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The chemical composition of REE-Y-Th-U-rich accessory minerals in peraluminous granites of the Erzgebirge-Fichtelgebirge region, Germany. Part II: Xenotime

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ABSTRACT

Xenotime, from a geochemically heterogeneous series of mildly to strongly peraluminous granites of the Erzgebirge, Germany, displays extended compositional variability with respect to abundances of HREE, Y, U, and Th. With few exceptions, the maximum and minimum concentrations for the lanthanides and actinides exceed those noted for this mineral from other geologic environments. Xenotime chemistry is dominated by the theoretical end-members HREE-PO_4 and YPO_4 (>90 mol% in total). Typical xenotime grains from the Erzgebirge granites and from other granites worldwide contain 70–80 mol% YPO_4, and 16–25 mol% HREE-PO_4. This study documents the occurrence of xenotime, abnormally rich in HREE in place of Y, with up to 45 mol% HREE-PO_4. Substitutions of thorite-coffinite, (Th,U,Pb)SiO_4, brabantite, (Ca,Th,U)$(PO_4)_2$, and monazite, (La-Sm)PO_4, are of minor importance, reaching maximum levels of 5–6 mol% each with a total contribution typically $\ll$10 mol%. Typically, the incorporation of actinides in xenotime from these and other granites, as well as from other rocks, is dominated by thorite-coffinite substitutions. However, in some xenotime grains, the U and Th concentrations are largely accounted for by the substitution mechanism 2 $(REE,Y)^{3+} \leftrightarrow (Th,U)^{4+} + Ca^{2+}$. The total lanthanide and actinide contents in xenotime and host granite are not strongly correlated. However, formation of xenotime unusually rich in HREE occurs only in the A-type Li-mica granites that are strongly enriched in these elements. The shapes of HREE patterns of xenotime and host rock are similar which, combined with mass-balance calculations, indicate the importance of this mineral in affecting the HREE as well as Y evolution of late-stage granitic melts. Late xenotime may show strong Y/Ho fractionation, thus recording the decoupling of Y and the HREE, which can occur in the latest stages of crystallization of evolved granites and which may be associated with deuteric alteration.