The role of country rock assimilation on chromite crystallization in the Ring of Fire, James Bay lowlands, Ontario, Canada

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The Ring of Fire (RoF) intrusion in the James Bay lowlands, Ontario, is emplaced in the 2.7 Ga McFauld's Lake greenstone belt, and hosts the Black Thor, Big Daddy, Blackbird, and Black Label chromite deposits, together comprising ~192.7 million tonnes of measured and indicated chromite resources. Evidence suggests that magma contamination occurred during the emplacement of the RoF intrusion - a process that has been widely invoked for the formation of massive chromitite segregations. We have evaluated the role of contamination as a chromitite-forming mechanism in the RoF context by combining phase equilibrium experiments with trace element measurements on chromite, and modelling. Experiments involved equilibrating mixtures of synthetic komatiite and country rocks to the RoF intrusion (banded iron formation, Fe-rich metasedimentary rock and granodiorite) at 0.1 MPa and the FMQ buffer to measure phase equilibria, chromite solubility, and chromite composition. The most notable results are: (1) melt FeO content has the strongest compositional influence on the chromium content of the melt at chromite saturation (CCCS); increasing melt FeO lowers the CCCS, although this effect is not large; (2) addition of contaminants shifts the olivine-chromite cotectic roughly parallel to the olivine-quartz join of the olivine-quartz-chromite ternary, but maintaining curvature concave to the olivine-quartz join; and (3) the Cr/Fe ratio decreases with temperature, and does not show any systematic changes with contaminant type. The presence of both cumulate chromite and ferromagnesian phases (olivine, orthopyroxene) suggests a chromitite-forming mechanism that increases the chromite/silicate ratio beyond normal cotectic proportions. Results from experiments suggests this is possible by the addition of a more siliceous component, or by cooling of any of the compositions investigated, but cannot solely account for rocks with chromite/olivine >1; other processes, such as crystal sorting, are required. We are now searching for additional evidence of contamination through LA-ICPMS analysis of individual chromite grains from various RoF chromitites, and employing available chromite-melt partition coefficients to establish the trace element characteristics of the chromite-forming magma. Results so far indicate that relative to average Munro Township komatiite (MTK), the compositions of chromite-forming magmas are similar to or enriched (up to 3-fold) in Hf, Ta, and Zr, and similar to or depleted (up to 2-fold) in Co, V, Ga, and Sc. Compared to mixtures of MTK and either BIF, Fe-rich metasedimentary rock or granodiorite, calculated chromite-forming magmas show more similarity to sediment-contaminated compositions, although the match is still imperfect.

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