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# Time-scales of most recent Phlegrean Fields eruptions inferred by application of the "diffusive fractionation" model of trace elements

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The geochemical variation of major and trace elements in two pyroclastic sequences belonging to Astroni 6 and Averno volcanic centres (Phlegrean Fields, Italy) is studied. A clear dichotomy in the behaviour of major and trace elements is observed in both sequences with major elements displaying linear inter-elemental trends and trace elements showing a variable scattered behaviour. In addition, the variations of chemical elements along each sequence are regarded as time series, and studied by applying the methods of Chaos Theory. Results indicate that both pyroclastic sequences display evidence of chaotic dynamics in the redistribution of chemical elements in the magma chambers. Together with previous petrological and mineral chemistry data these results argue in favour of the hypothesis that magma mixing processes played a key role in the evolution of the two studied magmatic systems.

Recent research suggests that chaotic mixing processes in igneous systems may strongly influence the mobility of trace elements inducing a "diffusive fractionation" phenomenon, which strictly depends on the mixing time-scale. By merging information from 1) magma mixing experiments, using as end-members natural compositions, which are known to be the predominant ones for the Phlegrean Fields system, and 2) numerical models, we could derive equations relating the degree of "diffusive fractionation" of trace elements to the mixing time-scales.

Application of the "diffusive fractionation" model to the two studied pyroclastic sequences indicates that such a process actually occurred in both magmatic systems allowing us to apply the relationships derived by numerical and experimental petrology experiments to estimate the mixing time-scales for these two magmatic systems. Results indicate that the mixing processes in Astroni 6 and Averno systems lasted for ca. two and eight days, respectively. These short time-scales for the mixing process argue in favour of the hypothesis that refilling of magma chambers and magma mixing processes likely represent the key processes triggering the eruption of the two volcanic systems.

In conclusion, it is shown that combining Chaos theory, classic petrology, numerical simulations and experimental petrology may highly increase our knowledge on the behaviour of volcanic systems and can provide useful methods to constraint the time-scales of volcanic eruptions furnishing a further tool for hazard assessment in active volcanic areas.