Hydrothermal activity and chromitite formation

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Chromitites (aggregates of chromite or chromian spinel) have given us various pieces of information on various mantle processes, including magmatism, magma/peridotite reaction and mantle dynamics [1]. Podiform chromitites typically form as magmatic cumulates from chromite-oversaturated melt within conduits in the mantle peridotite [2].

The role of water or aqueous fluids in chromitite formation has been proposed [3, 4], but no clear evidence for it has been shown to date. In early stages of chormitite study, geologists considered important roles of water in chromitite formation because of a selectieve association of serpentines or serpentinites with chromitites [e.g., 5, 6]. The close association of chromitites and serpentinites is, however, due to a high-Mg character of olivine in and around the chromitite. The high-Mg olivine suffers from serpentinization at lower temperatures than lower-Mg ones. Silicates, especially olivine, react with associated chromite to form chlorites at the temperature where olivine alone is not serpentinized. Water is apparently cocentrated as secondary minerals in and around chromitites, which had misled early geologists.

In the Oman ophiolite, high-temperature hydrothermal fluids precipitated diopsidites possibly replacing peridotites [7] or layered gabbros [8]. Some of them contain chromites, some of which show small pod-like or seam-like concentrations [9, 10]. High-T aqueous fluids containing Cl, S and C, can mobilize Cr and precipitate chromite in the mantle [9]. They are definitely “hydrothermal chromitites”. Sub-arc metasomatized peridotites contain secondary chromite closely associated with fluid inclusions [11], indicating Cr mobility via fluids within the mantle wedge. Hydrothermal chromitites are expected to form in the mantle where fluid circulation is available.

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