Taking fingerprints of metamorphism in chromite using minor and trace elements

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A two-stage mechanism associated with the infiltration of fluids during retrograde metsamorphism from eclogite to amphibolite facies in the ultramafic massif of Golyamo Kamenyane (Bulgaria) has produced four types of microstructures in chromites: i) porous chromite, with chlorite in the pores, ii) non-porous chromite, iii) partly altered chromite, with primary cores surrounded by porous chromite, and iv) zoned chromite, with primary cores surrounded by non-porous rims.

LA-ICP-MS analysis shows that partly altered chromite cores and their surrounding rims of Fe^{2+}-rich porous chromite show a distribution of minor and trace elements similar to chromite from MORB, except for a strong depletion in Ga and Sc. However, single grains of porous chromite produced after the massive infiltration of fluids show a significant enrichment in Zn, Co and Mn but depletion in Ga, Ni and Sc. Non-porous chromite (i.e., ferrian chromite), forming single grains and rims on zoned chromites, are also enriched in Zn, Co, Mn and depleted in Ga but are distictively enriched in Ti, Ni and Sc. This suggests that oxidising fluids have substantially obliterated the geochemical fingerprint of the magmatic chromite. The cores of zoned chromite show higher contents of Zn, Co and Mn as well as lower Ga, Ti and Sc than the cores of partly altered chromite. The complex changes in these elements with respect to the $Fe^{3+}/(Fe^{3+}+Fe^{2+})$ ratio suggests a complex interplay of substitutions between chromite in pre-existing cores and that in the younger metamorphic rims formed during subsequent subsolidus re-equilibrium.

Our results demonstrate that fluid-assisted metamorphism can effectively disturb the primary magmatic abundances and distribution of minor and trace elements in chromite.