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Parent melt composition and tectonic significance of chromites from an Archean mafic-ultramafic complex at the boundary between Western and Eastern Dharwar Craton, India

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Chromite-bearing mafic-ultramafic assemblages in Archean terranes preserve critical information on mantle melting regimes, magma evolution, and tectonic setting during the early history of the Earth. In this study, we present the major-element chemistry of chromites from the Archean ultramafic complex from the southern end of the Archean Chitradurga greenstone belt near the tectonic contact between the Eastern and Western Dharwar Cratons of the southern Indian shield.

The studied chromites display wide compositional variability across lithologies (dunite, chromitite, serpentinite, pyroxenite, and amphibolite). Petrographic observations indicate minimal compositional zoning, suggesting preservation of primary magmatic signatures. Massive chromitite bears chromites characterised by high Cr# (0.7-0.8) and moderate Mg# (0.4-0.5), while chromites in other lithologies span broader ranges with a high Cr# (> 0.6) and Mg# (< 0.5). Chromites in dunite, on the other hand, encompass both the high-Cr (Cr# > 0.6) and high-Al (Cr# < 0.6) varieties. Parental melt compositions calculated from chromite major element chemistry yield Al_2O_3 contents of ~5.9-15.1 wt%, FeO/MgO ratios of ~0.6-12.8, and TiO_2 concentrations of < 0.7 wt%, indicating derivation from high-Mg mantle melt, possibly of boninitic composition.

When compared with existing chromite datasets from different tectonic settings, the majority of studied chromites show compositional overlap with chromites from arc-basalts and SSZ peridotites due to their low Al_2O_3 and TiO_2 content. Higher Cr# (> 0.6) in these chromites across all lithologies is inconsistent with their evolved parent-melt composition, as observed in layered mafic intrusions. Such a comparison indicates that these chromites formed from primitive, high-degree partial melts derived from a depleted mantle wedge typical of an arc setting. Based on the existing data, we infer that the genesis of these rocks likely occurred in an Archean supra-subduction setting.