Tracking the mantle origins of Mid-Ocean Ridge Basalts using plagioclase-hosted melt inclusions

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Melt inclusions, pockets of melt trapped during mineral growth, are a powerful tool to assess magmatic processes. To gain a better understanding on the fomation of the oceanic crust, recent studies have mainly focused on olivine-hosted melt inclusions, as olivine is the first mineral to form within the mid-ocean ridge basalt crystallization sequence. Published olivine-hosted melt inclusion pressure data usually indicate that olivine crystallizes within the crust. We present new data on homogenized plagioclase-hosted melt inclusions from a plagioclase ultraphyric basalts (PUBs) from the Blanco Transform Fault. We collected CO_2 and H_2O concentrations from plagioclase-hosted melt inclusions in this basalt. The data suggest that plagioclase megacrysts crystallize at or below the local Moho with crystallization pressures averaging 0.4-0.45 Gpa (12-13.5 km). We interpret these plagioclase megacrysts to be derived from the disruption of troctolitic cumulates in the upper mantle. Density differences between olivine and plagioclase results in crystal sorting, with the preferential transport and sampling of plagioclase. However, the presence of a melt lens may prevent any megacrysts from being erupted. This explains why PUBs are found worldwide, but only at slow to intermediate spreading centers.

We also conducted time-series experiments on these melt inclusions in order to evaluate the degree to which CO_2 diffuses out of the melt inclusion. Run times were 30 min and 4 days. Our results indicate that CO_2 exsolves from the melt inclusion glass to a newly formed vapor bubble with time, with the total CO_2 staying constant. This result demonstrates the fidelity of plagioclase-hosted melt inclusions, and the importance of analyzing vapor bubbles in melt inclusions for CO_2. Combining vapor bubble CO_2 and melt inclusion glass CO_2 is a necessary step in determining total CO_2 for depth calculations. Increasing run-times also results in diffusive exchange of major and trace elements between the crystal host and the melt inclusions. We suggest that crystal relaxation is responsible for these observed changes.

Keywords: plagioclase-hosted melt inclusions, PUBs, mantle origins.