**Text S1: Density measurement**

Density of an ash sample was determined by helium pycnometer. The samples used for the density measurement were ash deposit of the vulcanian eruptions from Showa crater of Sakurajima volcano, and collected in southern part of the island. We sieved the sample into four size classes after ultrasound washing in distilled water for size range of 1-0.5, 0.5-0.25, 0.25-0.125, and 0.125-0.063 mm. The sieved samples were provided for the calculation of the density from mass and volume of samples. The volume was measured by using helium pycnometer (Accupyc by Micrometrics Instruments Corporation) in Nihon University. The volume measurements were done at least 5 times on samples for each size class to evaluate their errors. As the measurement was obtained on bulk sample, the results of the density estimation are average value of the ash particles. Although the ash sample used for the density measurement differs from ash particles obtained in the field experiment, it is considered that there is small difference in densities, because Sakurajima volcano has repeated similar vulcanian eruptions. As a result of the measurement, we obtain the average density of 2700±50 kg m-3.