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Textural and petrological characteristics of ultrahigh-pressure chromitites, indicating a mantle recycling origin?

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Podiform chromitites, which occur as irregular to lens-like chromite-rich bodies within mantle peridotite in ophiolites, show various petrological characteristics, suggesting various origins. Some of them contain ultrahigh-pressure (UHP) minerals such as diamond, moissanite and Fe silicides (= UHP chromitites) (e.g., Robinson et al., 2004; Yang et al., 2007). Their origin is highly enigmatic, because the podiform chromitites have been widely understood as low-P (uppermost mantle level) products (e.g., Arai and Yurimoto, 1994; Zhou et al., 1994).
Ordinary podiform chromitites show various lines of evidence for low-P genesis. Chromian spinel (or chromite) frequently contains solid mineral inclusions, and one of their main phases is pargasite, which is stable up to 3 GPa (e.g., Niida and Green, 1999), one of typical low-P minerals. The melt-harzburgite intereaction is a fundamental process in podiform chromitite genesis (e.g., Arai and Yurimoto, 1994), and associated with incongruent melting of orthopyroxene in harzburgite to form dunite and relatively Si-rich melt, which is operative at low-P conditions (e.g., Kushiro, 1969). We are strongly required to incorporate the genesis UHP chromitite into the framework of podiform chromitite genesis. Arai (2010) proposed a hypothesis of deep mantle recycling of ordinary low-P chromitite for the genesis of UHP chromitite. We try to examine petrographical and petrological characteristics of UHP chromitites to check the hypothesis of Arai (2010).
Some peculiar textures of podiform chromities, such as orbicular, nodular and anti-nodular textures, are interpreted to be primary igneous and particular to ordinary low-P igneous chromitites (cf. Nicolas, 1989). To be interesting, the nodular texture, characterized by oval aggregates of chromian spinel (= chromite nodules; $\sim$1 cm across) set in olivine-rich matrix, is also observed in some of UHP chromitites from the Luobusa ophiolite, Tibet (e.g., Yamamoto et al., 2009). We carefully examine the nodular-textured UHP chromitites from Luobusa (Yamamoto et al., 2009) to compare with nodular-textured chromities from the Oman ophiolite, which we consider as of typical low-P origin. They are completely different. The chromite nodule is an aggregate of subhedral to euhedral chromian spinel grains with interstitial olivine from the Oman chromitite, but is apparently an oval-shaped spinel grain cut by fractures filled with olivine (= COF (chromite cut by olivine-filled fractures) texture). Similar COF texture was confirmed from possible UHP chromitites from Ray-Iz ophiolite, the Polar Urals (Trumbull et al., 2009; Shmelev, 2011). Chromian spinel is totally free from pargasite and other inclusions in UHP chromitites (Miura et al., 2012). Olivine in chromitites with the COF texture is characterized by exceptionally high NiO contents (up to more than 1 wt%).
These characteristics are apparently consistent with the deep recycling origin for the UHP chromitites. The COF texture is a result of a rheological contrast between olivine and chromian spinel during the travel of the chromitite in the mantle. The high Ni character of olivine is due to diffusion of Ni from chromian spinel during the recycling. The primary nodular-textured chromitite of low-P igneous origin can be basically preserved even after deep recycling, although compaction and possible phase transformation had occurred.