Geophysical Research Abstracts
Vol. 19, EGU2017-13416, 2017
EGU General Assembly 2017

Insights on chaotic dynamics: mixing experiments between natural silicate melts from Vulcano island (Aeolian Islands, Italy)

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keywords: Magma mixing, chaotic dynamics, time series experiments

Magma mixing is a petrologic phenomenon which is recognized as potential trigger of highly explosive eruptions and its evidence is commonly observable in natural rocks. Here we tried to replicate the dynamic conditions of mixing performing a set of chaotic mixing experiments between shoshonitic and rhyolitic magmas from Vulcano island. Vulcano is the southernmost island of the Aeolian Archipelago (Aeolian Islands, Italy); it is completely built by volcanic rocks with variable degree of evolution ranging from basalt to rhyolite (e.g. Keller 1980; Ellam et al. 1988; De Astis 1995; De Astis et al. 2013) and its magmatic activity dates back to about 120 ky. Last eruption occurred in 1888-1890. The chaotic mixing experiments were performed by using the new ChaOtic Magma Mixing Apparatus (COMMA), held at the Department of Physics and Geology, University of Perugia. This new experimental device allows to track the evolution of the mixing process and the associated modulation of chemical composition between different magmas. Experiments were performed at 1200°C and atmospheric pressure with a viscosity ratio higher than three orders of magnitude. The experimental protocol was chosen to ensure the occurrence of chaotic dynamics in the system and the run duration was progressively increased (e.g. 10.5 h, 21 h, 42 h). The products of each experiment are crystal-free glasses in which the variation of major elements was investigated along different profiles using electron microprobe (EMPA) at Institute für Mineralogie, Leibniz Universität of Hannover (Germany). The efficiency of the mixing process is estimated by calculating the decrease of concentration variance in time and it is shown that the variance of major elements exponentially decays. Our results confirm and quantify how different chemical elements homogenize in the melt at differing rates. It is also observable that the mixing structures generated during the mixing experiments are topologically identical to those observed in natural mixed volcanic rocks.