responses. Both Japanese mainland and target volcanic region are modeled by seismic tomography result, and the topographic effect is also included. For example, static differential stress given to Mount Fuji magma reservoir, which is assumed to be located to be in the hypocentral area of deep long period earthquakes at the depth of 15 km, is estimated to be the order of about 0.001-0.01 and 0.1-1 MPa at the boundary region between magma reservoir and surrounding medium. This pressure change is about 0.2 percent of the lithostatic pressure (367.5 MPa at 15 km depth), but is enough to trigger an eruptions in case the magma is ready to erupt. Quasistatic stress is calculated based on the linear Maxwell model, and for the fault and boundary node, we applied MPC (multi-point-constraint) method instead of Split node method for static stress calculation. Our calculation suggests that the stress field around eastern mainland of Japan reduces to about 78 percent in 100 years, on the other hand, the stress is concentrated at the boundary of magma system and surrounding rock about 7 percent in 100 years. Quantitative estimation of stress changes around magma plumbing system may give information on eruptive potential triggered by earthquakes.