Various volcanic crustal deformations in recent years - For the evaluation of activity at inexperienced volcanoes of unrests

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Japan Meteorological Agency (JMA) started the announcement of Volcanic Alert Levels for major active volcanoes and Volcanic warnings / forecasts for every volcanoes in December 2007. Technical basis of this work of JMA is evaluation of volcanic activity, which conforms to the volcanic activity scenario made referring to the history and the characteristics of each volcano. However, there is less geophysical information on the past activity for each volcano and it is insufficient to evaluate the activity only with the experience rule from the past eruptive history. Of course, there is wide variety in the magma property, the magma supply system and the structure of the volcano, therefore, it is difficult to interpret them unitedly. But collecting and arranging similar volcano phenomena may be helpful for evaluation of abnormal phenomena at inexperienced volcanoes of unrests.

In Japan, volcanic ground deformations have been observed at more than 10 volcanoes with recent geodetic observation. These have been detected by GPS observation networks and others of JMA and/or research organizations, and various models have been proposed for them. In this research, we classified the scale, the temporal change, the depth, and the shape of them using the recent research results for Japanese volcanoes.

There is wide variety in the volumetric changes estimated from geodetic observation; from large amount magma intrusion of 10^9 m^3 as Niijima-Kozu region (Yamaoka *et al*., 2005) to very small inflation of less than 10^4 m^3 at Adatara (Yamamoto *et al*., 2008). Dyke-shaped models have been proposed for most of large volume changes, on the other hand, spherical pressure sources have been proposed for small volume change.

Volume change rate varies in 10-10^9 m^3/day. Most of the ground deformations with large volume change rate are considered to be from magma intrusion and volcanic eruptions took place in most of cases of intrusion at shallow part. On the other hand, slow ground deformation is classified into two types; magma accumulation at the deeper part and geothermal activity at the shallower part of the volcano. The former type of ground deformation has be followed by no immediate volcanic eruptions but the latter has be followed by phreatic eruptions or some other visual thermal phenomena at the surface. The two types of volume changes are sometimes observed simultaneously.

The volume change rate is correlative with the seismic activity around the source. Magma intrusion of more than 10^6 m^3/day is accompanied with vigorous seismic swarm, therefore, such events must be detected by seismological network around Japan but small inflation of less than 10^5 m^3/day is accompanied with no such seismic swarm. Especially, very small shallow inflation of 10-10^4 m^3/day from geothermal activity, which might be followed by small phreatic eruption, cannot be detected also with seismic network close to the volcano in some cases. It indicates that not only seismic but also geodetic observation near the active crater are important for volcano surveillance.