American Mineralogist, Volume 88, page 708, 2003

ELECTRONIC ARTICLE

Yttrium zoning in garnet: Coupling of major and accessory phases during metamorphic reactions

JOSEPH M. PYLE AND FRANK S. SPEAR

Department of Earth and Environmental Sciences, Rensselaer Polytechnic Institute,
Troy, New York 12180, U.S.A. <pylej@rpi.edu> <spearf@rpi.edu>

ABSTRACT

The concentration of yttrium in pelitic garnets as a function of metamorphic grade has been examined in relation to the distribution of xenotime (YPO_4) in samples from New England and British Columbia. Samples with xenotime present only as inclusions in garnet generally possess high-Y cores and concentrations that drop off discontinuously along zoning shoulders of variable width to low-Y outboard regions. Samples with matrix xenotime are restricted to the garnet zone; Y concentration of these garnets generally decreases smoothly from core to rim. Xenotime may also be present in reaction zones around garnet. In xenotime-bearing samples, $[Y]_{Grt}$ is strongly temperature-dependent and ranges from ~5000 ppm in the garnet zone to ~150 ppm in the sillimanite zone. Measured yttrium zoning profiles in xenotime-absent samples are reproduced with both Rayleigh fractionation and diffusion models, but *P-T* histories of the samples examined favor the Rayleigh model, with garnet volume, bulk-rock yttrium, and mode of (Y, HREE) accessory phases controlling the profile shape. High-yttrium annuli in staurolite-zone samples may form by garnet overgrowth of proximal matrix enriched in yttrium due to garnet consumption during discontinuous staurolite-forming reactions. An increase in $[Y]_{Grt}$ and $[HREE]_{Grt}$ in garnet from anatectic samples is related to dissolution of phosphates in vapor-absent, peraluminous melt, with partitioning of highly compatible Y and HREE into garnet grown during anatexis; textural analysis reveals that phosphates are absent from regions of garnet grown in equilibrium with melt. A main result of this study is identification of an intimate coupling between major pelite phases and accessory phases during reaction progress. This coupling is of great advantage in that it may be used to (1) calibrate sensitive geothermometers and geobarometers, (2) identify particular regions of garnet grown in different garnet-producing reactions over a range of grades, and (3) reveal portions of pelite reaction history invisible to major elements.

* This article is designed to be read on a computer with internet access. The full text of the article can be obtained in pdf format at http://gmr.minsocam.org/Papers/v1/v1n6/v1n6abs.html.

ORIGINALLY PUBLISHED IN GEOLOGICAL MATERIALS RESEARCH ON DECEMBER 14, 1999, 23 PAGES, 2 TABLES, 21 FIGURES.