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The relationship between $Fe^{3+}/\Sigma Fe$ of melts and peridotite minerals

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The relationship between the Fe^{3+}/FeT of MORB and the Fe^{3+}/FeT of the solid, convecting, upper mantle is unknown yet critically constrains geophysical observations and mantle fO_2 as a function of depth, temperature, lithology, and time. Natural observations and experimental determinations of Fe^{3+} partitioning between basalts and peridotite residues suggest that as melting proceeds in the spinel stability field, mineral chemistry and mode in the peridotite may evolve such that the system maintains approximately constant melt Fe^{3+}/FeT, and hence constant residue fO_2 [1]. To accurately model the evolution of the rock-melt system and project the composition of peridotite back along the melting column to infinitesimal melt fractions will require quantification of mineral chemistries (including Fe^{3+}/FeT) as a function fO_2, P, and T. We equilibrated silicate melts and mineral assemblages of olivine, orthopyroxene, and spinel, ±clinopyroxene, over a range of fO_2 and spinel Cr# at 1 atmosphere and 1.5GPa. Spinel oxybarometry and glass Fe^{3+}/FeT both record the measured furnace (or calculated FePt capsule) fO_2. increases as a function of spinel Fe_2O_3 [2] and decreases as a function of temperature [3]. New 1 atmosphere experiments show that increases by a factor of 2 to 2.5 as spinel Cr# increases from approximately 0.18 to about 0.65. Because average spinel Cr# increases as a function of mantle potential temperature, we predict that spinel Cr# and Tp will exert competing effects on during MORB generation and modulate observed variations in MORB Fe^{3+}/FeT as a function of extent of melting and potential temperature [4].

[1] Birner et al., EPSL (2021) *Earth and Planetary Science Letters* 566: 116951.

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[3] Davis and Cottrell, (2021) *Contributions to Mineralogy and Petrology* 176.9: 67.

[4] Cottrell and Kelley, (2011) *Earth and Planetary Science Letters* 305.3-4: 270-282.