Formation and modification of chromitite in the mantle

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Chromitites (aggregates of chromite or chromian spinel) inform us of various mantle processes, including magmatism, magma/peridotite reaction and mantle dynamics [1]. They typically form as magmatic cumulates from chromite-oversaturated melt within conduits in the mantle peridotite [2]. They are usually enveloped by replacive dunite [1]. In Oman, both concordant and discordant chromitites are of low-P (upper mantle) magmatic origin [3] [4]. Their chromite grains contain inclusions of pargasite, aspidolite and pyroxenes, which suggest low P. Mineral chemistry suggests involvement of MORB for the concordant chromitite, and of arc-related magma for the discrodant one. This is consistent with the switch of tectonic setting, from MOR to SSZ, for the Oman ophiolite magmatism. Only the concordant chromitite shows metamorphic characters, i.e. exsolution of diopside in chromite and outward diffusion of Ni (< 30 cm) in the dunite envelope [5], indicating its longer residence in the mantle.

Ultra-high pressure (UHP) chromitites have been reported from the Tibetan and Polar Ural ophiolites [6] [7]. Most of their petrographic characteristics can be explained by UHP "metamorphism" of low-P magmatic chromitites above [8]. This may suggest recycling of low-P chromitite as deep as the transion-zone mantle [9]. The UHP chromitite is, however, still highly enigmatic: some characteristics, e.g., the amount and origin of carbon as diamond, are difficult to explain.

High-T aqueous fluids containing Cl, S and C, can mobilize Cr and precipitate chromite in the mantle [10]. Chromite was dissolved and precipitated in/from high-T fluids which formed diopsidites in Oman. Chromite was concentrated to form thin "hydrothermal chromitite". Sub-arc metasomatized peridotites contain secondary chromite closely associated with fluid inclusions, indicating Cr mobility via fluids within the mantle wedge. Hydrothermal chromitites are expected in the mantle where fluid circulation is avalable.

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