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Timescales of magma processes occurred prior to recent Campi Flegrei caldera eruptions: first results from diffusion profiles on plagioclase phenocrysts

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Knowledge of the timescales of magma rising and stagnation, as well as mingling/mixing processes occurring in the shallow plumbing system of an active volcano is crucial for volcanic hazard assessment and risk mitigation. Among few recently developed methodologies, high-precision, high spatial resolution analysis of major-, minor- and trace elements on zoned phenocrysts through electron microprobe techniques represents a powerful tool to provide good estimates of timescales of pre-eruptive magma rising, stagnation and/or mingling/mixing processes. To this purpose, volcanic rock samples of trachytic composition representative of the Agnano-Monte Spina eruption (4.7 ka CAL BP) occurred at the Campi Flegrei caldera (southern Italy) have been selected. The investigation has been carried out in the framework of Project V2 – Precursori di Eruzioni, funded by the Italian Dipartimento per la Protezione Civile – Istituto Nazionale di Geofisica e Vulcanologia.
The investigated rock samples are pumice fragments from which double-polished, 100 μm thick thin sections have been prepared for analytical purposes. Back-scattered electrons (BSE) images have been acquired at the scanning electron microscope (SEM), in order to identify the plagioclase phenocrysts suitable to be analyzed successively, selected among those that best display their zoning. After a careful observation of the BSE images, major-, minor- and selected trace element contents have been determined through combined energy-dispersive and wavelength-dispersive system electron microprobe analyses (EDS-WDS-EMPA) on transects crossing the growth zones of the selected phenocrysts. This methodology has allowed reconstructing the diffusion profile of some key-elements through the growth zones of the investigated phenocrysts. Successively, the diffusion profiles have been combined with textural features obtained through BSE images in order to obtain diffusion models aimed at estimating the timescales of crystals' residence, and possibly mixing events among compositionally distinct magmas. The first results of the application of this methodology to the samples representative of the Agnano-Monte Spina eruption have yielded magma residence and mixing timescales in quite good agreement with previous, independent estimates. These and future results will be integrated with all available information for the interpretation of observed current variations in the dynamics of the Campi Flegrei caldera, and for an effective definition of possible precursors of a future eruption.