Relation between ground deformation and plume discharge after the phreatic eruption in 2014 at Mt.Ontake, central Japan

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ALOS-2, which is L-band SAR satellite operated by JAXA, has observed a local-scale subsidence at Mt.Ontake, central Japan, after the phreatic eruption in 2014. This subsidence is modeled as almost spherical deflation source at 500-m depth beneath eruptive vents (Narita and Murakami, in submission). This deflation accompanies coincident water-dominated plume discharge from the vents after the eruption. This activity has still continued up to now. As a simple mechanism of the deflation, water discharge from the boiling hydrothermal reservoir, which corresponds to the deflation source, to the surface can be considered. However, there are other candidates for water discharging; inflated hydrothermal reservoirs at 1-km and 3-km depth in 2007 eruption and subsidence source at 6-km depth in 2014 eruption. To discuss the origin of the water as the plume discharged from the vents, we investigated the contribution of the deflated reservoir to the discharged mass between 2014 and 2017.

Only comparison between the discharged mass of the plume and mass loss at the shallow reservoir corresponding to the deflated volume could not lead to meaningful conclusion. As a first step, we estimated mass loss assuming that the reservoir was filled with 2-phase boiling water. Estimated mass loss with possible range of pressure, porosity, and vapor fraction could widely range from 2×10^{10} to 1×10^{13} kg because of uncertainties of these parameters. On the other hand, observed mass of the plume between 2014 and 2017 is 1×10^{10} kg (Narita and Murakami, JPGU2018), which is less than the lower limit of the mass loss at the reservoir. This may be, for example, because of an assumption of reservoir filled with homogeneously boiling water which could overestimate the amount of mass loss.

However, focusing on time scale of the ground deformation and of the plume discharge gives us meaningful information. The ground deformation and the discharged mass are temporally decayed, which are most likely to be fitted by exponential function. We fit two kinds of time functions to the time series of both of them: one is only exponential function, and another has exponential and constant term. The fitting results show the clear difference in relaxation time between the ground deformation and the plume discharge; the deflation rate is greatly slower than the discharge rate of the plume. This means that there is little contribution of the deflated reservoir to the discharged mass, and that the discharged mass can consist of almost water discharged from another, deeper source.

Thus, we can give a primary constraint to the origin of the discharged plume by focusing the time scale difference of plume discharge and of the ground deformation. As future work, it is necessary to reveal the reason why there is large discrepancy between the discharged plume mass and the mass loss from the deflated reservoir calculated under the assumption of 2-phase compressible water. Further investigation is also necessary to give additional constraint to the source of the plume.

References

Narita S., Murakami M. Discharge rate of water-dominated plume after the phreatic eruption in 2014 at Mt.Ontake // *Japan Geoscience Union*, 2018. SVC41-P22.
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