Crystallization of spinel-structured oxides from hydrous mafic melts: Implications for liquidus stability of chromite and magnetite under oxidizing conditions

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Naturally occurring magnetite and chromite are common accessory minerals in mafic-ultramafic igneous rocks. Under the oxidising conditions prevalent in subduction zone settings, these spinel-structured oxides crystallise early and thus are likely to reflect the state of the primary or near-primary magmas. Experimental studies have elucidated spinel-melt chemical systematics. However, to date the majority of experiments have been conducted using common basaltic melts at low to moderate oxygen fugacities. To extend this restricted parameter space, we have performed a series of Internally-Heated Pressure Vessel experiments to induce crystallization of spinel-structured oxides in hydrous boninitic and basaltic melts at 2 kbar, at a range of magmatic temperatures (1100-1200°C), and elevated oxygen fugacities (*c*. 0-3 log units above the Ni-NiO buffer). The products of these experiments include spinels with a variety of compositions and display distinct petrographic relationships, which allow us to examine the role spinel plays in early melt evolution. Ferrichromite stabilizes in boninite during orthopyroxene crystallization, while titanomagnetite forms as a late-occurring phase in undercooled (1100°C>T>600°C) residual melts. Basalt crystallizes ferrichromite prior to pyroxene, which nucleates on microlitic spinel grains. At lower oxygen fugacities and high temperatures, spinel does not crystallize, and without a nucleation site, silicate crystallization is less prolific. At 1150°C and near the NNO buffer, chromite crystallizes from basalt in minute quantities. Thus, under oxidizing conditions (NNO to NNO+3), spinel-structured oxides are primary products of crystallization in mafic melts, forming before or stabilizing with commonly observed silicate phases. Silicate minerals drive melt evolution. Our data can be usefully employed to model liquid lines of descent of mafic arc magmas with a range of Cr_2O_3 and FeO-Fe_2O_3 contents.