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Melting of Earth Deep Mantle Materials

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Solidus phase relations and major elements partitioning have been determined at high pressure for a fertile peridotite (KLB-1) material, with melting experiments carried out on a glass made from a natural mantle peridotite at 50, 90, 110 and 150 GPa. The experiments were conducted in diamond-anvil cells at the high-pressure beamline of the European Synchrotron Radiation Facility (ESRF) so as to use clear in situ melting criterion and to determine phase relationships from X-ray diffraction. Focused ion beam (FIB) sections of the recovered diamond-anvil cell samples were further investigated at the nano-scale by scanning and analytical transmission electron microscopy to check melting/crystallization sequences as well as variations of phase composition with temperature and pressure. Our results show that Mg-perovskite is the liquidus phase as soon as pressures exceed 50 GPa, whereas ferropericlase is the solidus phase. Our results also yield strong constraints on the solidus curve of the lower mantle, which is measured at 4100 K at the core mantle boundary pressure and temperature conditions. These results are discussed in the light of previous measurements carried out on MORB and hydrous mantle materials, and provide new experimental insights into the possible existence of a deep molten layer at the base of the present-day mantle. Finally, our study, which drastically extend the pressure range of results from previous multi-anvil and diamond-anvil cell studies, allow us to constrain the way the putative magma ocean would have crystallized and its implications for deep mantle differentiation.

Keywords: deep mantle, melting, core mantle boundary, peridotite