

## Tracking basalt degassing using volatile stable isotope fractionation

E.C. HUGHES<sup>1\*</sup>, J.D. BLUNDY<sup>1</sup>, R.A. BROOKER<sup>1</sup>, EIMF<sup>2</sup>, P. CARTIGNY<sup>3</sup>, R.E. BOTCHARNIKOV<sup>4,5</sup>, R. BALZER<sup>4</sup>, I.N. BINDEMAN<sup>6</sup>, G. KILGOUR<sup>7</sup>, AND H.M. MADER<sup>1</sup>

<sup>1</sup>School of Earth Sciences, University of Bristol, UK  
(\*correspondence: ery.hughes@bristol.ac.uk)

<sup>2</sup>EIMF, University of Edinburgh, UK

<sup>3</sup>Lab de Géochimie des Isotopes Stables, IGP, Paris, France

<sup>4</sup>Inst für Mineralogie, Leibniz Uni Hannover, Germany

<sup>5</sup>Inst für Geowissenschaften, Gutenberg Uni Mainz, Germany

<sup>6</sup>Dept of Earth Sciences, University of Oregon, USA

<sup>7</sup>Wairakei Research Centre, GNS Science, Taupo, NZ

As volatiles (e.g., H<sub>2</sub>O and CO<sub>2</sub>) exsolve from the melt, they undergo stable isotope fractionation resulting in concentration and isotope ratio changes in the melt and vapour. Melt inclusions (MIs) provide a record of this process and concentration-isotope ratio systematics can be used to calculate the initial concentration, isotope ratio and style of degassing prior to eruption. Also, the isotope ratio of gases at volcanoes can be used to infer changes in the magma at depth. Interpretations of both data types require precise quantification of the volatile fractionation factor between melt and vapour ( $\Delta_{v-m}$ ) over the range of natural conditions.

There is a distinct lack of data for CO<sub>2</sub> in mixed (H<sub>2</sub>O-CO<sub>2</sub>) volatile systems. To address this issue we experimentally simulated various stages of degassing for basaltic melts of different initial H<sub>2</sub>O:CO<sub>2</sub> ratios at 1250 °C and 1 – 7 kbar (30 samples, IHPV) to measure equilibrium  $\Delta_{v-m}^{CO_2}$ . Glasses were analysed for H<sub>2</sub>O, CO<sub>2</sub>,  $\delta D$ , and  $\delta^{13}C$  using bulk (TCEA and SHMS) and micro-analytical (SIMS) techniques. SIMS allows  $\delta^{13}C$  measurements at very low CO<sub>2</sub> concentrations (~50 ppm and  $1\sigma \approx 5\text{‰}$ ) at the high spatial resolution (15 × 20  $\mu m$ ) required to analyse MIs.

Previous studies have measured  $\Delta_{v-m}^{CO_2}$  of predominantly anhydrous 'basaltic' melts to be  $+3 \pm 1\text{‰}$  at > 5 kbar and 1100 – 1400 °C [1]. Our data indicate that  $\Delta_{v-m}^{CO_2}$  is strongly effected by water, leading to extreme fractionation at low pressures (i.e., with significant H<sub>2</sub>O degassing) despite equilibrating in a closed system as kinetic fractionation would result in a negative  $\Delta_{v-m}^{CO_2}$ . We also analysed basaltic glassy MIs from Etna, Italy, and Rangitoto, New Zealand, using SIMS for H<sub>2</sub>O, CO<sub>2</sub>,  $\delta D$ , and  $\delta^{13}C$ . The  $\delta^{13}C$ -CO<sub>2</sub> systematics are very similar to the experimental glasses and we use this data to infer volatile concentration and isotope ratios of the magma.

[1] Blank & Brooker (1994) *RiMG* **30**(6), 187-230.