



Experiments on the effect of external parameters on the Cr-spinel composition in a primitive tholeiitic system

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In the suboceanic mantle Cr-spinel can occur as accessory Al-phase in spinel-peridotites or may form large aggregates known as podiform chromitites, often associated with dunites. In the oceanic crust Cr-spinel occur as accessory minerals in crustal ultramafic cumulates of the lower crust or in some MOR basalts of the upper crust.

We present systematic experiments in a tholeiitic system using a fused microgabbro from the Southwest Indian Ridge (drilled during ODP-Leg 176, Hole 735B) as starting material, where we observed Cr-spinel at near liquidus conditions. With the systematic experiments the individual effects of external parameters (pressure, temperature, water and oxygen fugacity) on the stability of cr-spinel and on its chemical composition in a tholeiitic system can be determined.

The experiments were performed in an internally heated pressure vessel, specially designed for high-temperature basic systems. The vessel is equipped with a hydrogen membrane for controlling the oxygen fugacity and with a rapid-quench system to prevent the formation of quench-crystals [1]. At temperatures $<1050^{\circ}\text{C}$ gold and at higher temperatures $\text{Au}_{80}\text{Pd}_{20}$ was used as capsule material. At reducing conditions (QFM), $\text{Au}_{80}\text{Pd}_{20}$ capsules pre-saturated with iron were used, no significant iron loss into the capsule material was observed.

Experiments in the temperature range $940\text{--}1220^{\circ}\text{C}$ and at pressures of 100, 200 and 500 MPa with durations of 1 to 91 hours (depending on T and $f\text{O}_2$) have been carried out. In these experiments four different water activities ranging from “dry” to water-saturated and two different oxygen fugacities (QFM+4 to +1 and QFM+0 to -3; the

range is related to the water activity) were applied.

In the performed experiments the Cr-spinel is homogeneously distributed in the capsule. In some experiments clusters of aggregated Cr-spinels occur. The Cr-spinels have compositions similar to those in MORBs, and its modal amount decreases with decreasing oxygen fugacity. In the experiments we observed a direct correlation between the stability of Cr-spinel and the absence of clinopyroxene or plagioclase.

The different experimental parameters also affect the chemical composition of the Cr-spinel. Generally, the Cr-spinel shows an increase in the Cr# depending on the amount of water in the coexisting melt. The amount of water is controlled by the water activity and by the pressure. Experiments under water saturated conditions show with increasing pressure a slight increase in the Cr#. The experiments under “dry” conditions show no pressure effect on the spinel composition. As well as pressure, increasing temperature also shifts the Cr# to higher values.

[1] Berndt et al. Am Mineral 87 (11-12): 1717-1726 Nov-Dec 2002