Geophysical Research Abstracts, Vol. 8, 02685, 2006
SRef-ID: 1607-7962/gra/EGU06-A-02685

Subduction-related and intraplate metasomatism in Kapfenstein lithospheric mantle (Styrian Basin, eastern Austria)

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Anhydrous and amphibole-bearing mantle xenoliths from Kapfenstein (Styrian Basin) have been studied with the aim of understanding both the processes responsible for amphibole formation and the nature of metasomatizing agents which affected this portion of lithosphere. The studied area is located in the westernmost part of the Pannonian Basin and, together with several others nearby, underwent a subduction event during Early to Middle Miocene, followed by alkaline intra-plate magmatism in a time span of about 10 Ma. Miocene shoshonites, calc-alkaline andesites and rhyolites are found in several localities of the Styrian basin, as well as strongly alkaline lavas and tuffs, carrying mantle xenoliths (Harangi et al., 1995; Harangi 2001).

Anhydrous lherzolites contain large, texturally well-equilibrated clinopyroxenes characterized by depleted to enriched LREE patterns [$(La/Yb)_N$: 0.27-4.35], coupled with high Th and U contents (up to 80 x Ch) and flat HREE at 8 to 13xCh. Their most peculiar characteristic is the strongly positive (to slightly negative) Zr and Hf anomaly, with Zr* varying from 0.64 to 4.36. Primary clinopyroxenes in amphibole-bearing lherzolites are similar to those of anhydrous samples, but present a larger compositional variability of LREE [$(La/Yb)_N$: 0.21-5.56], and Th, U, Zr, Hf. Another kind of primary clinopyroxenes is recognized in the peridotite matrix of a composite sample with an amphibole vein, where they are LREE-depleted [$(La/Yb)_N$: 0.21-0.51], with typical Zr-Hf and Ti negative anomalies.

Pargasitic amphiboles are present as disseminated crystals (Amph-D) but for the com-

posite sample where they form a large vein (Amph-V) up to 1cm wide. Amph-D are texturally well equilibrated; they surround spinel and/or are closely intermixed with clinopyroxene, while Amph-V cut the primary anhydrous peridotitic assemblage with sharp contacts. The great majority of Amph-D is enriched in LREE, LILE, Th and U. Their Zr and Hf anomalies vary from slightly negative to positive (Zr*: 0.54 - 3.77). A few Amph-D appear strongly depleted (to undepleted) in LILE, LREE, Nb and Ta, with $(La/Yb)_N$ ranging from 0.13 to 1.28, Yb at about 12 x Ch and slight positive Sr and Ti anomalies. On the contrary chondrite-normalized incompatible trace element patterns of Amph-V are characterized by remarkable depletion in Th and U and enrichment in Nb, Ta, Sr and Ti. Their $(La/Yb)_N$ ratios range from 2.82 to 5.02 and Zr (and Hf) always presents a negative anomaly (Zr*: 0.39-0.62). Textural and geochemical evidences indicate that Amph-D grew at the expenses of primary spinels and clinopyroxenes, mimicking their depleted or enriched trace element patterns.

The geochemical features of clinopyroxenes and related Amph-D cannot be explained by a simple alkaline-silicate and/or carbonatite metasomatism.

A subduction-related melt/s, probably derived from the melting of the oceanic crust, which interacted with a slightly depleted peridotite can account for the Th, U, Zr and Hf enrichments in clinopyroxene. These clinopyroxenes show in fact geochemical features similar to those recorded in peridotitic xenoliths reported from Kamchatka Volcanic Arc (Kepezhinskas et al. 1996), where the interaction between a slab-derived melt and the mantle parageneses resulted in a progressive rising of La/Yb, Zr/Sm ratios and Sr contents in clinopyroxenes.

Melt-peridotite interaction was afterward characterized by the development of Amph-D at expense of clinopyroxene, probably due to an increase in water content of the residual fluids. These fluids however did not change the chemical overall budget of the system, since Amph-D and co-existing clinopyroxenes have identical REE patterns, and Sr, Nb, Ta and HFSE basically controlled by cpx/amph partitioning.

Subsequently the infiltration of a Nb-rich alkaline melt caused an abrupt change in the Amph-D geochemistry, as recorded by their progressive increase in Nb (and Ta) contents.

The final step in this evolutionary process is represented by Amph-V, whose patterns compare well with both other veined amphiboles from Kapfenstein reported by Zanetti et al. (1995) and those of the megacrystals found in the eruptive tuffs of the Styrian Basin, which may represent the crystallization products of alkaline melts passing through the lithosphere at shallow depth.

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