Strontium isotope systematics of experimentally produced melts: understanding magma-carbonate interaction at Merapi volcano, Indonesia

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There is considerable evidence for ongoing, late-stage interaction between the magmatic system at Merapi volcano, Indonesia, and local crustal carbonate. In order to resolve the interaction processes in detail, we have performed a series of time-variable carbonate dissolution experiments in silicate melt using Merapi basaltic-andesite and local limestone as starting materials, at magmatic pressure and temperature. Major element profiling of the experimental products has identified strongly contrasting compositional domains of glass: a Ca-enriched zone containing up to 36 wt% CaO, and an unaffected, Ca-normal zone containing 8 to 10 wt% CaO.

To investigate the systematics of strontium isotopes and trace elements (TE) during carbonate assimilation, we have used micro-sampling and high-precision analytical techniques to measure $^{87}\text{Sr}/^{86}\text{Sr}$ ratios and TE concentrations over the magma-carbonate and intra-melt interfaces in two of our experimental products. The isotope variation between the different glass compositions is distinct, with $^{87}\text{Sr}/^{86}\text{Sr}$ ranging from 0.705641 in the Ca-normal glass to 0.706532 in the Ca-enriched glass. The upper end of this range is considerably more radiogenic than the range reported for Merapi whole rock volcanic products (0.70501 to 0.70583, Gertisser & Keller, 2003 J Pet, 44, 457-489). Our data hence support a model of assimilation of crustal carbonate with highly radiogenic $^{87}\text{Sr}/^{86}\text{Sr}$ (0.708799) at Merapi volcano. Given that the starting materials used in the experiments have markedly distinct $^{87}\text{Sr}/^{86}\text{Sr}$ values we here present new and detailed insights about the behaviour of Sr isotopes during carbonate assimilation, with a focus on the processes that operate across the carbonate-melt interface and the intra-melt transitions. Strontium is a reliable tracer of magma-crust interaction and so we anticipate that our results will significantly help to quantify our comprehension of magma-carbonate interaction processes occurring at Merapi volcano.