Time scales of mingling in shallow reservoirs.

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Arrival of magma from depth into shallow reservoirs has been documented as one of the possible processes leading to eruption, e.g. for the recent eruption of Eyjafjallajökull [1], or for most eruptions at Campi Flegrei [2]. Magma intruding and rising to the surface interacts with the already emplaced, degassed magmas residing at shallower depths, rejuvenating them and causing intense mixing and mingling. These processes can cause pressure variations in the reservoirs and eventually lead to eruptions. The chemical signatures of such processes are often identifiable in eruptive products.

We performed two-dimensional numerical simulations of the arrival of gas-rich magmas into shallow reservoirs. We solve the fluid dynamics for the two interacting magmas evaluating the space-time dependent evolution of the physical properties of the mixture, including density and viscosity. Volatile exsolution is computed self-consistently as well.

Our results show that patterns of convection and mingling develop quickly into the chamber and feeding conduit/dike, leading on longer time scales to a density stratification whereas the lighter, gas-richer magma, mixed with different proportions of the resident magma, rises to the top of the chamber due to buoyancy. Over time scales of hours, the magmas in the reservoir appear to have mingled throughout, and convective patterns become harder to identify.

Our simulations have been performed changing the geometry of the shallow reservoir, and the gas contents of the initial end-member magmas. Both parameters play an important role in determining the efficiency of the mixing processes. Horizontally elongated magma chambers favour mixing, while vertically elongate, dike-like reservoirs inhibit efficient convection. Higher density contrasts between the two magmas cause faster ascent velocities and increase mixing efficiency as well.

Petrological evidence suggests for Campi Flegrei residence and mixing times of few days, from the arrival of fresh magmas to eruption, supporting our findings [3].

[1] Moune *et al.* (2012) *J. Geophys. Res.* **117**, B00C07. [2] Arienzo *et al.*, (2010) *Chem. Geol.* **270**, 135-147. [3] Perugini *et al.* (2010) *Bull. Volc.* **72**, 431-447.

Do amino acids inhibit calcite growth?

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The organic matrix that regulates growth of biogenic calcium carbonate contains high concentrations of acidic amino acids. They can form long macromolecules, which bind to surface sites and inhibit growth of the mineral. In this study, we investigated the effect of single amino acid units on calcite crystal growth, to determine how their structure is related to inhibition. We tested glycine (Gly), the smallest amino acid, and aspartic acid (Asp), with concentration range from $8*10^{-6}$ to $4*10^{-4}$ M. Both have an amino group but they differ in the number of carboxylic groups. To quantify their impact on crystal growth rates, we undertook calcite precipitation experiments, using the constant composition method [1]. XPS (X-ray photoelectron spectroscopy) of calcite exposed to amino acid bearing solutions revealed that both molecules adsorbed. Calcite morphology was observed with SEM (scanning electron microscopy); rough corners and step edges indicate blocking of surface sites (Figure 1).

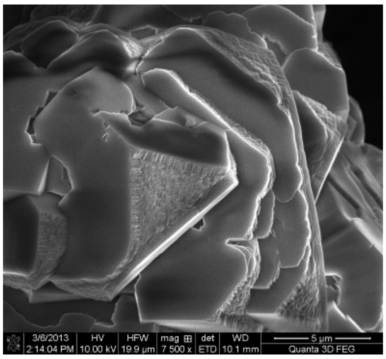

Figure 1: SEM image of calcite crystal exposed to Aspartic acid. Rounded and roughened corners and serrated edges are clearly visible.

Asp is a better inhibiting agent than Gly, which is active only for the highest concentrations investigated. The extra carboxylic group and the particular conformation of Asp can be the main factors promoting the interaction with surface sites. These results shed light on the parameters to take into account to predict or design a good scale inhibiting molecule.

[1] Lakshtanov *et al.* (2011) *GCA* **75**, 3945-3955.

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