Detection of crater floor change by a radar shadow analysis of satellite SAR: Validation in a collapsed caldera at Miyake-jima

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Upheaval of a crater floor is important indicator of volcanic activity. However, monitoring of inside of a crater by a visible band is difficult in a high volcanic activity period emitting intensive fumaroles. Synthetic aperture radar (SAR) using microwave has an advantage in observing craters covered by fumaroles, because microwave penetrates them. In previous study (Ozawa et al., 2004), we proposed new simple method for detecting crater floor change by using a radar shadow with a successful case study targeting the 2004 Asama-yama eruption. Especially, we found that the crater floor had risen by about 2400 m from RADARSAT SAR image observed on 1 Oct. 2004. To evaluate its significance, we compared obtained height profiles of two pairs of profiles in periods when the change was negligible, and its repeatability was about 5m corresponding to a size of SAR pixel. However such method cannot evaluate absolute accuracy, and obtained repeatability may show only a reading precision of locations of a radar-shadow. Therefore, it is necessary to use SAR image and DEM observed in near time for more exact evaluation. Then we tried to apply a radar-shadow analysis to a collapsed caldera at Miyake-jima, and to compare obtained crater floor heights with DEM published by Geographical Survey Institute (Hasegawa et al., 2001). In this analysis, RADARSAT SAR image acquired on 12 Oct. 2000 and DEM (5m mesh) generated from airborne SAR observation conducted on 28 Sep. 2000 were used. Thus SAR and DEM observation dates separated about 2 weeks, however, the effect of a caldera collapse can be negligible, because configurations of radar shadows on SAR images observed on September 18 and November 5 were similar to that observed on October 12. Although spatial resolution of DEM need to be sufficiently higher than that of SAR image, that of SAR and DEM are approximately 5m. Therefore the spatial resolution of SAR image was reduced to approximately 10 m by two looking in range and azimuth directions. Comparison between obtained and DEM heights gives a standard deviation of 8m and a bias of -11m, corresponding of a size of 1-2 pixels. In the application to Asama-yama volcano, more accurate DEM (1m mesh) generated from a laser scanner observation conducted by Tone-Sabo office was used, and therefore, it is expected that higher accuracy have been obtained. Considering this result, the accuracy in the application to the Asama-yama must have been at least 2 pixels (about 7m).