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Experimental constraints on mantle sulfide melting up to 8 GPa

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Abstract

We present high-pressure experiments up to 8 GPa that constrain the solidus and liquidus of a composition, $Fe_{0.69}Ni_{0.23}Cu_{0.01}S_{1.00}$, typical of upper mantle sulfide. Solidus and liquidus brackets of this monosulfide are parameterized according to a relation similar to the Simon-Glatzel equation, yielding, respectively, T (°C) = 1015.1 $[P(\text{GPa})/1.88 + 1]^{0.206}$ and T (°C) = 1067.3 $[P(\text{GPa})/1.19 + 1]^{0.149}$ ($1 \leq P \leq 8$). The solidus fit is accurate within ±15 °C over the pressure intervals 1–3.5 GPa and within ±30 °C over the pressure intervals 3.5–8.0 GPa. The solidus of the material examined is cooler than the geotherm for convecting mantle, but hotter than typical continental geotherms, suggesting that sulfide is molten or partially molten through much of the convecting upper mantle, but potentially solid in the continental mantle. However, the material examined is one of the more refractory among the spectrum of natural mantle sulfide compositions. This, together with the solidus-lowering effects of O and C not constrained by the present experiments, indicates that the experimentally derived melting curves are upper bounds on sulfide melting in the Earth's upper mantle and that the regions where sulfide is molten are likely extensive in both the convecting upper mantle and, potentially, the deeper parts of the oceanic and continental lithosphere, including common source regions of many diamonds.

Keywords: Sulfide, mantle, solidus, melting, experimental constraint, calibration