Melt-Rock interaction during fast-spreading oceanic crust accretion: processes at the top and bottom of mush zone: experimental constraints

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Several recent papers report on melt-rock interaction during the accretion of fast-spreading ocean crust. Here, we focus on two horizons of fast-spread crust, where we experimentally simulated the corresponding processes in Internally Heated Pressure Vessels (IHPV), in order to shed light on the involved reactions and conditions of these processes.

The first case is related to the lower layered gabbro from Hess Deep in the equatorial Pacific, where IODP Expedition 345 recovered coherent cores, highlighting the vast occurrence of orthopyroxene as an abundant phase in these deep-level cumulate rocks, which cannot be explainable by crystallization experiments from primary MORB melts. Melt/rock interaction experiments using a starting glass representing a primitive, upmoving MORB melt and a natural lherzolite representing mantle rocks show that interaction between MORB melt and peridotite can increase melt SiO_2 content effectively without significantly changing its MgO content, resulting in an evolving trend to orthopyroxene saturation. This experimental study demonstrates that melt-peridotite interaction at crust/mantle boundary may be a common scenario responsible for the formation of heterogeneous MORB melts, in which some are close to orthopyroxene-saturation composition with the potential of generating orthopyroxene-bearing cumulates in the lowermost crust, as observed at Hess Deep.

The other case of melt/rock interaction is related to the axial melt lens (AML) residing at the top of the mushzone at the dike/gabbro transition, where MORB melts are affected by significant contamination, as observed in the IODP drilling from Site 1256 (equatorial Pacific), which penetrated the dike/gabbro transition. With the help of trace element compositions of experimental melts produced by hydrous partial melting of dikes from IODP Site 1256, we were able to perform calculations of mixing and assimilation fractional crystallization (AFC) using the experimental partial melts as contaminant/assimilant. The results show that interaction between MORB and hydrothermally altered sheeted dikes is the dominant contamination process, while anatectic melts can only play a minor role.