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Relationship between Stratigraphic Variations of Grain Size Distribution in Fall Deposits and Initial Size Distribution

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In general, a stratigraphic variation in characteristics of grain size distributions of pyroclastic deposits may reflect the temporal behavior of the eruption intensity. However, quantitative methodology to link the stratigraphic variation and the temporal behavior of eruption intensity has not been established because of the complex coupling of several processes: eruption column dynamics, fallout process, sedimentation, erosion etc. In this study, we investigate only the effect of sorting process during settling on the stratigraphic variation of pyroclastic deposits.

In order to relate the variation of grain size distribution as a function of stratigraphic height to the sorting process during settling, we developed a theoretical argument from the view point of Lagrangian manner. If we assume that the terminal velocity of a particle is only a function of grain size and coagulation effect is negligible, an increasing rate of deposit layer equals the volume flux which is calculated from sedimentation rate, leading to an integrodifferential equation including the initial size distribution and the height in the deposit layer. If the initial distribution is given, the solution of the integrodifferential equation gives grain size distribution of deposits as function of height.

We carried out some simulations with our numerical model. In the simplest case that grains start to fall from a constant fallout height on an instantaneous time with no duration, grain size uniquely increases depending on stratigraphic height in deposits with no variance. Extending this simplest case to more realistic case with finite duration of falling, results show that the variation of grain size distribution takes non-zero value of variance. In these cases that fallout height and initial grain size distribution are constant with time, it is shown with the mathematical formalism that the values of Md vary from coarse to fine from the bottom to the top, although this grading behavior has been qualitatively predicted.

From comparison with the stratigraphic variation data of pyroclastic deposits of the 2011 Shinmoedake subplinian eruptions, which have the single coarsest peak of the Md value in a single eruption, we concluded that it is impossible to reconstruct this observed variations in the case of constant fallout height and initial size distribution with time. In order to successfully explain the observed grain size data, we need to give the temporal variation of fallout height or initial size distribution in future.

Keywords: grain size distribution, stratigraphic variation, pyroclastic deposit, eruption intensity