

Particle fractionation between scoria cone and plume; a case study for the Izu-Oshima 1986B eruption

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Scoria cones has been thought that they are formed during a long lived series of mild eruptions. However, recent studies revealed that there are some scoria cones that are know or inferred to be formed during intensive eruptions. Here, we discuss the cone forming process based on particle fractionation at the base of the uprising column. The 1986B Izu-Oshima eruption is a subplinian, cone forming eruption. We measured the total grain size distribution of the cone (CB) to obtain the coefficients for particle fractionation between the cone and tephra fall (TB; Mannen, 2006).

In this study, we adopt the fallout model presented by Bursik et al. (1992). In the original, they employed classical column model by Sparks (1986) to obtain parameters such as column shape, uprising velocity and density of the plume while we used the parameters deduced from the model of Woods (1988). We examined two models including and excluding the inflow effects (model 1 and 2, respectively) whether they match to the observed fractionation.

We found that the particles larger than 16 mm in diameter fit to the prediction of model 1, while particles smaller than that fit to the prediction of model 2. This result indicates that the larger particles tend to be affected by air inflow. However, the result seems to be inconsistent because the smaller particles that fall slowly do tend to be affected by inflow.

To overcome the discrepancy, here we would like to propose another model (model 3). In the model, particle that intersects the column margin defined by characteristic column radius L is laterally transported to wL immediately, where w is a coefficient depends on the particle size. Once the particle reached at wL , it free-falls down in the field of air inflow like the model 1.

The coefficient w can be calculated to fit the observation and we obtained nearly 1 for particles larger than 8 mm and nearly 2 for those smaller than 4 mm. The model implies that small particles can be transported by eddies of the plume to $2L$ that is the visible edge of the uprising column (Sparks, 1986).

In the previous work, the fallout from the uprising column is very limited and the major fallout at the transition to the umbrella region and its sweep back toward the vent construct the cone (Ernst et al., 1996). The model 1 and 3 in this study also predict that the fallout from the column margin is not significant in almost whole range of the column height. However, the model indicates that the contribution to form the cone by fallout from the column-umbrella is not significant while the fallout from the base of the uprising column is principal. Recent studies based on field survey argue that the fine particles consisting the cone are fallout from the basal part of the column (Sable et al., 2006; Fierstein et al., 1997) and the model 3 is consistent to the arguments.

The model 3 is a simple extension for the previous model but it seems to explain the observed fractionation patterns and the relationship between characteristic and visible radii of the column. The flow regime of the basal part of the eruption plume is considered to be instable and the fallout process of the region has been ignored since the knowledge is limited. However, the result of the present study implies that the simple model can represent the fallout from the basal part of the plume.