Basalt-limestone interaction at crustal conditions and implications for volcanic emission of CO_2

LAURA B. CARTER[1,*] AND RAJDEEP DASGUPTA[1]

[1]Dept of Earth Science, Rice University, Houston, TX (*correspondence: Laura.B.Carter@rice.edu)

Carbon dioxide released via volcanic systems is generally mantle-derived, but high degassing rates for some arc volcanoes (e.g. Merapi [1] and Colli Albani Volcanic District [2]) are thought to be influenced by magma-carbonate interaction in the continental crust [3]. Yet, systematic investigation on the effect of *P-T* on hydrous basalt-induced crustal decarbonation is limited.

Here we simulated basalt-limestone wallrock interactions at 0.5-1.0 GPa, 1100-1200 °C using a piston cylinder and equal mass fractions of pure calcite ($CaCO_3$) and a hydrous (~3 wt.% H_2O) basalt melt in a layered geometry contained in AuPd capsules. All experiments produce melt + fluid + calcite + cpx ± plagioclase ± calcic-scapolite ± spinel. With increasing *T*, plagioclase disappears and scapolite appears at 0.8 and 1.0 GPa, cpx becomes CaTs-rich, and fluid proportion increases. At 1.0 GPa, 1200 °C our hydrous basalt is superliquidus, whereas in the presence of calcite, the experiment produces calcite + cpx + scapolite + melt.

With the consumption of calcite with increasing *T* and decreasing *P*, melt, on a volatile-free basis, becomes silica-poor (69.0 wt.% at 1.0 GPa, 1100 °C to 34.9 wt.% at 0.5 GPa, 1200 °C) and Ca-rich (37.1 wt.% at 1.0 GPa, 1100 °C to 41.8 wt. % at 0.5 GPa, 1200 °C) whereas, with increasing *T* Al_2O_3 drops (e.g. 14.0 at 1100 °C to 10.6 wt.% at 1200 °C at 1.0 GPa) as cpx becomes more CaTs-rich.

Wall-rock calcite consumption is observed to increase with increasing *T* and decreasing *P*. At 0.5 GPa, our experiments yield carbonate assimilation from 10.8 to 24.6 wt% between 1100 and 1200 °C, similar to calculated ≤15 wt.% at Colli Albani [2]. Using a magma flux rate of 5.4×10^{12} g/y estimated for Mt. Vesuvius [4], we obtain a CO_2 outflux of 5.1×10^{11}-1.2×10^{12} g/y for *T* variation of 1100 to 1200 °C at 0.5 GPa. The lower *T* estimate appears similar to the observed flux of CO_2 in Vesuvius systems of 1.1×10^{11} g/y [5]. Our experiments thus suggest that one volcano such as Vesuvius alone can generate excess CO_2 that amounts to at least 1-2% of the present-day global arc flux of CO_2 [6].

[1] Troll *et al* (2012) *GRL* **11**, 1-6 [2] Iacono Marziano *et al* (2007) *JVGR* **166**, 91-105 [3] Freda *et al* (2008) *Lithos* **101**, 397-415 [4] Scandone *et al* (2008) *JVGR* **170**, 167-180 [5] Iacono Marziano *et al* (2009) *Geol* **37**, 319-322 [6] Sano & Williams (1996) *GRL* **23**, 2749-2752