Cryptic metasomatism during exhumation of Franciscan eclogite and hornblendite revealed by *in situ* $\delta^{18}O$ analysis of garnets

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Garnet-bearing metamafic rocks from the Franciscan Complex and Catalina Island preserve textural evidence of high fluid pressure (veins, vugs) and geochemical evidence of large fluxes of water during their metamorphism. Much of the published geochemical evidence is based on analyses of whole rock samples which homogenize differences that exist between and within grains. Eclogite (Junction School) and garnet hornblendite (Panoche Pass) high-grade blocks hosted by the Franciscan Complex contain volumetrically minor retrograde phases (phg + chl + sph ± ab ± gl). Garnets and zircons from these blocks were analyzed for $\delta^{18}O$ by ion microprobe (±0.5‰, 10μm spot) and matrix phases were analyzed by laser fluorination. Eclogite garnet cores contain prograde cation zoning and inclusion assemblages, but are homogeneous in $\delta^{18}O$ (4.0±0.5‰, 2SD) and are not in equilibrium with bulk matrix omphacite (5.8‰). Garnet rims show periods of resorption followed by regrowth (oscillatory cation zoning on a fine scale). Rims contain phg + omph inclusions that yield blueschist-facies P-T, are more variable in $\delta^{18}O$ (6.2±1.2‰), and some domains are in equilibrium with matrix omphacite. Garnet cores from the hornblendite are homogeneous in both $\delta^{18}O$ (11.0±0.5‰) and cation composition, and are also not in equilibrium with matrix hornblende (6.1‰). Garnet rims are compositionally and isotopically (6.6±0.9‰) different from cores, and are in equilibrium with matrix hornblende. The $\delta^{18}O$ of metamorphic zircon (7.2±0.5‰ eclogite, 8.9±1.1‰ hornblendite) are not in equilibrium with garnet cores, and REE patterns suggest formation in the absence of garnet. Zircons record relatively late ages (~145 Ma) for eclogite and hornblendite from the Franciscan, but are similar to garnet blueschist ages. Taken together these data suggest that both samples underwent massive metasomatism during exhumation but were relatively unmodified by fluids during subduction. Similar cation zoning patterns in garnets not in equilibrium with hornblende from Catalina may be indicative of a similar fluid history.

Trace elements in chromite by LA-ICP-MS to constrain the origin of podiform chromitites in the Thetford Mines Ophiolite

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The Thetford Mines Ophiolite (Canadian Appalachians) is a complete ophiolitic sequence consisting of a thick mantle section (5 km), a plutonic crust and a volcano-sedimentary cover dominated by boninitic lavas. This ophiolite is interpreted as a fragment of a fore-arc oceanic lithosphere. It hosts 50 chromitite occurrences and one third of them are of podiform-type and are hosted in a dunitic envelop within the mantle tectonites.

This study presents the concentrations of a complete suite of minor and trace elements (Sc, Ti, V, Mn, Co, Ni, Zn, and Ga) in chromites from podiform chromitites of the Thetford Mines Ophiolite, and from the associated boninite lavas, using laser ablation inductively coupled to a plasmaquadrupole mass spectrometer.

The aim of this study is to use trace elements to constrain the parental melt from which the podiform chromitites have crystallized. The chromites from Thetford Mines Ophiolite podiform chromitite deposits are Cr-rich (Cr# = 100xCr/(Cr+Al) = 69 to 84), Fe-rich (Fe^{2+}# = 100xFe^{2+}/(Fe^{2+}+Mg) = 32 to 46), Mn-rich (1081 to 1962 ppm), Co-rich (166 to 386 ppm), Sc-rich (5.5 to 11.3 ppm), and they are Ti-poor (TiO_2 = 0.06 to 0.18 wt%), Ga-poor (11.3 to 26.5 ppm), and Ni-poor (441 to 875 ppm) compared to MORB chromite (Cr# = 35; Fe^{2+}# = 23; Mn = 881 ppm; Co = 165 ppm; Sc = 5.3 ppm; TiO_2 = 0.22 wt%; Ga = 52.5 ppm; Ni = 1766 ppm). The chromites from Thetford Mines Ophiolite podiform chromitite deposits are similar to chromite in boninites from around the world and to the chromites in the boninite lavas of the Thetford Mines Ophiolite. In addition, the Al/Ti ratios of the chromites have been used to determine the nature of the melts from which podiform chromitites in the Thetford Mines Ophiolite have crystallized. These have been found to closely resemble the boninites capping the crust of the ophiolite.