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Mixing Experiments with Shoshonitic and Trachytic Melts using a High-Temperature Centrifuge and a Viscometer: a comparative study

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Evidence of cyclic replenishment of the shallow magmatic reservoir with deeper alkali basaltic (shoshonitic) magma (Campi Flegrei, in Italy; see Arienzo et al., 2008, Bull. Volcanol.) motivated this study. Results from different mixing experiments using natural volcanic samples from this region will be presented. The end-member melts derive from the Agnano-Monte Spina (trachytic) and Minopoli (shoshonitic) eruptions. Based on previous isotopic data, these are thought to be the most suitable counterparts for simulating the extreme interacting compositions in this system.

In order to study the mixing dynamics between these natural magmas, we performed time series of convection-diffusion experiments using two different techniques: 1) a high-temperature centrifuge and 2) a viscometer. For the centrifuge experiments the rotating speed was 1850 revolutions per minute and the acceleration 10^{3} g. In this way, dynamic conditions closer to those calculated for magma chambers (Reynolds Numbers [Re] around 10^2) could be simulated. For every experiment, a 4 mm thick disk of previously homogenized crystal free shoshonitic glass and an 8 mm thick disk of homogenized crystal free trachytic glass were loaded in a 5mm diameter Pt capsule. The capsule was then sealed on both sides, but for a small opening on the upper end, allowing intersticial degassing during the acceleration. Samples were arranged in a buoyantly unstable geometry, where the denser material is placed at the inner side of the rotating circle (basaltic trachyandesite, ρ=2.63 g/cm^3 at 1169^{o}C) and the lighter material at the external side (trachyte, ρ=2.45 g/cm^3 at $\sim$1000^{o}C). Temperature has been kept constant at 1,200^{o}C during all experimental runs, with a negligible thermal gradient ($<$ 1ºC). Forced convection was applied via centrifugal acceleration and density instabilities. Results from three experimental runs with the centrifuge: after 5, 20 and 120 min will be discussed.

The second set of experiments consisted of two experimental runs (25- and 168-hours duration) under Taylor-Couette flow, according to De Campos et al. (2008, Chem. Geol.). Higher amounts of the same end-members, in different proportions, have been mixed together using a concentric cylinder viscometer. For the 2nd set of experiments forced convection has been simulated by stirring with a spindle. Experimental conditions were constrained by: 1) constant angular velocity (0.5 rotations per minute) and 2) constant temperature (1,300° Celsius). The experiments terminated by stopping all movement, extracting the spindle from the sample and letting the sample cool to room temperature. Cylinders of the resultant mixed glasses were recovered by drilling and, prepared for microprobe analysis.

Microprobe and ICP-MS analyses along longitudinal lines from sections of all the resulting products reveal a complex non-linear mixing process with different mobility for different elements. Chemical data obtained from both experiments (with the centrifuge and the viscometer) will be discussed in a comparative way.