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Precipitation and dissolution of chromite by hydrothermal solutions in the Oman ophiolite: New behavior of Cr and chromite

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Abstract

Chromite is a typical refractory igneous mineral, precipitated from mafic magmas at relatively high temperatures. Chromites commonly occur in sedimentary, metamorphic, and metasomatic rocks, where they are interpreted as relics of an igneous phase and serve as the source of Cr for low-temperature Cr-bearing minerals. We present evidence for the nucleation of chromite within hydrothermal solutions. We have found minute euhedal chromite grains enclosed by uvarovite (Ca-Cr garnet) in a diopsidite, metasomatically replacing the layered gabbro of the Oman ophiolite. The uvarovite shows oscillatory concentric zoning in terms of Cr no. [Cr/(Cr+Al)], and the chromite is embedded only in the high-Cr-no. zones of the uvarovite. Another diopsidite, replacing peridotite in the underlying upper mantle section, contains xenocrystic chromite, which is partly dissolved. This suggests that a hydrothermal solution collected Cr by partial to total dissolution of chromite within the upper mantle and precipitated chromite, along with high-Cr-no. uvarovite, within the lower crust upsection. The metasomatic agent involved was a CO_2-, SO_2-, and Cl-bearing hydrothermal solution containing appreciable silicate components that could carry Cr, possibly as a complex. The hydrothermal chromite is similar in chemistry to that commonly found in igneous rocks [e.g., Cr no. = 0.8, $Mg/(Mg+Fe^{2+}) = 0.1–0.2$, $TiO_2 < 0.3$ wt% and $Fe^{3+}/(Cr+Al+Fe^{3+})$, up to 0.3], but its Cr no. is clearly different from that of mantle chromite (0.6–0.7) in peridotites and chromitites from the Oman ophiolite. The results from this study suggest that a hydrothermal origin is possible for chromites in ultramafic rocks that have experienced fluid activity assuming that there is sufficient chromite at the fluid source.

Keywords: Hydrothermal chromite, uvarovite, diopsidite, Oman ophiolite