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Trace element characterization of Cr-spinel in forearc mantle peridotites from the Marianas and Himalayas

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Chromium-spinel (chromite) is a common accessory phase of mafic and ultramafic rocks. Since it is alteration resistant, it is useful in petrogenetic studies of host igneous rocks, but the major element composition of spinel is not sufficient to fingerprint different tectonic settings. Since there are very few data on the trace element composition of spinel, we examined the minor and trace element composition of spinel in forearc mantle peridotites from two well-known locations: Marianas and Himalayas. In the Marianas, partially to totally hydrated peridotites protrude as serpentinite diapirs from the base of the mantle wedge in the outer 100 km of the forearc. The origin of the Himalayan peridotites is similar to that of the Mariana samples. They were exumed together with the Tso Morati ultrahigh pressure unit, once sedimentary rocks on the margin of the Indian continent prior to being subducted to a depth of ~ 120 km beneath Eurasia at ~55 Ma.

Bulk rock compositions, relict minerals and textures indicate that all samples are harzburgite. This is consistent with high Cr in spinel (Cr# = Cr/[Cr+Al] = 0.60-0.76 in the Marianas and 0.68-0.73 in the Himalayas). Cr-spinel is commonly rimmed by ferritchromite and magnetite, but cores contain low YFe^{3+} (Fe^{3+}/[Fe^{3+}+Al+Cr]= 0.01-0.06 in the Marianas and ~0.04 in the Himalayas); these cores were analyzed for trace elements using a laser-assisted ICP-MS.

Spinel contains significant contents of Mn, Zn and V: 1160-4310 ppm Zn, 1610-2660 ppm Mn and 363-1900 ppm V in the Marianas, and 2365-4080 ppm Zn, 2430-5540 ppm Mn and 701-1020 ppm V in the Himalayas. All three elements are inversely correlated with Mg#. The contents of Ni and Co are similar in two locations, ranging from 276 to 700 ppm. Titanium contents of different spinel grains in individual samples are similar, but they vary from ~ 20 to 800 ppm among different samples. Gallium and Al show a strong positive correlation in both locations, with Ga/Al ratios of 2.1 - 4.2E-4. The values are comparable to primitive mantle values, suggesting the coherent behavior of Ga and Al. Elements that are known to have an affinity with oxides are all detected in these Cr-spinels, including Zr (<0.46 ppm), Y (<0.015 ppm), and Sc (<4.2 ppm). Surprisingly high Nb/Zr (0.6-1.2) Zr/Y (20-180) and Sc/Y (700-3900), in contrast to primitive mantle values (0.06 2.4 and 3.8, respectively) suggest that spinel contributes to the fractionation of high-field strength elements.