MINERAL CONTROLS ON THE TRACE ELEMENT AND REE GEOCHEMISTRY OF HIGH-PRESSURE LEUCOGRANULITES FROM THE BOHEMIAN MASSIF

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Trace element distributions in garnets and accessory phases from high-pressure (15 kbar) leucogranulites of the Bohemian Massif have been studied by SIMS. The deformed and recrystallized leucogranulites consist of quartz, alkali feldspar, plagioclase, garnet, kyanite and minor biotite, accessory phases include rutile, apatite, zircon and monazite.

Chondrite-normalized garnet REE patterns show strong LREE depletion, negative Eu anomalies, and high HREE abundances (60–200 x chondrite). The degree of Eu depletion in garnet correlates with that of the whole rock. Although high-temperature diffusional homogenization has affected the major element zoning profiles in these garnets, relics of REE growth zoning are still preserved due to the slow diffusion of REE compared to major elements. This preservation of REE zoning is favoured by a relatively high bulk rock Ca contents and high grossular contents in the garnets themselves.

We suggest that the zoning reflects REE fractionation into garnet cores during their growth in equilibrium with a leucogranitic melt. Our arguments for the leucogranulites being largely equivalent to melts are: 1) the P–T conditions of granulite formation are located at higher temperatures than the dry solidus of muscovite granite and Bt–out dehydration melting reactions, 2) the negative Eu anomalies observed in the leucogranulite garnets are comparable to those typical of migmatites from granulite terrains and of leucogranites, and 3) measured garnet–whole rock K_d values for several REE are similar to predicted garnet–melt K_d values for these REE. An interpretation of the leucogranulites largely as recrystallized felsic melts is also supported by their geochemical similarities to strongly peraluminous S-type granites, their wet granite minimum composition, and their low FeO_{tot} and MgO contents, with $FeO_{tot}/MgO > 1$.

SIMS analysis and electron-probe concentration maps of garnet and accessory phases indicate that garnet-forming reactions were influenced by REE-bearing accessory phases. Abundant apatite suggests that P may have reached saturation in the melt, leading to the formation of zircon rims with high P + Y compared to Zr + Si. Zoning of Ca in garnet to lower rim contents, as revealed in concentration maps, is also concentric around apatite inclusions and indicates that garnet growth continued as P saturation was reached in the melts. The influence of zircon on the REE budget of the crystallizing melt is indicated by fluctuating Zr profiles through garnet and the correlation between Th and Zr in whole-rock analyses. Low total HREE contents in the leucogranulites are considered to have been produced as a result of the limited dissolution of initial accessory zircon under the fluid-absent melting conditions under which Grt + L formed.

We suggest that negative Eu anomalies in the rocks and garnets reflect Grt–Kfs–L partitioning relationships. Moreover, knowledge of REE distribution in garnets and the timing and composition of accessory phases is essential in order to evaluate the roles of equilibrium and disequilibrium in crustal melting and melt evolution.