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The role of contamination in the formation of chromitites: Further evaluation of Irvine's hypothesis

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The Ring of Fire Intrusive Suite (ROFIS) in the James Bay lowlands, Ontario, is emplaced into the 2.734 Ga McFauld's Lake greenstone belt, and hosts five chromite deposits, including nearly monomineralic chromitites. Here and elsewhere on Earth, such concentrations of chromite represent apparent anomalies in the magma differentiation process, requiring a change from the "normal" sequence of olivine, then olivine + chromite, with the latter olivine:chromite of ~50:1. The origin of chromitites is still debated, with contamination as one model, whose details were proposed in the oft-cited work of Irvine (1975; GCA vol 39, pp 991-1020). Although Irvine later questioned the general applicability of his model, contamination is a common feature of chromitite-bearing intrusive suites, and its effect on chromitite formation has not been extensively tested. We have addressed this shortcoming in a series of experiments involving mixtures of komatiite-ROFIS country rock (granodiorite, banded iron formation; BIF) to measure phase equilibrium, chromite solubility, and chromite composition. Experiments involved equilibrating synthetic Cr-bearing komatiite containing 0-50 wt.% Cr-free contaminants on Fe-presaturated Pt or Ir loops at 1200-1450^{o}C and 0.1 MPa at the FMQ oxygen buffer in a vertical tube furnace. Additional experiments were done at 1 GPa using graphite-lined Pt capsules to assess the effect of water on olivine-chromite phase relations. Results of the low pressure experiments show that the effect of contamination on the chromite solubility is minor: at 1400^{o}C, the solubility decreases by 3.5% and 6% with the addition of up to 50% granodiorite and BIF, respectively. The primary effect of contamination is to decrease the modal abundance of olivine, and increase the chromite:olivine cotectic proportions. At 1400^{o}C, chromite crystallization in the absence of olivine requires assimilation of relatively large (~40%) amounts of either contaminant. Therefore, in agreement with Irvine (1977), although *possible*, chromitite formation by contamination under dry conditions seems geologically *implausible*. Results of the high pressure experiments indicate that the addition of water-alone increases the solubility of chromite, which could eliminate any chromite-only crystallization interval induced by contamination. The combined effects of water and contamination are as yet uncertain, and is the subject of onging experiments.