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Melting of garnet peridotite: Effects of capsules and thermocouples, and implications for the high-pressure mantle solidus

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ABSTRACT

Experimental solidus determinations for nominally anhydrous fertile peridotites at 4–6 GPa differ by as much as 150 °C. These differences have recently been ascribed to experimental methods, specifically, the use of graphite capsules leading to elevated CO_2 contents during the runs. We examine this claim by directly comparing phase relations of fertile peridotite KR4003 encapsulated in rhenium and graphite sealed in Pt, using an extensively calibrated double capsule and thermocouple assembly. Experiments are conducted at 5 GPa and 1750 to 1575 °C using the MA6/8 multianvil apparatus. We found that the phase assemblages recovered from both capsules of a given experiment are largely indistinguishable down to solidus conditions. The solidus is estimated to be 1600 ± 15 °C, in good agreement with previous experiments on KR4003, but substantially below most other determinations for garnet peridotite solidi at 5 GPa. We find Opx to be stable at the solidus of KR4003 at 5 GPa, in contrast to earlier findings and relate its stability to Fe^{3+} content. Our work further shows that a loss of calibration of the W-Re thermocouple circuit connected through the Re capsule at high temperatures is of the same order as the temperature discrepancy reported previously for fertile peridotite solidi. Revisions to the anhydrous peridotite solidus at high pressures invite reconsideration of potential temperatures of mantle plumes, which could be as much as 150 °C lower than commonly assumed.