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Experimental constrains on hydrothermal activity at very high temperatures under mid-ocean ridges

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Recent observations in ophiolites and in the recent oceanic crust showed that hydrous fluids may interact with the just frozen, still very hot lithosphere triggering partial melting processes which may produce distinct late-stage modification of existing gabbros or which may even result in the formation of special rock types. In some cases it is evidenced that the water-rich fluids are seawater-derived, thus suggesting a model that hydrothermal circulation at fast-spreading ridge operates much deeper than previously known with the potential to reach the magma chambers below the ridges. Moreover, it has been suggested that this new type of hydrothermal circulation at very high temperatures even has the potential to reach the sub-MOHO level causing interaction between seawater and harzburgite at magmatic temperatures.

In order to understand the magmatic processes/reactions behind, we started different series of experiments on the crystallization and differentiation in a hydrous gabbroic system as well as on the water-triggered partial melting behavior of both typical oceanic gabbros and harzburgites. Experiments were performed in specially designed internally heated pressure vessels enabling the control of oxygen fugacity and the rapid quenching of the experimental runs. Temperatures varied between 900 and 1220˚C and pressures between 100 and 500 MPa at both reducing and at oxidizing conditions. Starting materials were natural rocks, typical oceanic gabbros and ophiolitic harzburgite, for the partial melting experiments and glasses produced by melting of natural oceanic gabbros for the crystallization experiments.

The presented experimental results address the following topics: (1) Hydrous partial

melting of gabbro can lead to plagiogranitic melt and a characteristic late-stage paragenesis. (2) The interaction of tholeiitic magmas with water may produce crustal wehrlites. (3) Hydrous partial melting of harzburgite at shallow pressure can result in the formation of "High-Ca boninitic" melts, depleted gabbronoritic cmulates, and dunitic restites, consisting of olivine and chromite.