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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. To mitigate disaster on phreatic eruptions, an effective proactive monitoring method is desired. One of the tools to overcome the drawbacks is SAR observation.
I here report several observation results in which locally distributed crustal deformation has been detected in geothermal areas where phreatic eruptions has occurred recently or historically. One of the most important studies is the case of Mt. Hakone where the crustal deformation has been successfully detected two months before small phreatic eruptions. Mt. Hakone holds an active geothermal area, called Owaku-dani, with active fumaroles although no eruption has been known since 12-13 centuries. However, the anomalous activity such as an increase of seismicity started in the end of April, 2015. With this anomalous activity, SAR (ALOS-2) observations have been conducted, and small but significant crustal deformation has been detected in a local area with a diameter of $\sim$200 m with a displacement of $\sim$5 cm. The amount of deformation has increased with time although the spatial size has not changed, and resultantly the amount reached up to $\sim$60 cm. Finally, in the end of June, eruptions occurred just at the local crustal deformation area. It should be noted that the eruption started from the InSAR-detected inflational area. This is an excellent case that we were able to identify the location of small phreatic eruption in advance by detecting anomalous ground inflation. It is also noted that the detection of the precursory signal has contributed to the administrative decision making such as setting up no-go area. In this presentation, in addition to this case, I will show some local ground inflational signals observed in geothermal areas where eruptions have not occurred as yet.

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