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The parental melt of lherzolitic shergottite ALH 77005: A study of rehomogenized melt inclusions

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Abstract

Lherzolitic shergottite ALH 77005 is one of the most primitive martian meteorites. To characterize the parental melt of this primitive meteorite, olivine and chromite-hosted melt inclusions have been experimentally rehomogenized. The rehomogenization was performed with hydrostatic pressures (800–1000 bars) of CO_2 + CO gas along with finely powdered graphite at temperatures of 1150–1185 °C. Equilibrium between the host and inclusion melt was determined based on the lack of zonation in the host surrounding the melt inclusion, equilibrium K_D values of host and melt inclusions, and textures of the melt inclusion. Chromite-hosted melt inclusions, where chromite is poikilitically enclosed by olivine, contain ~7.5 wt% MgO. This composition most closely reflects the parental melt of ALH 77005. The melts trapped in Fo_{75} olivine contain ~7.1 wt% MgO when brought to equilibrium with the host. This olivine-hosted melt inclusion composition has lower SiO_2 (~50 vs. 53.9 wt%) and higher Cr_2O_3 (~1.2 vs. 0.2 wt%) and P_2O_5 (~1.2 vs. 0.5 wt%) than previous estimates for ALH 77005. In addition, compared with the chromite-hosted inclusions, the olivine-hosted ones have higher Al_2O_3 and lower CaO than can be explained through crystallization of phases known to be on the liquidus. This finding suggests that magma mixing occurred between chromite and olivine crystallization or olivine-hosted inclusions were contaminated by secondary minerals such as phosphate. Both olivine- and chromite-hosted melt inclusions in ALH 77005 have slightly higher Al_2O_3 than olivine inclusions in Chassigny but significantly higher Al_2O_3 than nakhlites such as MIL 03346 and Nakhla at similar values of MgO.

Keywords: ALH 77005, SNC meteorite, melt inclusion, parent melt, lherzolitic shergottite, olivine, chromite