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Effect of water on the phase equilibria in a primitive tholeiitic system - An experimental study

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We present an experimental study of systematic crystallization experiments with the aim of determining the effect of water on the phase relations and phase chemistry in a natural tholeiitic system. The comparison of the experimental results with natural oceanic gabbros and basalts will help to constrain the role of water in MORB differentiation processes occurring in the oceanic crust.

A fused microgabbro from the Southwest Indian Ridge (drilled during ODP-Leg 176, Hole 735B), showing characteristics of a crystallized melt was used as starting material. Experiments in the temperature range 940-1220˚C and at pressures of 100, 200 and 500 MPa have been carried out in an internally heated pressure vessel. In these experiments four different water activities were applied. In a first step, an experimental series under relatively oxidizing conditions (QFM+1 to +4, depending on the water activity) were performed. A series at reducing conditions (QFM+0 to -3, depending on aH_2O) is under investigation.

Water has a strong effect on the amount of melt produced at fixed P-T-conditions. Furthermore, adding water to the system causes a shift in the stabilities of phases to lower temperatures. Moreover, water could also change the crystallization sequence. For example at 200 MPa, clinopyroxene crystallizes before plagioclase at high water activities, while at lower water activities plagioclase crystallizes first. And finally, water changes the composition of the occurring phases and, in some cases, the element partitioning. For example, the partitioning coefficient for CaO between olivine and melt or for calcium and sodium between plagioclase and melt is affected.

The performed experiments open interesting perspectives for the generation of specific

gabbroic rock-types, which are typical constituents of the oceanic crust. For example, the generation of ultramafic wehrlites (rocks consisting of olivine and clinopyroxene) occurring as enigmatic intrusion within the gabbroic crust of the Oman ophiolite could be explained by crystallization of a primitive tholeiitic liquid under high water activities (at pressures above 100 MPa at relatively low temperatures of $\sim$1060°C).