An experimental study of the effect of water on chromite saturation in komatiites

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Chromite is an oxide mineral and the only chromium ore. Economically important deposits of chromite (massive chromitite) are associated with ancient ultramafic magmas known as komatiites. One such deposit has recently been discovered in the Ring of Fire area of the James Bay Lowlands, Ontario. Despite their economic value, the conditions of formation of massive chromitite are poorly constrained. The purpose of this investigation is to characterize the impact of magmatic water on the mineral phase relationships in komatiitic magmas. Orthopyroxene, an important constituent in komatiites, readily incorporates chromium into its crystal lattice. The early crystallization of orthopyroxene, therefore, inhibits the precipitation of chromite by depleting chromium in the melt. Studies of more felsic systems have shown that magmatic water significantly decreases the crystallization temperature of most silicate phases, but that it has a relatively lesser effect on oxides. Phase equilibrium experiments allow us to test the hypothesis that, by depressing the liquidus of orthopyroxene relative to that of chromite, magmatic water can facilitate the early crystallization and subsequent accumulation of chromite in a komatiitic melt. To accommodate water, experimental charges are sealed in graphite-lined platinum capsules and pressurized to 1 GPa in a piston-cylinder apparatus. This results in fixed pressure and redox state, allowing phase equilibria to be determined as functions of temperature and composition. Preliminary data from this study suggest that water does affect the chromite liquidus, and that olivine may be a heretofore overlooked competitor for chromium. In addition to phase characterization by electron microprobe analysis, we will analyse for chromium and trace element partitioning between mineral phases and melt using laser-ablation inductively coupled plasma mass spectrometry. If trace element partitioning is sensitive to water content, and water content affects the chromite formation capacity of a melt, then such a fingerprint may have applications in characterization of natural komatiites. Komatiites are some of the oldest lavas and best-preserved relics of the Archean Earth. Expanding our understanding of komatiites and their crystallization behaviour could provide important constraints on early Earth processes, including those associated with highly valued ores.

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