

Inter-mineral magnesium and iron isotope fractionations in ultrahigh-pressure metamorphosed mafic-ultramafic rocks

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To explore the behavior of inter-mineral Mg and Fe isotope fractionations during melt/fluid metasomatism in subduction zones, we obtained high-precision ($\pm 0.06\%$ on $\delta^{26}\text{Mg}$ and $\pm 0.05\%$ on $\delta^{56}\text{Fe}$, 2SD) Mg and Fe isotopic data of olivine (Ol), orthopyroxene (Opx), clinopyroxene (Cpx), phlogopite (Phl) and garnet (Grt) for 15 garnet peridotites and garnet pyroxenites from the Dabie–Sulu and Northern Qaidam ultrahigh-pressure (UHP) metamorphic belts, China.

Magnesium and Fe isotope fractionations between pyroxenes and Ol ($\Delta^{26}\text{Mg}_{\text{Cpx-Ol}} = -0.04$ to $+0.16\%$, $\Delta^{26}\text{Mg}_{\text{Opx-Ol}} = +0.07$ to $+0.16\%$; $\Delta^{56}\text{Fe}_{\text{Cpx-Ol}} = -0.05$ to $+0.22\%$, $\Delta^{56}\text{Fe}_{\text{Opx-Ol}} = -0.07$ to 0.00%) are generally consistent with equilibrium isotope fractionations. By contrast, large disequilibrium Mg isotope fractionation occurs between Cpx and Phl ($\Delta^{26}\text{Mg}_{\text{Cpx-Phl}} = -0.55$ to $+0.40\%$), whereas Fe isotope fractionation between this mineral pair ($\Delta^{56}\text{Fe}_{\text{Cpx-Phl}} = -0.11$ to $+0.04\%$) is close to equilibrium. Both types of inter-mineral isotope fractionation also occur between Cpx and Grt ($\Delta^{26}\text{Mg}_{\text{Cpx-Grt}} = +0.50$ to $+1.12\%$, $\Delta^{56}\text{Fe}_{\text{Cpx-Grt}} = -0.11$ to $+0.56\%$).

Considering the metasomatic origin of phlogopites and some garnets in the samples, the disequilibrium isotope fractionation between Cpx and Phl or Grt implies both a rapid metasomatic process and a rapid exhumation of these UHP rocks. Therefore, inter-mineral Mg and Fe isotope fractionations can potentially be used to constrain the timescale of interactions between melt/fluid and peridotite during subduction processes.