3-D deformation mapping by exploiting ALOS-2 InSAR from four different viewing directions -case of Sakurajima volcanic activity in 2015 -

*Yu Morishita[1], Tomokazu Kobayashi[1], Hiroshi Yarai[1]

1.GSI of Japan

InSAR can measure surface displacement with high spatial resolution and precision, and has contributed to estimating underground crustal deformation caused by earthquakes and volcanic activities which is difficult to observe directly. One of the limitations of InSAR is its one dimensional measurement capability, i.e., change of distance between the satellite and the ground. Whereas three dimensional (3-D) displacement can be retrieved from multiple InSAR measurements acquired from three or more different viewing directions, it had been unlikely to occur because almost all of satellite SAR acquisitions were right-looking. Although combination with a pixel offset method or multiple aperture interferometry (MAI), which provide displacement along azimuth direction, has been applied to resolve 3-D deformation, it would sacrifice of an inherent capability of InSAR because spatial resolution and precision of a pixel offset method and MAI are lower than that of InSAR.
In Sakurajima, a lot of volcanic earthquakes occurred and extensive deformation was detected by tiltmeters, extensometers and continuous GNSS observations on 15 August 2015. In order to measure the deformation caused by the volcanic activity, emergency observations have been conducted by ALOS-2 shortly afterward. The observations were not only right-looking but also left-looking, resulting in InSAR results from four different viewing directions (i.e., ascending/descending and right-/left-looking) in just nine days.
We estimated 3-D deformation caused by the volcanic activity in Sakurajima and its errors using four interferograms acquired from different viewing geometry. Horizontal expansive displacement of 15 cm at maximum with northeast-southwest direction around Showa crater and uplift of 12 cm at maximum around southeast of Showa crater were detected. The estimated errors of east-west (EW), north-south (NS) and up-down (UD) components are 0.8, 3.4, and 0.7 cm, respectively. The reason why the error of the NS component is larger than that of the other components is that the satellite has a polar orbit. Still, the error is much smaller than the displacement, hence the detected displacement is significant. The RMS errors of EW, NS and UD components between the 3-D deformation and GNSS observations at seven stations installed in Sakurajima are 1.2, 1.6 and 0.7 cm, respectively, which means the 3-D deformation and the GNSS observations are consistent taking into account the error of 3-D deformation.
We also tried to utilize azimuth displacement derived from MAI. However, its precision is much lower than that of InSAR and the estimated 3-D deformation is hardly improved by the MAI result.

Keywords: ALOS-2, InSAR, 3-D deformation, Dike intrusion, Sakurajima

