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Chromian spinel during melting experiments of dry peridotite (KLB-1) at 1.0–2.5 GPa

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ABSTRACT

The stability and chemistry of chromian spinel were determined for dry mantle (spinel lherzolite) melting at pressures between 1.0 and 2.5 GPa and temperatures between 1250 and 1500 °C. To find the most suitable sample container, we tested three different possibilities at 1.5 GPa: a Pt capsule, a Re/Pt capsule, and a graphite/Pt capsule. The oxygen fugacity of the run products with Pt, Re/Pt, and graphite/Pt are FMQ + 4 to 5, –2 to 0, and < –10, respectively. We conclude that the Re/Pt capsule is most suitable for melting experiments of dry peridotite at high temperatures and the oxygen fugacity similar to that of the terrestrial upper mantle, which has been estimated to be near FMQ. Using Re/Pt capsules, batch-melting experiments of a dry spinel lherzolite from Kilborne Hole (KLB-1) were performed. Our experimental results and natural mantle peridotites are significantly different in terms of the stability field and the Cr/(Cr + Al) atomic ratio (= Cr') of chromian spinel. Spinel, which is common in natural mantle peridotite regardless of their bulk chemistry, disappeared at a much lower degree of melting in our experiments. The upper limit of the Cr' of spinel just before its disappearance decreases rapidly from 0.45 to 0.13 with increasing pressure, whereas natural peridotites have a wide range of Cr' from 0.1 to 0.8. Our dry experiments, compared with previous hydrous experiments, indicate that the upper limit of Cr' increases with increasing H_2O content. These findings suggest that the petrological variation of natural mantle peridotite cannot be formed by simple batch melting but may be the result of more complex melting.