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The dynamics of magma chamber refilling at the Campi Flegrei caldera.

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The volcanologic and petrologic reconstructions of several eruptions during the last tens of thousand years of volcanism at the Campi Flegrei caldera show that in most cases a small, chemically evolved, partially degassed magma chamber was refilled by magma of deeper origin shortly before the eruption. New magma input in a shallow chamber is revealed from a variety of indicators, well described in the literature, that include major-trace element and isotope heterogeneities, and crystal-liquid disequilibria (e.g., Arienzo et al., *Bull. Volcanol.*, 2009). In the case of the 4100 BP Agnano Monte Spina eruption, representing the highest intensity and magnitude event of the last epoch of activity, it has been suggested that the refilling occurred within a few tens of hours from the start of the eruption. Notably, in such a case the two end-member magmas that mixed shortly before eruption onset are not recognized as individual members in the deposits, rather, their composition and characteristics are reconstructed from small scale disequilibria, revealing that a relatively short time was sufficient for efficient mixing of the liquid components. In order to investigate the dynamics of magma chamber refilling and mixing at Campi Flegrei we have applied the GALES code (Longo et al., *Geophys. Res. Lett.*, 2006) in a series of numerical simulations. The initial and boundary conditions have been defined in the frame of two subsequent projects coordinated by INGV and funded by the Italian Civil Protection Department, that gather a large number of experts on Campi Flegrei, and are consistent with the bulk of knowledge on the deep magmatic system. In all cases an initial compositional interface is placed at a certain depth, with non-degassed, buoyant magma placed below. The simulations investigate both the dynamics in a very large, 8 km deep reservoir revealed by seismic tomography (Zollo et al., *Geophys. Res. Lett.*, 2008), and those in shallower and smaller chamber systems connected by dykes and representative of pre-eruptive conditions. The numerical results reveal the complex dynamics of magma mixing, dominated by the interplay between buoyant magma rise and dense magma sinking. In all simulated cases efficient mixing takes place at dyke levels, the buoyant magma entering the chamber is already a mixture of the two initial end-members, and the initial deep magma is never found as an individual component in the chamber. Over the time scale of our longest simulation (about 8 hours of real time), and with reference to the spatial resolution of our simulations (max 1 m), the magma chamber is occupied by a nearly homogeneous mixture of the two initial end-members, with minor but still visible density stratification continuously perturbed by the rise of small buoyant plumes. Consistent with the observations, an eruption occurring a few tens of hours after new magma ingression would be characterized by a magmatic composition intermediate between the two initial end-members, that can therefore be revealed only from small-scale heterogeneities and possibly from crystal-liquid disequilibria.