Constraining tephra dispersion and deposition from cyclic subplinian explosions at Shinmoedake volcano, Kyushu, Japan, 2011

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Constraining physical parameters of tephra dispersion and deposition from explosive volcanic events is crucial to quantitatively evaluate eruption dynamics, the process of tephra deposit formation, and resultant hazards, while it is a significant challenge because of difficulties of direct and comprehensive observations in real time. In general theoretical and empirical models or methods are used to study tephra dispersal and physical parameters, in which a large amount of tephra data is required to give improved constraints on modeling results and to reduce uncertainties in estimates of eruption parameters. Although large-scale volcanic eruptions have provided such opportunities to examine theoretical and empirical approaches, small-scale eruptions are more difficult to constrain because smaller volumes of erupted tephra tends to give only a small number of outcrops due to poor preservation of deposits. Data typically needs to be collected soon after an eruption. Thus model applications to relatively small-scale eruptions have not been well studied.

Repetitive subplinian explosions occurred at the andesitic Shinmoedake volcano, Kyushu, Japan, on 26-27 January 2011. Physical parameters (volumes, columne heights and discharge rates) of three subplinian explosions were constrained based on theoretical and empirical approaches for tephra deposits. The volumes of erupted magma was estimated to be 12-21 million m^3 for the 26-27 am eruptions, and 2-4 million m^3 for the 27 pm eruption. Different approaches produced similar results. Based on maximum pumice clast isopleth, clast density and tephra dispersal models, the column height and the mass discharge rate for all three eruptions were estimated to be 7.3-9.4 km a.s.l. and 2-10*10^5 kg/s, respectively. These data is consistent with results from other methods (tephra volume estimation, duration and column height observations). Three subplinian explosions occurred approximately every 12 hours with a decrease of erupted magma volume and with a constant mass discharge rate. This pulsating cycle may be controlled by the chamber-conduit system beneath the Shinmoedake volcano. Deposits from three subplinian explosions don't show clear boundaries corresponding to repose periods but grain size fluctuation. The absence of fine ash layers is probably due to a strong wind which can significantly affect dispersion and deposition of fine particles.