# Precursory deformation of the 2017 Shinmoe-dake volcano detected by PALSAR-2 and Sentinel-1 data

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Inflation at active volcanoes is driven by overpressure due to supply of magma or hydrothermal volcanic fluid from depths, heating or others phenomena related to volcanic activities. Ground deformation at volcanoes is often a precursor to eruptions, as well as an increase in volcanic gas emissions, earthquakes, and ground temperature. Several previous studies have reported precursory deformations of eruptions of Shinmoe-dake volcano. In this study, we investigate spatio-temporal characteristics of deformation preceding the eruption in 2017 using satellite SAR data, and discuss the geometry of pressure source and the precursory processes.
We analyzed ALOS-2/PALSAR-2 data acquired in 2016–2017 and Sentinel-1 data in 2017, and applied multi-temporal InSAR analysis to extract spatio-temporal characteristics of precursory deformation. The results of the SAR processing showed line-of-sight (LOS) shortening at the volcanic flank, implying inflation, and LOS lengthening at the crater, suggesting contraction. The LOS shortening was mainly distributed at the near-range side of the volcanic flank. The magnitude of LOS shortening at the flank and LOS lengthening at the crater began to increase in May–June 2017, and became greater toward the eruption that occurred on 11 October.
We also modeled the geometry of pressure source driving the detected precursory deformations using analytical solutions of surface deformation caused by outward displacements of an open pipe and overpressure of a closed pipe. The outward displacement of an open pipe is expected to induce both contraction above the pipe and expansion on the side of the pipe, which are similar to the spatial characteristics of the detected precursory deformation. The best-fit geometry was that the top depth of the open pipe was 1152m above sea level, and its length was ~530m, that is, with most of the source distributed above the sea level. The geometry of the open pipe successfully reproduced both the inflation at the flank and the contraction at the crater, while overpressure of the close pipe could not reproduce the contraction at the crater. However, the best-fit model also estimated the outward displacement of the open pipe to be between 5.5–7.3 m, assuming a conduit radius of 4.5–6.0 m which was inferred from the flux rate of tephra of the 2011 eruption (Sato et al., 2013). The estimated value would be implausible and implies the limitation of modeling under the assumption of elastic behavior.

Keywords: Satellite SAR, Shinmoe-dake volcano, Ground deformation, Precursory process

 