

Redistribution of REE, Y, Th, and U at high pressure: Allanite-forming reactions in impure meta-quartzites (Sesia Zone, Western Italian Alps)

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ABSTRACT

Accessory phases are important hosts of trace elements; allanite may contain >90% of the REE in a bulk rock. The mobility and redistribution of several trace elements, notably HREE, Th, U, and Y is thus controlled by reactions involving allanite and other REE phases, as well as several rock-forming minerals. As these elements are commonly concentrated in mature clastic sediments, a suite of impure quartzite was studied. Two eclogite facies samples from the Monometamorphic Cover Complex of the Sesia Zone (Western Italian Alps) are presented in some detail, as they reveal a remarkably rich spectrum of reaction relationships that involve REE phases.

Two allanite-forming reactions were inferred from textures and phase compositions

(1) monazite + Ca-silicate(?) + fluid → allanite + apatite + thorite;

(2) monazite + thorite + Ca-silicate(?) + fluid → Th-rich allanite + auelrite ± apatite.

Petrographic observations and thermodynamic models suggest that allanite entered the HP assemblage at ~530 °C and 17–18 kbar during prograde metamorphism.

In one sample, allanite is rimmed by epidote rich in Y and HREE that grew at the expense of xenotime. Two net transfer reactions were derived

(3) xenotime + allanite + fluid → Y-rich epidote + apatite + thorite;

(4) xenotime + allanite + fluid → Y-rich epidote + aeschynite + thorite + (phosphate?).

Textural relationships and trace element analyses of coexisting allanite/monazite and xenotime/Y-rich epidote reveal systematic partitioning of the REE. Partition coefficients for the HREE are compatible with equilibrium fractionation, whereas those for the LREE show patterns that seem to be inherited from the precursor phases, in this case zircon with variable LREE composition.

Keywords: Allanite, HP metamorphism, REE relations, REE partitioning, reaction sequence, HREE-LREE