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Residence times of alkali feldspar phenocrysts from magma feeding the Agnano-Monte Spina Eruption (4.7 ka), Campi Flegrei caldera (Napoli, southern Italy) based on Ba-zonation modelling

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Timescales governing the development of crustal magma reservoirs are a key for understanding magmatic processes such as ascent, storage and mixing event. An estimate of these timescales can provide important constraints for volcanic hazard assessment of active volcanoes. We studied the Agnano-Monte Spina eruption (A-MS; 4.7 ka; VEI = 4; 0.85 km3 D.R.E. of magma erupted) of the Campi Flegrei caldera, one of the most dangerous volcanic areas on Earth. The A-MS eruption has been fed by magmas varying from more to less evolved trachyte whose variable 87Sr/86Sr and trace elements features suggest magma mixing between two end-members.

Ba zonation profiles of alkali feldspar phenocrysts have been determined through combined energy-dispersive and wavelength-dispersive electron microprobe analyses (EDS-WDS-EMPA). We focused on distinct compositional breaks near the rim of the crystals that likely represent the last mixing event prior to eruption. We always chose the steepest gradients close to the crystal rims, taking into account that any effects related to cutting angles or crystal orientation should give longer apparent diffusion times. Two different approaches were undertaken: (1) a quantitative Ba compositional profiles were measured by point analyses along a short transect crossing growth discontinuities and (2) grey-scale profiles were taken parallel to the acquired point profiles. Assuming that Ba dominates the backscattered electron intensities in sanidines, greyscale gradients can be used as a diffusive tracer. BSE images were processed using the ImageJ® software, in order to extract a numerical greyscale profile. In both cases, each profile was interpolated through a non-linear Boltzmann fit curve with the Mathematica® software. A few traverses done at angles smaller than 90° to the compositional boundary interface were corrected by multiplying the distance values by the sinus of the traverse angle relative to the vertical on the interface.

Our preliminary estimates gave diffusion times from quantitative point analyses between 100's up to 4000 years at 900°C. At higher T (950°C) these values reduce to a range from a few years to 600 yrs. Grey-scale profiles gave diffusion times of ∼400 yrs (900°C) and between 60 and 70 yrs (950°C). This comparison and the uncertainty in T values indicate that further work needs to be done to better constrain diffusion times. In the future we will use accumulated back-scatter images for higher greyscale (i.e. mass) resolution and X-ray cps profiles on Ba for a systematic comparison of these different approaches.

In any case, it appears that short times scales down to years and decades since mixing and coalescence of distinct magma batches in the reservoir, is consistent with our data. Such timescales might represent the time required for the A-MS magma to collect from different magma batches into a reservoir of eruptible magma before eruption. From a volcanological and geochronological point of view, a centuries to decades timescale is in reasonable agreement with the reconstructed volcanic history preceding the A-MS eruption.