Locally distributed crustal deformation in potential areas of phreatic eruptions detected by InSAR analyses

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Phreatic eruptions may be related to transient pressure changes in subsurface regions of hydrothermal systems attributing a heating of shallow aquifers from magma. It means that crustal deformation presumably proceeds with the pressure increase under the ground, which can be a kind of precursor if it would be detected. One of the most difficult points is that as the eruption size becomes smaller, the precursor signal should be more local, suggesting that it is rather hard to identify the anomaly using conventional ground-based observation tools. An effective proactive monitoring method for phreatic eruptions is desired, and one of the tools to overcome the drawbacks is SAR observation.

Hakone Owaku-dani: Inflational signal has been detected in a local area with a diameter of ~200 m by InSAR analysis, associated with the volcanic activity that started from the end of April, 2015. The distribution of the crustal deformation has a concentric pattern at the initial stage, but the location of the maximum displacement shifted southwestward although the spatial size has not changed. The small eruption occurred in the end of June at the location where the largest displacement was observed. The most important point for this event is that locally distributed crustal deformation has been successfully detected prior to the eruption, and the eruption did occur at the anomalous area. In Hakone volcano, there has been several remarkable volcanic activities since 2001. In this context, it is vital to investigate the crustal deformation at these activities to better understand the relationship between an eruption and such local deformation. Applying InSAR analysis to ALOS data for the 2008 activity, no significant signal can be identified in the Owaku-dani area. In 2001 and 2015, fumarole activities has increased outstandingly, while no significant anomaly of fumarolic activity can be identified in other activities. It is probably suggested that pressure increase associated with heat supply from the depth has not proceeded in the subsurface in the 2008 activity. I will report InSAR analysis results for other past activities.

Tateyama Midagahara (Jigoku-dani): Jigoku-dani area is known as an active geothermal area with fumarole and boiling water activity. In the past few years, geothermal activity on the ground has become more visibe with burning and flow out of sulfur in 2010 and increased temperatures of fumarole. Applying InSAR time series analysis to ALOS data, I detected locally distributed inflational deformation in the Jigoku-dani geothermal area. The deformation speed is estimated to be at about 4cm/yr at maximum. The deformation area is spatially consistent with the area where active fumarole and boiling water are seen on the ground. I additionally applied InSAR analyses to ALOS-2 data to investigate recent crustal deformation. The result shows that there appears no significant deformation in these two years. The geothermal activity is still in high-level, but the state is relatively stable in time. These SAR observation results probably suggest that no significant pressure change has proceeded in the geothermal system at shallow.

Anomalies observed on the ground surface such as fumarolic activity is thought to be directly related with the state change of the geothermal system. It seems that there is a good correlation between the SAR-derived local crustal deformation and the geothermal anomaly on the ground. It is suggested that the InSAR-derived deformation data can be a kind of indicators exploiting the state of pressure under the ground, and can extract some physical parameters related to phreatic eruptions. In this presentation, in

addition to above-mentioned cases, I will show some local ground inflational signals observed in geothermal areas where eruptions have not occurred as yet.

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