American Mineralogist, Volume 106, pages 1835–1843, 2021

Sulfur content at sulfide saturation of peridotitic melt at upper mantle conditions

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Abstract

The concentration of sulfur that can be dissolved in a silicate liquid is of fundamental importance because it is closely associated with several major Earth-related processes. Considerable effort has been made to understand the interplay between the effects of silicate melt composition and its capacity to retain sulfur, but the dependence on pressure and temperature is mostly based on experiments performed at pressures and temperatures below 6 GPa and 2073 K. Here we present a study of the effects of pressure and temperature on sulfur content at sulfide saturation of a peridotitic liquid. We performed 14 multi-anvil experiments using a peridotitic starting composition, and we produced 25 new measurements at conditions ranging from 7 to 23 GPa and 2173 to 2623 K. We analyzed the recovered samples using both electron microprobe and laser ablation ICP-MS. We compiled our data together with previously published data that were obtained at lower *P*-*T* conditions and with various silicate melt compositions. We present a new model based on this combined data set that encompasses the entire range of upper mantle pressure-temperature conditions, along with the effect of a wide range of silicate melt compositions. Our findings are consistent with earlier work based on extrapolation from lower-pressure and lower-temperature experiments and show a decrease of sulfur content at sulfide saturation (SCSS) with increasing pressure and an increase of SCSS with increasing temperature. We have extrapolated our results to pressure-temperature conditions of the Earth's primitive magma ocean, and show that FeS will exsolve from the molten silicate and can effectively be extracted to the core by a process that has been termed the "Hadean Matte." We also discuss briefly the implications of our results for the lunar magma ocean.

Keywords: Peridotitic melts, sulfur solubility, high pressure, high temperature, magma ocean