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Dynamics of the Axial Melt Lens/Dike transition at fast spreading ridges: assimilation and hydrous partial melting

L. France (1,2), B. Ildefonse (1), and J. Koepke (2)

(1) Université de Montpellier 2, Géosciences Montpellier, Montpellier, France (lfrance@um2.fr), (2) Institut fuer Mineralogie, Universitaet Hannover, Germany

Recent detailed field studies performed in the Oman ophiolite on the gabbro/sheeted dike transition, compared to corresponding rocks from the EPR drilled by IODP (Site 1256), constrain a general model for the dynamics of the axial melt lens (AML) present at fast spreading ridges (France et al., 2008). This model implies that the AML/dike transition is a dynamic interface migrating up- and downward, and that the isotropic gabbro horizon on top of the igneous section represents its fossilization. It is also proposed that upward migrations are associated to reheating of the base of the sheeted dike complex and to assimilation processes. Plagiogranitic lithologies are observed close to the truncated base of the dikes and are interpreted to represent frozen melts generated by partial melting of previously hydrothermalized sheeted dikes. Relicts of previously hydrothermalized lithologies are also observed in the fossil melt lens, and are associated to lithologies that have crystallized under high water activities, with clinopyroxene crystallizing before plagioclase, and An-rich plagioclase.
To better understand our field data, we performed hydrous partial melting experiments at shallow pressures (0.1 GPa) under slightly oxidizing conditions (NNO oxygen buffer) and water saturated conditions on hydrothermalized sheeted dike sample from the Oman ophiolite. These experiments have been performed between 850°C and 1030°C; two additional experiments in the subsolidus regime were also conducted (750°C and 800°C). Clinopyroxenes formed during incongruent melting at low temperature (<910°C) have compositions that match those from the corresponding natural rocks (reheated base of the sheeted dike and relicts of assimilated lithologies). In particular, the characteristic low TiO2 and Al2O3 contents are reproduced. The experimental melts produced at low temperatures correspond to compositions of typical natural plagiogranites. In natural settings, these silicic liquids would be mixed with the basaltic melt of the AML, resulting in intermediate compositions that can be observed in the isotropic gabbro horizon.
Our study suggests that assimilation of previously hydrothermalized lithologies in the melt lens is a common process at fast spreading ridges. This process should consequently be carefully considered in geochemical studies that deal with the origin of MORB.

France L., Ildefonse B., Koepke J., (2008) The fossilisation of a dynamic melt lens at fast spreading centers: insights from the Oman ophiolite. Eos Trans. AGU, 89(53), Fall Meet. Suppl. Abstract V51F-2111