Spatial variation of inter-eruption caldera subsidence on Miyakejima volcano based on PALSAR multi-temporal InSAR data

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Miyakejima volcano is one of the active basaltic-andesitic volcanos in the Izu-Bonin arc, Japan. A caldera was formed on the summit of Miyakejima volcano during an eruption in 2000, which was the most recent explosive eruption. The caldera formation was driven by underpressure in a magma chamber and the collapse of a cylindrical structure caused by magma withdrawal associated with a dike intrusion prior to the 2000 phreatomagmatic eruption at the summit. Previous geological surveys have categorized the Miyakejima caldera as funnel-type and suggested that the caldera evolution is mainly driven by gravity. Recent satellite SAR observations have indicated a rapid deceleration of the caldera subsidence in mid-2009 based on SAR time-series analysis of PALSAR data acquired during 2006-2011 (Ozawa and Ueda, 2011). However, few spatiotemporal variations in seismicity on Miyakejima volcano or few significant variations in the GNSS baseline change rate were identified in the period. While the previous study proposed a flat elongated source in the northeast-southwest direction to reproduce the crustal deformations near the summit excluding the caldera, the physical interpretation of the rapid termination of the caldera subsidence is still poorly understood. We expect that examining the time-series of crustal deformation on the Miyakejima caldera would contribute to understanding the spatiotemporal caldera evolution during inter-eruption periods.

In this study, we applied conventional multi-temporal InSAR (MTI) analysis to PALSAR/PALSAR-2 data to investigate the time-series of crustal deformation on Miyakejima volcano during the periods of 2006-2011 and 2014-2019. The PALSAR/PALSAR-2 MTI data suggested that the location of the maximum subsidence moved from the central part to the southernmost part of the caldera in mid-2009, that is, the spatial characteristics of caldera subsidence varied from the concentric patten (funnel-like) to the north-south asymmetric subsidence with a hinge at the northernmost caldera (trapdoor-like). The central caldera was the location of the initiation of the caldera collapse associated with the 2000 episode, and active fumaroles with volcanic gas and steam emission are located at the southernmost caldera. We also confirmed that the line-of-sight change rate at the central caldera decelerate in mid-2009 as the previous study showed. Therefore, the deceleration of caldera subsidence proposed by Ozawa and Ueda (2011) can be interpreted as portion of the spatial variation of the caldera subsidence. Although the north-south asymmetric subsidence can be related to volcanic fluids, such as heated groundwater at the ambient aquifer, we have no way to explain the spatial variation in the caldera subsidence. We also found SAR image distortions (foreshortening or layover) of the caldera wall caused by the observation geometry of SAR image acquisition, however, the spatial variation of caldera subsidence is plausible because the spatial feature of caldera subsidence varied for the north-south direction, and the PALSAR/PALSAR-2 images were distorted for the east-west direction.

Keywords: InSAR, Miyakejima volcano, Caldera collapse

