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Numerical modeling of bubble dynamics in magmas

Christian Huber (1), Yanqing Su (1), Andrea Parmigiani (1,2)

(1) Georgia Institute of Technology, United States (christian.huber@eas.gatech.edu), (2) Institute for Geochemistry and Petrology, ETH, Zurich, Switzerland

Understanding the complex non-linear physics that governs volcanic eruptions is contingent on our ability to characterize the dynamics of bubbles and its effect on the ascending magma. The exsolution and migration of bubbles has also a great impact on the heat and mass transport in and out of magma bodies stored at shallow depths in the crust. Multiphase systems like magmas are by definition heterogeneous at small scales. Although mixture theory or homogenization methods are convenient to represent multiphase systems as a homogeneous equivalent media, these approaches do not inform us on possible feedbacks at the pore-scale and can be significantly misleading. In this presentation, we discuss the development and application of bubble-scale multiphase flow modeling to address the following questions : How do bubbles impact heat and mass transport in magma chambers ? How efficient are chemical exchanges between the melt and bubbles during magma decompression? What is the role of hydrodynamic interactions on the deformation of bubbles while the magma is sheared? Addressing these questions requires powerful numerical methods that accurately model the balance between viscous, capillary and pressure stresses. We discuss how these bubble-scale models can provide important constraints on the dynamics of magmas stored at shallow depth or ascending to the surface during an eruption.