Stability assessment of Unzen lava dome by long and short range displacement monitoring

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The eruptions of Unzen volcano occurred in 1990, leading to the recurrent formation and collapse of lava dome that almost ceased by 1996. Although these hazardous failures of the dome have ceased, the large remaining lava dome(100 million cubic m) that exist along the steep slope, pose threat to the public. Hence, Unzen Restoration Work Office (Ministry of Land, Infrastructure, Transport and Tourism) has been monitoring the lava dome, by surveillance cameras, vibration sensors, and electronic distance measurements (EDMs), in order to ensure the safety of the public. This presentation mainly reports the recent results of monitoring the movements of the lava dome.

One of the ongoing main monitoring methods for detecting the movements of lava dome is the automatic long distance EDM of the eight reflecting prisms placed at near the end of the dome. The results, obtained with the two EDM stations at 3 km and 3.5 km from the dome, suggest that the eight prisms are continuously moving at a rate of 50 mm to 100 mm per year. The vertical component of the displacement, however, is not clear due to limitation with the accuracy in measuring the change in elevation of the eight prisms. On the other hand, the manual short range EDM, performed at a distance of approximately 500 m from the end of the dome, was able to measure the vertical displacement component and indicated that the dome may be moving downward at an angle close to that of the original slope surface before eruption.

While the results of automatic EDM provide valuable data in help revealing the mechanisms of the movements of the lava dome, the noise due to climatic variation is relatively large such that it is difficult to examine whether the increase in the displacements are associated with the rainfalls or earthquakes. Moreover, the measured displacements are limited to those obtained by the eight prism points on the large lava dome and therefore it is not clear whether the whole lava dome is deforming or there are areas more active than other areas.

Recently, ground based synthetic aperture radar has become available for monitoring of landslides. This radar has been scanning the lava dome of Unzen volcano at distance of approximately 3.5 km since October 2011. The scanned area of roughly 800 m by 400 m is resolved into 20,000-30,000 pixels, allowing coverage of wide areas that cannot be measured with EDM. The displacement maps, corresponding to 1 year of measurement, show that there are areas with larger movements than the other areas. It was also found that the variation in the GBSAR, due to the climatic effects, is smaller than that of the EDM and permits detection of change the displacement velocities, which were not easily performed with the EDM. Thus, GBSAR is expected to be a viable method to assess the deformation mechanisms of the lava dome in more detail and also to detect precursor of instability for early warning purpose.