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Morphochemistry of Patterns Produced by Mixing of Rhyolitic and Basaltic Melts

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We present the results of time series experiments performed by mixing basaltic and rhyolitic melts at high temperature using a device recently developed to trigger chaotic dynamics in a mixing system. The morphology of mixing patterns is quantified at different times by measuring their fractal dimension and a linear relationship is derived between mixing time and morphological complexity. The complexity of mixing patterns is also compared to the degree of homogenization of chemical elements during mixing and empirical relationships are established between the fractal dimension and the temporal variation of concentration variance of elements.
New concepts and tools to study the magma mixing process unfold from the experimental results presented in this work. The first one is that the mixing patterns are fractals and they can be quantified by measuring their fractal dimension. This represents a further step in the quantification of the magma mixing process. The second outcome is that the relationship between the fractal dimension of the mixing patterns and mixing time is linear. This has important volcanological implications as the analyses of the morphology of mixing patterns in volcanic rocks can be complemented by experiments to build a new chronometer to estimate the mixing-to-eruption time. A further result from this work is the relationship between the fractal dimension of mixing patterns and concentration variance of chemical elements. This represents the first morphochemical study in igneous petrology bringing with it the potential to infer the relative mobility of chemical elements during the time progression of mixing by analyzing the morphology of mixing patterns in the rocks.