Surface deformation of Ayaz-Akhtarma mud volcano in Azerbaijan detected by ALOS/ALOS-2 InSAR and its source modeling

飯尾 研人[1]、*古屋 正人[1]
Kento Iio[1], *Masato Furuya[1]

1. 北海道大学大学院理学院
1. Hokkaido Univ.

Interferometric synthetic aperture radar (InSAR) allows us to image a wide area with dense spatial resolution without a need for ground-based measurement tools with a precision on the order of a few centimeters. This technique has been mainly used to investigate such ground deformation associated with earthquakes, volcanic eruptions and ground subsidence due to water pumping. However there have been relatively fewer studies that applied the technique to the activity of mud volcanos.

Azerbaijan, located on the western edge of the Caspian Sea in Central Asia, is one of the most abundant countries in term of the population of mud volcanoes over the land. Antonielli et al., (2014) detected the ground deformation of Ayaz-Akhtarma mud volcano, using ENVISAT/ASAR C-band SAR data spanning from 2003 to 2005 along only descending path. While the ground displacement at the volcano was 20 cm in line of sight (LOS) for the two years, Antonielli et al., (2014) interpreted the observed LOS changes to the uplift and subsidence in the eastern half and western half, respectively, whereas no source model was presented in the study.
We used the satellite-based synthetic aperture radar (SAR) images derived from two L-band satellite, ALOS/PALSAR along the ascending track from 2006 to 2011 and its follow on ALOS-2/PALSAR-2 along the both ascending and descending tracks from 2014 to 2017. First, we apply InSAR technique to detect the surface displacements at the Ayaz-Akhtarma mud volcano in Azerbaijan. We could obtain 35 interferograms, which suggest that the on-going deformation at Ayaz-Akhtarma mud volcano mostly consists of horizontal displacements. Beside the InSAR technique, we also apply multiple aperture interferometry (MAI) to derive the surface displacements that are parallel to the satellite flight direction and to complement the InSAR data. The MAI data allow us to acquire more complete deformation image that we cannot derive by InSAR data alone. The observed MAI data show large displacements toward the opposite direction to the satellite flight direction. Using the InSAR and MAI measurements data, we obtain the 3D displacements that indicate horizontal displacements are dominant accompanied with smaller subsidence and uplift. To explain the InSAR and MAI displacements, we performed a source modeling, assuming an elastic half space. The modeling suggests that the surface deformation is caused by mud and other materials intrude onto a sill source accompanied with fault slip.

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