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High-Cr and High Al chromite from the Nidar Ophiolite Suite, Ladakh, India: implications for its petrogenesis and tectonic evolution

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The Nidar Ophiolite Suite (NOS) is well exposed in the Indus Suture Zone that separates the Indian plate in the south from Asia to the north, where the ophiolite sequence is best exposed in the Nidar Valley and the outcrop is elongated NW-SE along the regional tectonic trend. The Nidar ophiolite contains both mantle and crustal sections. The mantle section includes ultramafic rocks, namely lherzolite, harzburgite, dunite and serpentinized peridotite with chromite. In the present study, our focus is on chromium-spinel (chromite), which is a common mineral in ophiolitic rocks, and the study of this mineral from the mantle sections of NOS ophiolites can shed light on their petrogenetic origin and tectonic setting.

NOS contains disseminated chromite grains in mantle harzburgites and podiform chromitites associated with dunites and serpentinized peridotites. Due to alteration, most chromite grains display compositional zoning, but the fresh cores preserve primary igneous compositions. Podiform chromitites in the NOS dunites and serpentinized peridotites are compositionally similar to typical ophiolitic chromitites elsewhere. NOS chromite samples exhibit two clusters based on Mg and Cr numbers, indicating two different chromite formation stages.

They are in the initial chromite precipitating stage and later form chromite pods due to the accumulation of chromite crystal precipitation. Chromite from can be texturally and chemically classified into two main types: primary high-Al (spinel Cr# < 0.67) and high-Cr (spinel Cr# > 0.75) chromite. High Cr/Al ratios of the investigated spinel cores (Cr# 0.7– 0.81) point to a higher degree of partial melting of the depleted mantle source. Low (Cr# 0.27-0.4) indicates a lower degree of partial melting. MORB-like tholeiitic melt generated during proto-forearc spreading at the onset of subduction leads to the generation of high-Al chromite. In contrast, the latter was formed from boninitic melts resulting from the high degree melting of the sub-arc depleted mantle in slab-derived fluids at a mature-arc stage.

However, chromite grains in the peridotites show mixed MORB and arc signatures. Thus, the mineralogy and geochemistry of the NOS peridotites suggest that the chromite in the NOS formed in a forearc tectonic setting during a reaction between boninitic melts and MORB-type harzburgite in a supra-subduction zone (SSZ) mantle wedge.