

Quantifying the initial CO₂ content of basaltic arc magmas using stable isotope fractionation

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Volatiles play a critical role in the eruption dynamics of volcanoes, providing the driving force for eruptions and effecting their crystallisation. Recent work suggests that the CO₂ content of arc magmas, as estimated from melt inclusions, is significantly underestimated meaning that arc volcanoes may be a far larger contributor to atmospheric CO₂ than previously estimated. Arc volcanoes provide a unique insight into the fate of subducted material at destructive margins and it is currently unclear how much CO₂ is released during this process versus recycled into the deep interior of the Earth.

Tiny pockets of melt trapped in crystals, called melt inclusions, provide a window into the pre-eruption magma. For volatiles (F, Cl, S) that exsolve at low pressures, their concentration in melt inclusions should equal their initial concentration. For volatiles that exsolve at depth (H₂O and, particularly, CO₂), knowledge of the initial content is less straightforward as significant degassing may precede melt inclusion trapping.

Using carbon isotopes to derive initial CO₂ contents is based on the fractionation of ¹²C and ¹³C during degassing. Preferential loss of ¹³C to the gas phase renders the residual melt isotopically lighter. By measuring $\delta^{13}\text{C}$ in melt inclusions that span a range of CO₂ contents it is possible to reconstruct the initial CO₂ content and $\delta^{13}\text{C}$ of the magma. Here, we present work-in-progress towards using this technique on melt inclusions from basaltic arc magmas.