Two stage metamorphic evolution of a Variscan paragneiss constrained by EPMA monazite dating and Zr-in-rutile thermometry

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Two distinct tectonothermal events are recorded in a paragneiss from the southeastern Moldanubian Superunit, Bohemian Massif by two texturally and chemically different garnet generations. Both carry abundant inclusions of monazite, rutile and crystallized melt droplets. Metamorphic conditions could be constrained by Zr-in-rutile thermometry in combination with thermodynamic modelling. We propose a P–T path for the first garnet (grt1) forming event starting at 0.7–0.8 GPa and 700–730°C with peritectic garnet growth and resulting in a peak at 1.0–1.2 GPa and 760–790°C. After an intermittent phase of cooling and exhumation, the second garnet forming event (grt2) set in under amphibolite facies conditions and it continued prograde to peak conditions of 1.0–1.2 GPa and 780–800°C. Subsequently, the gneiss experienced near isothermal decompression.

In order to obtain age constraints for the polymetamorphic evolution, in-situ EPMA dating of monazite was carried out. Three different generations of monazite could be identified and assigned to specific processes. The A first inherited monazite generation with an age of 654 ± 17 Ma and U- and Y-rich composition is enclosed in grt1. A second monazite generation, also included in grt1, gives an age of 373 ± 9 Ma and dates the first metamorphic event. It consists of relatively Y- and U-rich, Th-poor core domains and Th-rich rim domains. The latter sometimes contain inclusions of crystallized melt droplets indicating peritectic growth together with grt1 following the reaction:

Bt + Pl + Ky + Qz + Mnz (Th-poor, Y-rich) → Grt + Kfs + Melt + Mnz (Y-poor, Th-rich) (1)

Monazite inclusions in grt2 and in the matrix have an age of 340 ± 3 Ma and date the second metamorphic event. Again, a Th poore core domain is overgrown by a Th-rich rim domain with crystallized melt inclusions (reaction 1). A narrow Y- and HREE-enriched monazite fringe is found around matrix monazite grains. It probably formed during the decompressions stage in connection with garnet resorption.