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Genesis and magmatic evolution of layered chromitites in the Gayahe mafic-ultramafic complex (East Kunlun Orogenic Belt, China)

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The Gayahe mafic-ultramafic complex in the East Kunlun Orogenic Belt (EKOB) hosts layered chromitites spatially and genetically linked to a rhythmic lithological sequence of serpentinized dunite, pyroxenite, and olivine pyroxenite. Apatite U-Pb geochronology constrains chromite mineralization to peak mantle-derived magmatic activity at ca. 430 Ma in the EKOB, confirming their coeval formation.

Chromitites occur as massive ores and disseminated spinel-group minerals within ultramafic hosts. Primary chromite compositions exhibit limited $Cr^{\#}$ [Cr/(Cr+Al) = 69.2–83.3] and $Mg^{\#}$ [Mg/(Mg+Fe^{2+}) = 46.7–59.5], reflecting melt evolution under high oxygen fugacity. Post-magmatic hydrothermal alteration produced core-rim textures in spinel grains, marked by progressive $Cr^{\#}$ and $Mg^{\#}$ depletion. Massive chromitites, shielded by high chromite/silicate ratios, retain pristine compositions, while altered chromite displays distinct “ferrian-chromite” rims attributed to solid-state re-equilibration and serpentinization.

Trace element trends reveal systematic enrichment: massive chromitites show low Ti, Ni, and Ga with elevated Zn, Co, and Mn, mirroring parental magma evolution. MORB-normalized trace element patterns align with layered intrusion analogues. Reduced parental melt calculations (Al_2O_3-TiO_2 systematics) and elevated Ni in ultramafic-hosted olivine (up to 2,800 ppm) indicate derivation from melts in a subduction-modified island arc. Chromitite geochemistry further points to boninitic affinities, consistent with arc-related melt-peridotite interaction in a suprasubduction zone.

These findings establish that Gayahe' s high-Cr chromitites formed via melt segregation from boninitic precursors in an arc setting, with subsequent hydrothermal overprinting governed by chromite abundance. The study provides a robust framework for understanding chromitite genesis in convergent margin mafic-ultramafic systems.