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Magma-carbonate interaction processes at Merapi volcano, Indonesia: insights from High-P High-T experiments

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At Merapi volcano, Indonesia, frequent calc-silicate xenoliths within basaltic-andesite display reaction rims with evidence of intense interaction between magma and carbonate crust. Further evidence for late-stage interaction between limestone and the magmatic system has recently been identified through crystal isotope stratigraphy.

In order to resolve the actual interaction processes in detail, we have performed piston cylinder de-carbonation experiments using Merapi basaltic-andesite glass and local limestone at magmatic pressure and temperature (fixed at 0.5GPa and 1200˚C, respectively). The dwell time for the experiments was varied, and set at: 0, 60, 90, 150, and 300s. All runs were carried out using both nominally anhydrous and hydrous (glass doped with 2.23wt% H_2O) starting glass. Consequently, we have constructed a high-resolution time-sequence of magma-carbonate interaction in our experimental products. In addition, EMP line traverses through the reaction interfaces were carried out to assess major element behaviour across these zones.

Several processes of magma-carbonate interaction can be observed in the experiments:

1. The development of a zone of Ca-rich, Si-poor glass surrounding the carbonate. **2.** Severe de-gassing of the carbonate, promoting the development of CO_2 bubbles, with several generations of bubbles frequently identified. **3.** Partial melting and dis-

aggregation of the carbonate xenoliths. **4.** Magma mingling and subsequent mixing. A transition zone of hybrid composition between the Ca-rich and Ca-normal glass domains is often observed. **5.** Complete dissolution of the carbonate in some cases (examples from both dry and wet experiments).

In addition to the experimental work carried out, we have studied natural samples of Merapi calc-silicate xenoliths in detail. The natural samples are considerably more complex than the experimental products with notable features including: **1.** The presence of an amorphous fringe zone, strongly enriched in CaO at the margin of the xenoliths. **2.** Micro-vesicular textures and rare carbonate inclusions within the xenoliths and their pyrometamorphic reaction rims.

These experiments contribute considerably to our understanding of magma-carbonate interaction processes, and provide important insights into the progression of such interaction with time. Moreover, they help to further refine current understanding of crustal interaction at Merapi volcano, especially when considered in conjunction with the natural xenoliths, and point towards a potential impact of such interaction on the volatile budget of the volcano.