Linking mineralogical and geochronological record of monazite during ultra-high temperature granulite-facies metamorphism

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Monazite is a common accessory mineral in metamorphic rocks that often shows complex chemical zoning at the μm- to nm-scale. The large number of cations that may be accommodated in monazite lattice makes it particularly sensitive to changes in the rock-forming minerals and fluid composition. Chemical zoning resulting from dissolution / precipitation or new overgrowth may coincide, or not, with age zoning derived from U-Th-Pb isotopes. In this study, we focus on the mineralogical, U-Pb and Th-Pb isotopic responses of monazite to polyphase metamorphism reaching ultra-high temperature (> 900 °C) in the Proterozoic province of Rogaland, S. Norway. The P-T path of several granulite samples is derived from phase diagrams. Monazite grains were analyzed for trace elements with a FEG-microprobe that allows to compute U-Th-Pb chemical age maps and substitution maps with sub-μm spatial resolution. These maps, coupled with LA-ICP-MS U-Pb and Th-Pb isotopic measurements reveal (1) perturbed domains that underwent differential U, Th, Pb mobility and (2) domains of consistent chemical and isotopic composition. From the latter domains, it is possible to link prograde sulfide breakdown to growth of monazite cores enriched in S at ca. 1020 Ma and high-Y rims to garnet breakdown during decompression at ca. 930 Ma. Finally, in order to check the presence of nano-phases or filled pores able to disturb the isotopic signal, a detailed TEM study of the perturbed domains was undertaken.