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Simulation of magma mixing in refilled magma chambers driven by gas exsolution

A. Longo (1), M. Vassalli (1), P. Papale (1) and M. Barsanti (2)

(1) Istituto Nazionale di Geofisica e Vulcanologia, Italy, (2) Università di Pisa, Dip.to Matematica Applicata, Italy

The dynamics of convection in volatile-rich replenished magma chambers is studied by means of numerical simulations. Simulations are carried out with an appositely developed advanced finite element numerical code, named GALES, which solves the fundamental mass, momentum and energy equations for 2D transient, multicomponent, compressible to incompressible single-fluid flows. The physical properties of magma such as density, viscosity, and volatile saturation depend on local composition, phase distribution, pressure and temperature. The investigated system is an elliptic chamber hosting magma with a certain amount of volatiles, refilled with a volatile-rich magma. Volatiles are water and carbon dioxide. Cases of different amounts of CO_2 in the refilling magma, reservoirs located at different depths, magmas with different viscosities, and inlet boundary conditions of either fixed velocities or fixed pressure, are considered. The results show the formation of a gas-rich convective plume along or close to the chamber axis, mixing of resident and refilling magma, and development of large-scale convective cells inside the chamber, with time-scales and efficiencies depending on the specific conditions investigated. Fluid instabilities related to the compressible nature of magma are responsible of the development of pressure transients along the chamber walls, with amplitude of the order of kPa and frequencies in the range of those pertaining to LP or VLP events registered in volcanic areas.