Two dimensional analysis on slope slide of Unzen lava dome using space-borne InSAR

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Introduction

Lava dome complex of Mt Unzen was formed during 1990-1995 eruption and sitting on thick deposit of soft pyroclastic flow unstably distributed on a steep slope. The risk of a sudden collapse of the dome complex is of a great concern of local government and inhabitants. A continuous plastic deformation of Heisei Shinzan (Heisei New Dome) has been detected by the GPS observation since early 1990's (e.g., Takagi, 2002). In addition, the ground-based EDM and GBSAR observations which are being carried out by the Ministry of Land, Infrastructure and Transport also confirm the quasi-constant downward sliding of No. 11 dome with an annual speed of about 10cm. However, a spatial coverage of ground based observation is so limited, that the detailed spatial distribution of the displacements and accordingly the mechanisms of deformation and sliding remain unknown. Those uncertainties make the accurate prediction on scale and the spatial range of the hazard when collapse occurs difficult.
On the other hand, the interferometric analysis of space-borne SAR (Satellite InSAR) enables us to map the spatial displacement field of ground surface deformation of any type of origin, which is sometimes difficult to be depicted if one only uses data derived by ground based observations. This study aims to visualize deformations field and its temporal evolution of lava dome complex on Mt. Unzen since 2006 up to the present time making the most of AlOS/Palsar and ALOS2/Palsar2. It will be a good start for a numerical modelling of dome deformation which will contribute to the improvements of hazard estimation for the disaster mitigation planning.

2. Analysis of PalSAR and PalSAR2 data

We analyzed multiple combinations of pairs of ALOS/PALSAR and ALOS2/PALSAR2 data and acquired the following results.

(1) Spatial patterns of the sliding of the dome complex
The displacement field mapped by InSAR clearly shows that it is comprised of at least two deformation units. The western unit overlaps Heisei New dome and its deformation is dominated by subsidence. This is congruent with a result of Takagi et al. (2002). On the other hand, the center of the activity unit of the eastern unit almost overlaps with the 11th robe, and it is likely that the movement is slope sliding to the largest direction of tilt of the topography. However, a change domain is distributed in the surrounding area of the 11th robe. The displacement velocity decays toward the outskirts. Those characteristics suggest that a simple blocky slide without internal deformation of robe is unlikely as the mechanism of movement. Probably a viscous flow of a combination of lava robe and pyroclastic deposit might play a key role in the mechanism.

(2) The influence caused by the 2016 Kumamoto earthquake:
A comparison between two pairs of the same orbit of PALSAR2 with and without 2016 Kumamoto earthquake revealed that there was no co-seismic triggered by the strong vibration of the Kumamoto

earthquake. On the other hand, a comparison between PalSAR2 pairs spanning about a year before and after the quake indicated that the post seismic velocity increased in an area of near 11th dome. At the time of writing, only one pair of PalSAR2 is available for the post seismic period; further confirmation should be made using additional PalSAR2 data.

(2) mid- and long-term behavior of slope sliding of Unzen dome (2006-2016) using PalSAR data

PalSAR is a second generation L-band sensor which was operational during 2006 to 2011. Combining those data with PalSAR2 data we can understand a long-term behavior of slope sliding of Unzen dome complex. Preliminary time series analysis of those data indicates that the deformation velocity is almost constant. However, the possibility of the change of the spatial pattern of the deformation field remains as an open question. In the talk, results of time series and attempts for a simplified numerical modelling of sliding mechanisms will be presented.

Keywords: Volcano, Collapse of Lava Dome, Remote Sensing, SAR, InSAR, Unzen

