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Li Metasomatism During Exhumation of the Ultra High-Pressure Garnet Peridotite from the Alpe Arami, Central Alps (Switzerland)

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The internal parts of collisional belts often contain (ultra)high-pressure peridotites. Deciphering the metamorphic and chemical evolution of these rocks potentially provides important information on orogenic processes. One of the most intriguing examples of a subduction-related ultrahigh-pressure garnet peridotite is exposed in the Central Swiss Alps at Alpe Arami (AA). The origin and metamorphic evolution of this peridotite body is the subject of current controversy (e.g. Brenker & Brey, 1997; Bozhilov et al., 1999; Nimis et al., 1999; Paquin & Altherr, 2000). As deduced from inter- and intraphase distribution of major and trace elements (transition metals) and from geo-thermobarometric calculations, the AA peridotite experienced complete recrystallisation at 5.9 ±0.3 GPa / 1180 ±40 C followed by rapid decompression at near-isothermal conditions and subsequent cooling at pressures ~ 2.5 GPa (Paquin & Altherr, 2000). In combination with geochronological data published previously (Gebauer, 1996 and references therein), the relatively cold peak metamorphic conditions suggest that the AA peridotite originated by rapid subduction to a depth of ~ 180 km with subsequent exhumation in an extensional environment possibly accompanied by some advective input of heat. The P-T evolution deduced for the AA peridotite thus differs significantly from those experienced by two bodies of amphibole-bearing garnet peridotite from the same nappe unit (i.e. Cima di Gagnone and Mt. Duria) for which peak conditions of ~ 3 GPa / 850 C have been suggested (e.g. Nimis et al., 1999).

The $\delta^{18}O$ values obtained for minerals from the AA peridotite (5.34‰ for olivine, 5.46‰ for orthopyroxene, 5.59‰ for clinopyroxene and 5.42‰ for garnet) are typical for normal high-temperature mantle peridotite and do not suggest an origin from serpentinised peridotite. In contrast, the amphibole-garnet peridotite from Cima di Gagnone is characterised by lower $\delta^{18}O$ values (4.12‰ for olivine, 4.70‰ for clinopyroxene and 4.68‰ for garnet) that are in line with the proposed origin by subduction of hydrothermally altered oceanic lithosphere (serpentinite).

Li in mantle rocks has been recognised as an indicator of metasomatic processes (Seitz & Woodland, 2000). We have analysed Li in our AA samples to look for a possible cryptic metasomatic overprint. Li abundances in garnet (0.1-0.3 ppm), opx (0.2-0.4 ppm) and olivine (1.0-1.5 ppm) are normal for mantle peridotite and reflect equilibrium partitioning of Li between these phases. Clinopyroxene, however, shows elevated Li concentrations (1.3-16.2 ppm) that indicate moderate to strong disequilibrium with the other phases. The abundances of Li are lowest in cpx inclusions in garnet, slightly higher in cpx porphyroclasts and highest in cpx neoblasts. The overall elevated abundances of Li in any type of cpx can be explained by a metasomatic overprint. This hypothesis is supported by Li zoning in grt with increasing Li contents towards the rims, indicating interaction between the metasomatising agent and the grt rims. Li profiles through cpx porphyroclasts also exhibit increasing Li concentrations towards the rims. Due to the lack of hydrous minerals such as phlogopite or amphibole in the matrix and the type of disequilibrium (Seitz & Woodland, 2000) we suggest that the metasomatic overprint was a mafic silicate melt rather than a hydrous fluid phase. Observed partitioning of Fe and Mg between garnet and opx as well as of Co and Ni between opx and cpx suggests temperatures in excess of 1000ºC suggesting that the metasomatic overprint occurred at high temperatures in the mantle.

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