The role of melt-rock interaction on the CO_2/Ba ratio of depleted MORBs

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Carbon in Earth's upper mantle can significantly reduce its solidus temperature, which in turn can affect other physical properties through generation of partial melt. Carbon content of the depleted upper mantle has been estimated using CO_2/ITE ratios such as CO_2/Ba in depleted mid-ocean ridge basalt (D-MORB) glasses and melt inclusions that are undersaturated in CO_2.

One of the potential issues with this approach is the effect of melt-plagioclase chemical interaction on the CO_2/Ba ratios in D-MORBs. Plagioclase is ubiquitous in the oceanic crust and is enriched in Ba relative to other phases. Assimilation of plagioclase-bearing rocks into MORB melts has been shown to affect the Ba (and Sr and Eu) concentrations in MORBs, implying that such a process may also affect their CO_2/Ba ratio. Hence, understanding the effect of chemical interaction between plagioclase and D-MORB melts is important for providing better constraints on CO_2/Ba ratios and carbon content in Earth's upper mantle.

In this study, we report on the compositions of olivine-hosted melt inclusions and glasses from the Siqueiros and Garrett transform faults. The melt inclusions are CO_2 undersaturated D-MORBs with highly depleted incompatible trace element compositions. Subsets of melt inclusions from both transform faults show signatures of assimilation of plagioclase such as significant increases in Al_2O_3 and decreases in FeO with decreasing MgO, positive Sr anomalies, and low Nb/Ba. CO_2/Ba ratios show significant ranges of 113±48 and 86±40 for the Garrett and Siqueiros melt inlcusions respectivley. We model assimilation fractional crystallization of plagioclase into the D-MORBs under both high and low melt/rock ratio scenarios. These models reproduce the range in CO_2/Ba ratio and trends between CO_2/Ba, Nb/Ba, and Nd/Sr as well as between Al_2O_3, FeO, and MgO observed in the melt inclusions. Hence, chemical interaction with plagioclase may affect the CO_2/Ba ratio in D-MORBs, and care should be taken to evaluate this effect using Nd/Sr and Nb/Ba ratios.