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Time Evolution of Chemical Exchanges During Mixing of Rhyolitic and Basaltic Melts

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We present the first set of chaotic mixing experiments performed using natural basaltic and rhyolitic melts. 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 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 exponent of the exponential function quantifying the element mobility. Our results confirm and quantify how different chemical elements homogenize in the melt at differing rates. The differential mobility of elements in the mixing system is considered to be responsible for the highly variable degree of correlation (linear, non-linear, or scattered) of chemical elements in many published inter-elemental plots. Elements with similar mobility tend to be linearly correlated whereas, as the difference in mobility increases, the plots become progressively more non-linear and/or scattered.
The results from this study indicate that the decay of concentration variance is in fact a robust tool for obtaining new insights into chemical exchanges during mixing of silicate melts. Concentration variance is (in a single measure) an expression of the influence of all possible factors (e.g. viscosity, composition, fluid-dynamic regime) controlling the mobility of chemical elements and thus can be an additional petrologic tool to address the great complexity characterizing magma mixing processes.