Experimental constraints on mixing between basaltic and rhyolitic magmas along the Norris Mammoth Corridor in the Yellowstone National Park (USA)

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The magma mixing process in the Norris Mammoth Corridor in Yellowstone National Park (USA) is observed at different scales, including variable structural and textural patterns, as well as morphologies such as filament like structures, enclaves, and mineral phases showing physicochemical disequilibrium. The type and geometry of these structures strongly depends on the mixing dynamics (e.g. Perugini et al., 2012; Morgavi et al., 2013). The quantification of the morphology and the compositional variability of these structures are essential to understand the mixing process and require detailed analytical and experimental studies.

We present the first set of chaotic mixing experiments performed using natural basaltic and rhyolitic melts from the Yellowstone Norris-Mammoth Corridor. The mixing process is triggered by a recently developed apparatus that generates chaotic streamlines in the melts, mimicking the development of magma mixing in nature. The study of the interplay of physical dynamics and chemical exchanges between melts is carried out performing time series mixing experiments under controlled chaotic dynamic conditions. The variation of major and trace elements is studied in detail by electron microprobe (EMPA) and Laser Ablation ICP MS (LA ICP MS).

The mobility of each element during mixing is estimated by calculating the decrease of concentration variance in time. Both major and trace element variances decay exponentially, with the value of the exponent of the exponential function quantifying the element mobility. Our results confirm and quantify how different chemical elements homogenize in the magmas at differing rates. These results constitute a robust basis for determining the timescale of the mixing process at Yellowstone volcano using the differential mobility of chemical elements.