High CO_2/Ba ratios measured in olivine-hosted melt inclusions from Midfell, Iceland

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Over the last few decades there has been significant interest in the carbon content of the mantle and the flux of carbon at Mid-Ocean Ridges (MORs). Studies of undegassed MOR basalts and olivine-hosted melt inclusions have determined the global variability of mantle carbon through the measurement of carbon-incompatible trace element (ITE) ratios (e.g. CO_2/Ba, CO_2/Nb, CO_2/ Rb). Ba and C are both highly incompatible during silicate melting, therefore the ratio of the source mantle is thought to be preserved in primary melts. Such studies find that the upper mantle CO_2/Ba ratio is heterogeneous. The volatile element chemistry of the lower mantle, however, remains elusive.

In this study we have measured the major, trace and volatile element contents of olivine-hosted melt inclusions and pillow-rim glass from Midfell, an edifice that was generated by a subglacial eruption during the last glacial period in SW Iceland. The melt inclusion suite is trapped within highly forsteritic olivine host crystals and shows significant chemical variation. This variability delineates the minimum range of melt compositions that mixed beneath Midfell prior to eruption. This diversity can be attributed to melts produced by different extents of partial melting, or from melts of different source lithologies.

We measure the highest CO_2/Ba ratios ever recorded in basaltic glass in our most depleted melt inclusions. The low CO_2 content of these melt inclusions is likely to reflect the entrapment values of undegassed melts. Independent petrological constraints on entrapment pressure indicate that the olivine crystallised at depths greater than 10 km, such that only melts with >4000 ppm CO_2 are likely to have lost gas prior to entrapment.

Previous studies have shown that Midfell has a distinctive noble gas isotopic composition, consistent with the presence of a primordial mantle reservoir within the Midfell mantle source regions. This association of high CO_2/ITE with primordial noble gas signature may provide a means of constraining the C content of the primitive mantle.