An attempt of density measurement for sub-millimeter pumiceous volcanic ash particles using a pseudo-fluid displacement method

*Shingo Takeuchi[1], Kosuke Ishige[1], Shimpei Uesawa[1], Yukiko Suwa[2]

1. Central Research Institute of Electric Power Industry, 2. CERES, Inc.

The density of volcanic ash particles is one of the physical properties governing the settling velocity of partcle. Among volcanic ash, pumiceous particles have been an important research target because the particle density varies greatly depending on the porosity. Previous studies have shown that the density of pumiceous particles increases with decreasing particle size (Cashman and Rust, 2016) and be considered in ash dispersion models (e.g., Mannen, 2013).

However, density measurements of submillimeter volcanic ash particles have yet to be well-established techniques due to difficulties in volume measurement. In previous studies, volume measurements have been made by several methods. Manville et al. (2002) perfomed volume measurements of submillimeter volcanic ash particles in a cylinder using quartz sand as a pseudo-fluid or by filling a container of known volume with submillimeter volcanic ash particles and assuming a packing efficiency. Water pycnometry of submillimeter volcanic ash particles was performed, assuming no significant water infiltration into the pore of the pumiceous particles occurred (Eychenne and Le Pennec, 2012). An attempt has been made to estimate particle volume using an image-based particle size analyzer (Trafton and Giachetti, 2021). In these methods, the volume of a large number of particles rather than a single particle is measured, and an average value is obtained.

We have developed a volume measurement technique using a pseudo-fluid displacement method for drifting pumice from the Fukutoku-Oka-no-Ba 2021 eruption and have measured not only volumes of a centimeter-size particle but also a volume of millimeter-size particles (Takeuchi et al., 2022). Our pseudo-fluid displacement method is similar to that of Manville et al. (2002). In this study, the pseudo-fluid volume was precisely measured before and after setting the sample, and the pseudo-fluid packing was precisely controlled by Micromeritics' GeoPyc1365. The measurement was performed using a special powder (DryFlo) as the pseudo-fluid, which has reduced inter-particle friction.

In a preliminary measurement, the possibility of volume measurement for submillimeter particles by the pseudo-fluid displacement method was explored using glass beads, nylon beads, and artificial crystals that are homogeneous and pore-free. We measured the volume of submillimeter particles of various sizes and shapes by the pseudo-fluid displacement method and compared them with the results of volume measurement by the gas displacement method, which is considered to be a closer measurement to the true value. The present results indicate that when the particle size of the pseudo-fluid (64–250 μm in particle size) and sample are close, the sample volume obtained by the pseudo-fluid displacement method becomes overestimated, and the accuracy is reduced as the sample particle size decreases. However, the precision is relatively good. If an appropriate correction formula can be obtained, it is possible to measure the volume of sub-millimeter particles and evaluate the error.

The presentation will show our attempts to measure pumiceous particles in natural volcanic ash fall. Beyond the "volcanic ash porosimetry" that this study intends to establish, there are possible topics, such as the relationship between magmatic properties and pumiceous volcanic ash density, the behavior of volcanic ash particles in air and water and the relationship between degassing from volcanic ash particles

and volcanic plume dynamics.

Keywords: particle density of volcanic ash , density measurement, volcanic ash fall, pumice, porosity, pseudo-fluid displacement method

