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Estimation of thickness of volcanic ash falls using In-SAR Analysis

Takeshi Matsushima[1*], Atsushi Watanabe[2], Takao Tabei[3], Jun Oikawa[2]

[1]SEVO, Kyushu University, [2]ERI, University of Tokyo, [3]Kochi University

It is important to estimate volume of volcanic ash falls around active volcano in order to speculate activities of the volcano. However, it is very impracticable to measure thickness of the ash by a field survey during a large eruption. If we can estimate the volume using remote sensing technique, it should be very powerful tool to scientific and disaster prevention researches. We successfully find out the thickness of volcanic ash fall and erosion of ash surface using interferometric synthetic-aperture radar (In-SAR) analysis of Japanese advanced land observing satellite (ALOS) PALSAR data.

Anatahan volcano is one of active volcanoes in the northern Mariana island arc, a part of the Ring of Fire around the Pacific Ocean. Science eruptions started in May 2003, we have observed Anatahan volcano using GPS, tilt meter, and seismometer. And a field survey to sample tephra deposits was carried out for several times. Science 2007 we execute In-SAR analysis of ALOS/ PALSAR data of Anatahan volcano. As the result of our GPS survey, we found the west part of the island of the Anatanan volcano subsided as 2.5cm/yr due to depression of a magma chamber, which was estimated to be at depths 10km to 15km of west off of the island. There is no obvious uplifting crustal deformation detected after the eruption started. However, the result of the In-SAR analysis shows much larger surface uplift and subsidence than movement estimated from GPS survey during same observation period.

Anatahan volcano is very active during the period of December 2007 and March 2008, and many phreatomagmatic eruptions were continued. The ash deposit has a thickness of more than 2 m around the active creator. The interferogram formed from PALSAR images acquired in December 2007, and May 2008 shows incoherent area in around the active creator and spreading toward SW direction from the creator. The NE wind is predominant in Anatanan during winter season. The thick ash fall deposit had changed ground surface totally enough to make the interferogram incoherent. Also, if ash mounded as volcanic base surge deposit, moving laterally across uneven surface, depressed ground would be filled by ash, and it makes the incoherent area in the interferogram. While the thin ash fall accumulated parallel to old ground surface, and acts like surface uplift in the interferogram. We visited uplifted sites in the interferogram, and measured thicknesses of ash fall from the old surface. The thickness up to 20cm corresponded to value of uplift in the interferogram very well. In other word, ash fall of more than 20 cm thick may change surface geometry so much that we could not get thickness of the ash fall using the In-SRA analysis.

Interferogram acquired in May 2008 and August 2009 shows subsidence of several centimeter in the central and east part of the island where thick ash deposit since eruption started. This phenomenon was thought as compression of ash layer and surface-erosion of ash fall deposit. Generally, ash fall deposit was multi layered with hard and soft deposit. The soft layer tended to erode easily, and reduced height of surface similarly to old surface. This subsidence is detected by In-SAR analysis, also this result supported by our temporal observation of ash deposit change.

Finally using In-SAR analysis, we could detect thickness ash fall deposit up to 20cm, and surface erosion of ash fall layer in Anatahan volcano. These results were supported by our temporal observation about thickness change of ash deposit.

Keywords: In-SAR, volcanic ash falls, surface erosion, Anatahan volcano, ALOS/PALSAR