InSAR analysis for detecting surface displacement around Owakudani in the Hakone volcano, Japan

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Earthquake swarm activity in the Hakone volcano, which is located in the western part of Kanagawa Prefecture, Japan, has been observed every few years. Based on the observation of earthquakes and crustal deformation at the volcano, it is considered that the swarm activity is caused by hydrothermal activity in the shallow part of Hakone volcano (Daita et al., 2009; Yukutake et al., 2011). In the 2015 event, abnormal fumarolic was observed at the hot spring supply facility in Owakudani in early May. A local swelling was found around the hot spring supply facility, where abnormal fumarolic was found, by InSAR analysis of the data of ALOS-2/PALSAR-2. It is thought that the local swelling was caused by the hydrothermal water or volcanic gas in the very shallow part, directly underneath Owakudani, and it is presumed that it is closely related to the fumarolic activity in Owakudani.
This study aims to clarify the mechanism of fumarolic activity and steam eruption at the Hakone volcano, by detecting the surface displacement caused by hydrothermal activity in the shallow part of the volcano. In this study, an InSAR time series analysis of ALOS/PALSAR data was performed. As a result, in Owakudani, local subsidence was detected at about 400-500 m west of the area where the local swelling was observed in the 2015 activity. Additionally, to clarify the displacement around Owakudani after the 2015 steam eruption, InSAR analysis of ALOS-2 / PALSAR-2 data was performed.

Result of InSAR time series analysis of ALOS/PALSAR data

InSAR time series analysis by the SBAS method (Beradino et al., 2002) was carried out for the data obtained by Ascending orbit (405-690) and Descending orbit (59-2910), respectively. Then, 2.5D analysis (Fujiwara et al., 2000) was carried out using the results in each orbit to obtain displacement velocities of quasi-EW and quasi-UD components. As a result, during the period from 2006 to 2011, it was observed that the range of about 500 to 600 m in diameter was locally subsided in the west of Owakudani. The subsidence rate was about 30 mm/yr at the peak position of the quasi-UD component. In the quasi-EW components, the ground surface had displaced towards the center of the subsided zone. Therefore, it is inferred that the ground surface is contracted toward the center of the subsided area. This contraction can be roughly explained by assuming a spherical pressure source that contracted at a rate of 1.04×10^{4} m^3/yr at an altitude of about 702 m (depth of about 300 m from the ground surface).

Result of DInSAR analysis of ALOS-2/PALSAR-2 data

The two pairs of ALOS-2/PALSAR-2 data, in which the observation intervals are about two years, were analyzed by the DInSAR method. The first pair is the data obtained from Ascending orbit (125-700 scene shift -4; 2015/11/8 - 2018/1/2), and the second is the data obtained from Descending orbit (18-2910; 2015/10/22 - 2017/12/14). Also, the displacements of quasi-EW and quasi-UD components were calculated by 2.5D analysis. As a result, remarkable subsided exceeding 120 mm at the maximum was observed around 2015 crater of Owakudani. These displacements are more significant in the steep slope from the Southwest to the South of the valley, and it is also accompanied by the movement of the quasi-EW components. Therefore, it is considered as displacements of landslides. Moreover, the range, including the subsided zone observed in the previous ALOS/PALSAR InSAR time series analysis, subsided as a whole, and its displacement is about 20 to 40 mm, except for the crater zone. Because the tendency of this displacement is the same trend as the vertical displacement by leveling (Murase et al. this

conference), the analysis result can be judged to be valid.

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