Monazite evolution in diamond-bearing gneisses

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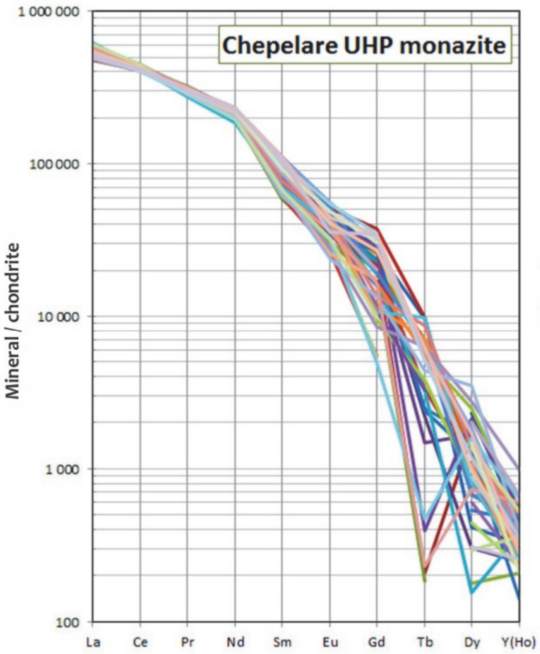
Most of the rocks, which experienced ultrahigh-pressure metamorphism, were retrogressed *en route* to the middle/upper crust. This resulted in replacement of original eclogite facies minerals (garnet, omphacite, coesite, phengite, kyanite, rutile) by granulite facies minerals (biotite, plagioclase, quartz, muscovite, ilmenite). Relics of the original assemblage may however, be found by careful examination: phengite, omphacite, and in some rocks, also microdiamonds may occur in garnet cores. Another characteristic metamorphic mineral, monazite, is also common in high-grade gneisses, found either enclosed in by garnet or in leucocratic portions of commonly migmatized gneisses. Monazite may or may not preserve signature of ultrahigh-pressure in its chemistry. Metamorphic monazite was studied in six diamond-bearing gneisses from five localities in the Scandinavian Caledonides and one from the Rhodope massif (Janák et al 2013, Petrík et al. 2015; Klonowska et al. 2017).



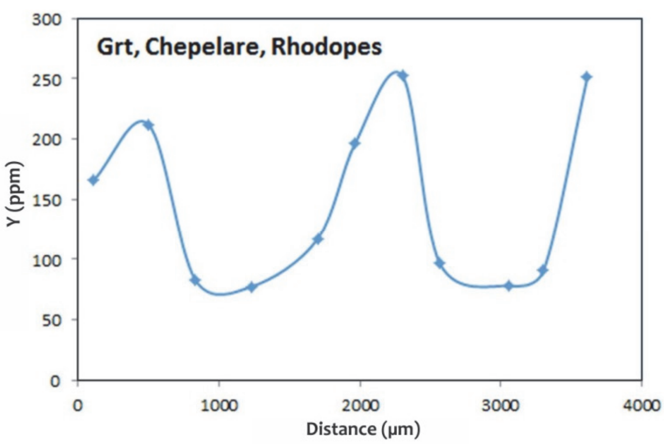


***Fig. 1.** Left, rare earth lemenet (REE) patterns of ultra-high pressure (UHP) monazite. Right, profile of the Y concentration across a garnet grain. All samples from Chepelare (Rhodope massif, Bulgaria)*

Monazite sensitively reacts to changing P-T-X conditions by changing its chemistry in relation to equilibria among silicate minerals. Two parameters appear to be most useful; i.e Eu anomaly (Eu/Eu*) and Y content. First parameter evolves depending on the presence/absence of plagioclase, whereas latter depends on the amount of coexisting garnet. The smallest Eu anomaly indicating absence of plagioclase in equilibrium with monazite is found in Chepelare gneiss (Rhodope massif, Bulgaria, Fig. 1A), followed by Tonsvika gneiss (Tromsø Nappe, Norway). Accordingly, monazite in these rocks may reflect UHP conditions. The largest negative Eu anomaly in monazite indicating coexistence with plagioclase is seen in Åreskutan gneiss (Seve Nappe Complex, Sweden); monazite being fully equilibrated in granulite facies conditions. Passing granulite facies conditions *monazite* typically dissolves and re-precipitates on cooling, incorporating new Y from reacted garnet and losing Eu to newly forming plagioclase.

Garnet shows behaviour analogical to that of monazite in its HREE patterns. While major elements are typically more or less homogenized, garnet preserves prograde metamorphism indicated by decreasing Y, which enters increasing amount of garnet. The decrease is best explained by metamorphic fractionation caused by growing volume of garnet (up to 24 vol. % calculated for UHP stage of the Chepelare gneiss). Some garnets which experienced a new metamorphic phase (Chepelare), similarly to monazite, show Y-rich rims (Fig. 1B) indicating the garnet re-growth at granulite facies conditions with the same source of Y as in monazite. Both processes can be modelled using Rayleigh fractionation. Retrograde reactions of garnet to biotite resulting in the modal decrease of garnet to 15 vol.% (Chepelare) provide enough Y to form high Y rims.

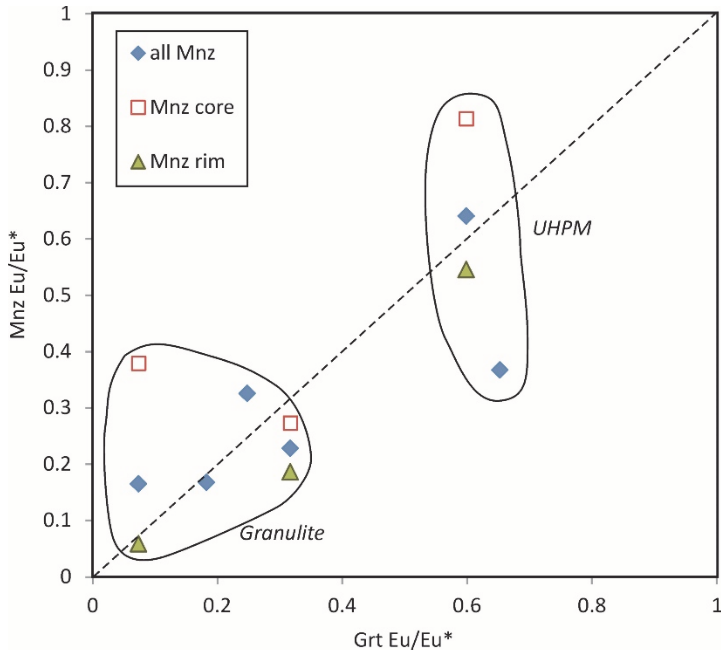


Fig. 2. *Correlation of Eu anomalies in garnet and monazite from the studied rocks*

Positive correlation between Eu/Eu* in garnet and monazite, broadly following 1:1, was found in the studied localities suggesting the approach to equilibrium between garnet and monazite (Fig. 2) both in UHP and granulite stages of metamorphism.

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