Pressure source inferred from long-term volcanic deformation observed by GPS in Izu-Oshima

Tetsuya Yamamoto, Shin'ya Onizawa, Akimichi Takagi

Meteorological Research Institute, Japan Meteorological Agency, Japan

E-mail: tyamamot@mri-jma.go.jp

In Izu-Oshima, one of the most active volcanoes in Japan, GPS observation has been conducted since 1990s to detect volcanic deformation, and the data shows a continuous inflation of the volcano edifice indicating magma accumulation. Onizawa el al. (2012) investigated the long-term deformation by the GPS displacement data and analyzed the inflation using a spherical pressure source in a homogeneous semi-infinite earth, namely the Mogi model. Here we carried out further analysis using the finite element method (FEM).

Based on the result of Onizawa et al., the horizontal components of the observed displacements were found almost similar to the values expected by the Mogi model which pressure source was located beneath the northern part of the summit caldera at 6.7km depth. For vertical component, however, the observed and extected values were different in a part. The vertical displacement (uplift) by the Mogi model was estimated to be largest just above the pressure source, though the observed uplift at a corresponding location was smaller than the surrounding area.

In order to investigate this difference, we carried out further analysis by the FEM considering the topography of the volcano, the underground structure and a pressure source of not simple shape; all those were not accounted in the Mogi model. In the finite element models a prolate spheroidal source elongated vertically was utilized, assuming axisymmetric underground structure and topography. The models were characterized by two source parameters, the aspect ratio of the spheroid and the depth of the source. Searching in the parameter space, we found that the displacement expected by the FEM was most similar to the observed one when the source depth was about 4km and the aspect ratio was larger than 3. The observed feature of the uplift was realized by this model as well. Compared with the case of the Mogi model, the source depth was shallow significantly and the change of source volume was only about a half. It shows such analysis by the FEM is useful for a precise investigation of a magma plumbing system of the volcano.