Volcanic deformation caused by gas bubbles rising in the magma chamber: Application to periodic deformation at Izu-Oshima volcano

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Recent geodetic observation networks were succeeded in detecting volcanic deformations with high time-resolution in active volcano. These data can be used for understanding the volcanic activities. In this study, we present the temporal changes of volume increase of magma chamber due to gas bubble rising and try to apply it to volcanic deformation at Izu-Oshima volcano.
In a magma chamber, small gas bubbles rise due to their buoyance force. As the gas bubbles rise, the gas bubbles expand due to pressure difference between gas bubbles and surrounding melt. As the expansion of gas bubbles, the volume of magma increases. The amount of volume increase of magma chamber is depended on the ratio of bulk modulus of melt and rigidity of surrounding elastic medium. The gas bubbles rise in the magma with a velocity proportional to the square of the gas bubble radius. We calculate the temporal changes of the volume changes of magma chamber, assuming the initial condition that the gas bubbles homogeneously distributed in the magma. The results show that the volume of magma chamber increases with constant rate, at first. Then the rate of volume change gradually decrease with time.
We compare these results and volcanic deformation detected by GNSS observation network at Izu-Oshima volcano. The pressure source of this deformation was estimated at a depth of 4-5 km below sea level and the amount of volume increase of 10^6 m^3. Considering the gas bubble radius of 2×10^{-4} and the number density of gas bubbles of 10^8 m^{-3}, the amount of volume changes and time scale of volcanic deformation observed at Izu-Oshima volcano was expressed.

Keywords: volcanic deformation, Izu-Oshima, gas bubble

