Light element distribution in an amphibolite-facies metapelite

R. GIERÉ[1], T. JEFFRIES[2], R. GARCIA-SANCHEZ[2], AND C.T. WILLIAMS[2]

[1] Albert-Ludwigs-Universität, 79104 Freiburg, Germany; giere@uni-freiburg.de

[2] Department of Mineralogy, The Natural History Museum, London, SW7 5BD, Great Britain

Tourmaline-rich metapelites with an unusual chemical and mineralogical composition have been found in the basement of the Simano nappe in the Central Alps. The nappe today consists of metamorphosed rocks representing the transition between the European plate and the Tethyan ocean. From top to bottom, the rock sequence comprises metadolomites, quartzites, and gneisses interbedded with thin metapelites enriched with tourmaline. The metapelites further contain biotite, chlorite, cordierite, garnet, kyanite, muscovite, paragonite, and plagioclase (An_{18}), but no quartz. The metapelites are rich in MgO, Na_2O, and Al_2O_3, but depleted in CaO and SiO_2 relative to North American Shale Composite (NASC). Moreover, their B contents are extremely high compared to those of typical shales (6580 vs. 150 ppm). Because there is no evidence of partial melting in the studied area, the anomalous bulk composition points to an association of the protolith with evaporites.

The chemical compositions of all the major minerals were obtained by EPMA and by LA-ICP-MS. One of the characteristics of the metapelites is that, with the exception of tourmaline and garnet, REE were not detected in any of the major phases, even though the light REE contents of the rocks are higher by a factor of 1.5-2 compared with NASC. Other REE hosts are the accessory minerals monazite, allanite and apatite, all of which display complicated reaction textures. Cordierite contains high amounts of several components including MgO (9.4 wt%), Na_2O (6.3 wt%) and Li (450 ppm). It further contains 3700 ppm Be, which corresponds to 0.2 Be atoms per formula unit, equivalent to the number of Na atoms per formula unit. These relationships suggest that Be was accommodated via the substitution $Be+Na \Leftrightarrow Al+\square$. Whereas Be is primarily hosted by cordierite in these rocks, Li is incorporated to a significant extent into biotite (180 ppm), paragonite (130 ppm), and chlorite (100 ppm). Due to its abundance, tourmaline is also an important host for Li, even though it only contains 10 ppm. Boron is partitioned between paragonite (40 ppm) and tourmaline, and was not detected in any other phase.

The studied metapelites were metamorphosed under amphibolite-facies conditions during the main Alpine metamorphism in the Tertiary (~630 ºC, ~600 MPa). In combination with textural relationships, the element distribution patterns will be used to establish the residence and behaviour of some key trace elements, in particular Li, Be and B, during the various stages of metamorphism.