Oral | Symbol S (Solid Earth Sciences) | S-VC Volcanology

[S-VC50_2AM2]Dynamics of volcanic eruptions and igneous activities

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Fri. May 2, 2014 11:00 AM - 12:45 PM 315 (3F)

This session discusses the dynamics of volcanic and igneous activities such as magma accumulation, magma ascent in volcanic conduits, and dispersion of volcanic products. In order to understand such multi-scale phenomena, the researches of microscopic and macroscopic scales and the techniques that combine the different scales are required. We aim to discuss the latest approaches as well as the recent observations, laboratory experiments and analyses numerical simulations from the viewpoint of cross-cutting research.

12:30 PM - 12:45 PM

[SVC50-P04_PG]Numerical treatment of dry bed problem in the model of pyroclastic flows based on the 1-D shallow-water equations

3-min talk in an oral session

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Keywords:pyroclastic flows, gravity currents, shallow-water equations, numerical simulation, volcanic disaster prevention

During explosive volcanic eruptions, a mixture of pyroclasts and volcanic gases is released from the vent. When the mixture loses its upward momentum before the density of the mixture becomes lower than the atmospheric density, the mixture forms a pyroclastic flow. Dynamics of pyroclastic flows can be approximated by that of an inviscid gravity current. The dynamics of inviscid gravity currents are controlled by an inertial-buoyancy balance on the front (e.g., Benjamin, 1968); we refer to this condition as "the front condition". The front condition, and hence, the dynamics of the inviscid gravity currents strongly depends on the density ratio of the current (ρ_c) to the ambient (ρ_a) (e.g., Ungarish, 2009). When $\rho_c/\rho_a \sim 1$, the current is characterized by a high front, whereas a front height does not develop when $\rho_c/\rho_a \gg 1$. In pyroclastic flows, because density ratio ρ_c/ρ_a varies spatially and temporally, the dynamics of pyroclastic flows becomes complicated; the basic features of pyroclastic flows, such as the run-out distance, have not been fully understood. The aim of our study is to develop a unified model of the inviscid gravity currents for various density ratio ρ_c/ρ_a.In general, the dynamics of shallow inviscid gravity currents can be described by the shallow-water equations. There are two numerical models to solve the shallow-water equations: "shock front condition model" (SFC model) and "artificial bed-wetting model" (ABW model). SFC model is a model, in which the front condition is applied to the boundary condition (e.g., Ungarish, 2009). The boundary condition is given as a function of ρ_c/ρ_a. On the other hand, in ABW model, an artificial wet bed with the height of εh_0 is set on the dry bed in order to express the front condition, where h_0 is a characteristic height scale (e.g., Toro, 2001; Larrieu et al., 2006; Doyle et al., 2007). This model has the only parameter ε for the front condition. Although the front condition, and hence the appropriate value of ε must be a function of ρ_c/ρ_a, the relationship between ε and ρ_c/ρ_a

has not been studied. In order to resolve these problems, we carried out parameter studies using the two models for solving a simple "one-dimensional (1-D) dam-break problem".On the basis of systematic comparisons between the results of SFC model and ABW model, we found the relationship between the parameter ε and ρ_c/ρ_a : $\varepsilon \sim 8.62 \bullet 10^{-2} \bullet (\rho_c/\rho_a)^{-1.87}$. We also found that the application of ABW model should be limited to $15c/\rho_a$. In the case of $1c/\rho_a$