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Surface deformation in the Shinmoe-dake crater detected by Pi-SAR-L2/InSAR

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Shinmoe-dake in the Kirishima volcano group erupted in January 2011. Ozawa and Kozono (2013) analyzed spaceborne SAR images and revealed that lava extruded to the crater with constant rate of 88.7mˆ3/sec during January 29 and 31; it was after three sub-Plinian eruptions. After that, eruption type changed to Vulcanian eruptions, and frequency of eruption occurrence decreased with time. Since last eruption of September 2011, eruption has not occurred. However, Miyagi et al. (2014) carried out InSAR analysis with RADARSAT-2 and TerraSAR-X and revealed that lava extrusion had continued. Although lava extrusion rate tended to decrease with time, extrusion rate of 50-100mˆ3/day was estimated in May 2013.

In this study, we attempt to apply InSAR analysis with JAXA's airborne SAR data (sensor name: Pi-SAR-L2). SAR data used in this study were observed on 13 Sep. 2013 and 7 Aug. 2014 from three flight paths. In the simulation of topographic fringes, we used digital terrain model which was generated by SBAS analysis with RADARSAT-2 acquired after the last eruption. Large non-deformation component remained in differential SAR interferogram. Then we confined analysis area to 1km x 1km around the crater and removed its component so that phase difference outside of the crater became negligible, assuming its component to be a plane. Obtained results show slant-range shortening in the crater, and its area is almost the same with results from spaceborne InSAR. Since slant-range changes from three flight paths were obtained, we estimated three-dimensional displacement map from them. Uplift exceeding 20cm was found. On the other hand, horizontal displacement with radial direction was found surrounding uplift area, but its amount was less than 3cm in most area. It suggests that viscosity of extruded lava is high and that fluidity to horizontal direction was low.

The lava extrusion volume during 13 Sep. 2013 and 7 Aug. 2014 was estimated to 10044mˆ3 from obtained uplift map. On the other hand, spaceborne SAR images up to 14 Apr. 2014 were available, and the lava extrusion volume during 13 Sep. 2013 and 16 Apr. 2014 was estimated to 7507-7704 mˆ3 from InSAR analysis using them. Then the lava extrusion volume during 16 Apr. 2014 and 13 Sep. 2013 was estimated to 2340-2537 mˆ3. Huppert and Woods (2002) indicated the model for temporal change of lava extrusion in the case that shallow magma chamber with overpressure exists. We fitted extrusion rates from spaceborne InSAR analysis to the model in the case that magma is injected to shallow magma chamber from deep source, and the lava extrusion volume of 2339 mˆ3 during 16 Apr. 2014 and 13 Sep. 2013 was estimated, corresponding to that from observed one. Miyagi et al. (2014) suggested continuous magma supply to shallow magma chamber from spaceborne InSAR analysis by May 2013, and result in this study suggests that such magma supply decreased.

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Keywords: airborne SAR, InSAR, Shinmoe-dake, crater, lava, deformation