Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.36745

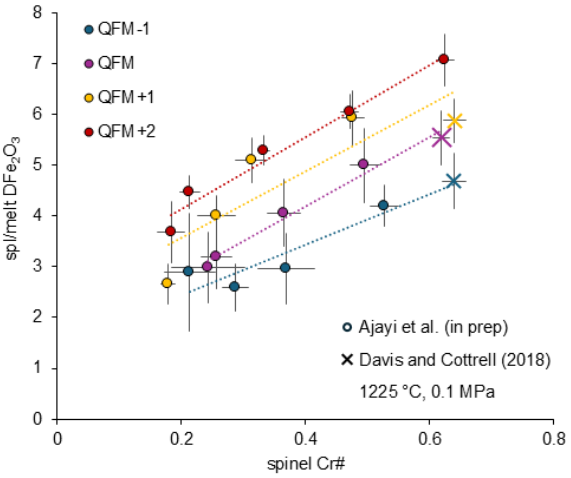
Effects of mineral and melt composition on partitioning of Fe_2O_3 between spinel and melt during basalt generation in Earth's upper mantle

FRED A DAVIS[1,2], ELIZABETH COTTRELL[1], AYOMIDE R AJAYI[2] AND LOGAN T LITTLE[2]

[1]National Museum of Natural History, Smithsonian Institution
[2]University of Minnesota Duluth

$Fe^{3+}/\Sigma Fe$ of mid-ocean ridge basalt (MORB) source mantle is a key variable for predicting phase equilibria in Earth's upper mantle. Depth of metal saturation [1] and the carbonatite to diamond transition [2] depend on mantle fO_2 and, therefore, $Fe^{3+}/\Sigma Fe$. Connecting $Fe^{3+}/\Sigma Fe$ measured in MORB to the $Fe^{3+}/\Sigma Fe$ of their mantle sources requires accurate mineral/melt partition coefficients for Fe_2O_3 (DFe_2O_3). Despite its low modal abundance, spinel is a major host of Fe_2O_3 in peridotites and has significant leverage over bulk partitioning of Fe_2O_3 between peridotite and low-degree melts. Davis and Cottrell [3,4] demonstrated that spinel/melt DFe_2O_3 increases as the concentration of Fe_2O_3 in spinel increases and suggested that spinel/melt DFe_2O_3 decreases with increasing temperature. Compositional variables, especially spinel Cr# (Cr/[Al+Cr]), may also affect spinel/melt DFe_2O_3.

We performed experiments with liquids saturated in a spinel peridotite mineral assemblage at 0.1 MPa and 1.5 GPa to explore the effects of varying spinel Cr# on spinel/melt DFe_2O_3. These experiments corroborate the effect of spinel Fe_2O_3 on spinel/melt DFe_2O_3 [3,4] and demonstrate a positive correlation between spinel Cr# and spinel/melt DFe_2O_3. In experiments performed at 1225 ºC and log fO_2 of QFM-1, QFM, QFM+1, and QFM+2, spinel/melt DFe_2O_3 increased in each fO_2 series by 0.5 to 0.7 per 0.1 increase in spinel Cr# (Figure 1). Although high Cr# spinels in 1.5 GPa experiments tend to have higher DFe_2O_3 than low Cr# spinels, the relationship is less clear. Generating multiply saturated melts at constant temperature but varying spinel Cr# necessitated compositional changes to coexisting melts. These changes led spinel Cr# to correlate positively with melt SiO_2, Na_2O, and K_2O and negatively with melt MgO. Using the current data set, we cannot deconvolve potential spinel Cr# effects from those of melt composition. Melt and mineral compositions evolve as melt is extracted from the MORB source region, and refining the compositional variables that affect DFe_2O_3 is critical for accurately modeling $Fe^{3+}/\Sigma Fe$ of primitive MORB and its residues.



[1] Rohrbach et al. (2007), *Nature* 449; [2] Stagno & Frost (2010), *EPSL* 300; [3] Davis & Cottrell (2018), *Am. Mineral.* 103; [4] Davis & Cottrell (2021), *Contrib. Mineral. Petrol.* 176