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Melting phase equilibrium relations in the $MgSiO_3$-SiO_2 system under high pressures

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Abstract

Melting relations in the $MgSiO_3$-SiO_2 system have been investigated at 13.5 GPa using a Kawai-type multi-anvil apparatus. The system displays eutectic melting with the eutectic point located at $SiO_2/(SiO_2+MgO) = 0.61$ (in mol; which is denoted by X_{Si} hereafter) and at 2350 ± 50 °C. Taking into account the eutectic compositions at lower pressures reported in previous studies, i.e., 0.556 at 1 GPa (Hudon et al. 2005) and 0.60 at 5 GPa (Dalton and Presnall 1997), the eutectic composition is slightly enriched in SiO_2 with increasing pressure. The silica-rich eutectic composition is not consistent with the present peridotitic mantle composition ($X_{Si} = 0.43$). Considering Si incorporation into iron alloys in a magma ocean, however, mass-balance calculations based on an E-chondrite model demonstrate that the silicate magma ocean could have X_{Si} consistent with the present peridotitic mantle.

Keywords: Melting, high pressure, $MgSiO_3$-SiO_2 system, mantle, enstatite chondrite model, multi-anvil, pressure calibration, thermal expansion