The Discharge rate of water-dominated plume after the phreatic eruption in 2014 at Mt.Ontake

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Deflation at a shallow depth at Mt.Ontake, central Japan, has been observed by ALOS-2/PALSAR-2 after the phreatic eruption in September 2014 (Narita and Murakami JPGU2017). This ground deformation has accompanied continuing discharge of water-dominated plume which started after the eruption. The plume probably consists of not only the water discharged from the shallow source but also the water originating from deeper part because the deflation source detected by InSAR is the shallowest source among the pressure sources estimated in previous studies. Aiming to investigate the mass balance between the deflation source and the discharged plume, we estimated in this study discharge rate of the plume.

We obtained heat flux of the plume using plume-rise method (Kagiyama 1978). Then, the discharge rate can be estimated by dividing the heat flux by latent heat of water. For this estimation, we used images of a visible camera at Takigoshi station directly viewing the rising plume from eruptive vents. These are resampled at every 10 seconds from video record between 2014/12/01-2017/03/31 by Japan Meteorological Agency.

The estimate results showed the exponential decay of the discharge rate after the eruption. Specifically, the discharge rate seems to be constant (100 kg/sec) from June 2015. Integrating the previously estimated discharge rate between September-November 2014 with those in this study, a total discharged mass is about 1.2e+10 kg between 2014/09/28-2017/03/31, which is the same order of magnitude as 3-years values of 1.8e+10 kg after Kuju 1995 eruption (Nakaboh et al. 2003).

Comparison between the mass loss (M_{def}) corresponding to the deflation volume (dV) and discharged mass of the plume (M_{out}) showed that M_{def} was one order of magnitude larger than M_{out}. To calculate M_{def} based on the deflation volume, we used the relation (Segall 2010): $M_{def} = D\ dV\ (1+B_f/B_c)$ where D is mean density of the liquid-vapor mixture of water, dV is the deflation volume, B_f is mean compressibility of the mixture and B_c is compressibility of the deformation source. The discrepancy can arise from infiltration of water associated with the deflation within the volcanic edifice, heterogeneous distribution of 2-phase zone, and model-dependent problem of cavity source model. For further investigation, we will need to evaluate the influences of the factors mentioned above by using numerical models for simulating the decompression process of the hydrothermal reservoir.

Keywords: phreatic eruption, ground deformation, hydrothermal system, SAR

