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Archean Komatiitic Sill-hosted Chromite Deposits in the Zimbabwe Craton

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Abstract

Lenticular chromite deposits of widely varying age, metamorphic grade and strain rate, as well as size, shape, and ore quality, are widespread in greenschist to amphibolite grade greenstone-gneiss terrain in the south-central part of the Zimbabwe craton and in granulite grade equivalents in the Northern Marginal zone of the Limpopo belt in the far south. In order of age and, very approximately, decreasing abundance, they form three groups: (1) early Archean (3.5–3.2 Ga) deposits associated with amphibolite grade greenstone remnants in the 3.6 to 3.35 Ga Tokwe gneisses (e.g., Hornet, Valley) and on the amphibolite grade eastern flank of the Shurugwi greenstone belt, and granulite grade greenstone remnants in the Northern Marginal zone (e.g., Inyala, Rhonda); (2) mid-Archean deposits within the ca. 3.0 Ga Shurugwi Group in the main greenschist part of the Shurugwi belt (e.g., Peak, Railway Block) and associated with the ca. 3.0 Ga Belingwean Supergroup in several other belts; and (3) late Archean (ca. 2.74 Ga) deposits mostly in the western segment of the Masvingo belt (e.g., Prince).

With their host and country rocks, the deposits together preserve geologic and chromite compositional evidence of formation within poorly differentiated, komatiitic sills intruded into predominantly siliciclastic, BIF platformal sedimentary sequences associated with mafic and/or ultramafic lavas. Unlike the thin, laterally extensive chromitite layers associated with macrocyclic units of large, layered intrusions, the komatiitic sill-associated deposits are the remnants of laterally discontinuous (up to several tens of meters) thick chromitite layers or dunite-chromitite zones located at high stratigraphic levels of their host intrusions not far below the upper pyroxenite differentiates. In at least some deposits—for example, at Railway Block, where the chromitites form narrow, elongate bodies at least 1,000 m long—the lateral discontinuities are most likely primary; in many others, later deformation obscures the primary geometry.

Chromitite formation may have been delayed by the late attainment of equilibrium crystallization and the reduced nature of the magma. The crystallization of thick, massive, cyclically layered, Cr-rich chromitites was most probably controlled by the stabilization of chromite relative to olivine by absorption of connate water derived from wet host sediments and by episodic, flow-through processes which, at Railway Block, may have been focused along narrow pathways across the magma chamber floor. The remarkable abundance of such chromitites and their formation in repeated episodes over 1,000 m.y. (cf. other cratons) can be attributed to generation of komatiitic magmas in a mantle source that was both Cr rich and strongly reduced. Archean komatiitic sill-hosted deposits constitute a third type of chromite deposit in addition to stratiform and podiform deposits in layered intrusions and ophiolites, respectively.

The economically important variability of bulk ore compositions (especially Cr, Fe, Al, Mg) is due to several factors: magnetite introduction during serpentinization and talc-carbonate alteration at greenschist grade, subsolidus fluid-related and other metamorphic cation exchange processes (dependant on chromite body size), and, possibly, exsolution of Cr-Al and magnetite phase pairs, both at midamphibolite to granulite grade, as well as fluid-related retrogression and partial conversion of chromite to (mainly) chlorite during amphibolite metamorphism.

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