Geophysical Research Abstracts
Vol. 18, EGU2016-5474, 2016
EGU General Assembly 2016

Quantifying the condition of eruption column collapse during explosive volcanic eruptions

Takehiro Koyaguchi (1) and Yujiro Suzuki (2)

(1) Earthquake Research Institute, The University of Tokyo, 1-1-1 Yayoi, Bunkyo-ku, Tokyo 113-0032, Japan (tak@eri.u-tokyo.ac.jp), (2) Earthquake Research Institute, The University of Tokyo, 1-1-1 Yayoi, Bunkyo-ku, Tokyo 113-0032, Japan (yujiro@eri.u-tokyo.ac.jp)

During an explosive eruption, a mixture of pyroclasts and volcanic gas forms a buoyant eruption column or a pyroclastic flow. Generation of a pyroclastic flow caused by eruption column collapse is one of the most hazardous phenomena during explosive volcanic eruptions. The quantification of column collapse condition (CCC) is, therefore, highly desired for volcanic hazard assessment. Previously the CCC was roughly predicted by a simple relationship between magma discharge rate and water content (e.g., Carazzo et al., 2008). When a crater is present above the conduit, because of decompression/compression process inside/above the crater, the CCC based on this relationship can be strongly modified (Woods and Bower, 1995; Koyaguchi et al., 2010); however, the effects of the crater on CCC has not been fully understood in a quantitative fashion.
Here, we have derived a semi-analytical expression of CCC, in which the effects of the crater is taken into account. The CCC depends on magma properties, crater shape (radius, depth and opening angle) as well as the flow rate at the base of crater. Our semi-analytical CCC expresses all these dependencies by a single surface in a parameter space of the dimensionless magma discharge rate, the dimensionless magma flow rate (per unit area) and the ratio of the cross-sectional areas at the top and the base of crater. We have performed a systematic parameter study of three-dimensional (3D) numerical simulations of eruption column dynamics to confirm the semi-analytical CCC. The results of the 3D simulations are consistent with the semi-analytical CCC, while they show some additional fluid dynamical features in the transitional state (e.g., partial column collapse).
Because the CCC depends on such many parameters, the scenario towards the generation of pyroclastic flow during explosive eruptions is considered to be diverse. Nevertheless, our semi-analytical CCC together with the existing semi-analytical solution for the 1D conduit flow model (Koyaguchi, 2005) allows us to intuitively and quantitatively understand how the eruption column dynamics approaches to the CCC as the crater radius increases during the waxing stage of an eruption, or as the magma chamber pressure decreases during the waning stage.