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Redistribution of lead in metamorphic monazites from Napier Complex, East Antarctica

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Monazite ($REEPO_4$) is an accessory mineral important for U-Th-Pb geochronology of metamorphic processes. This mineral is accumulating much less radiation damage than zircon due to an alpha-particle-induced annealing process occurring even at low temperatures. Unlike in zircon, Pb is incorporated in the monazite crystal lattice, what explains a low tendency to lose Pb in diffusion processes. Following the discovery of metallic Pb nanospheres in zircon from the Napier Complex of East Antarctica [1] and later documented in other areas, monazite was a natural choice for further studies. Although natural monazite grains are not completely amorphous, mobilization of Pb and the formation of Pb-rich clusters and nanoinclusions have been documented for monazites from several locations, e.g. Madagascar [2] and Casey Bay in Antarctica [3].

This work reports on the mobility of Pb discovered in monazites from granitic and trondhjemitic orthogneisses (Eastern Tula Mountains, Napier Complex, East Antarctica). The Napier Complex consists of gneisses with protolith ages of up to ca. 3.8 Ga, with at least two metamorphic events at 2.8 Ga (high-grade) and 2.5 Ga (ultra-high temperature). The FIB foils cut from metamorphic monazite grains reveal domains differing in microstructure, crystalline Th-poor areas and damaged by irradiation as well as porous Th-rich areas. In strongly damaged monazite precipitations of Pb associated with Si-rich pores have been observed and a Pb-rich phase associated with Ca (hexagonal $Ca_2Pb_3(PO_4)_3Cl$, phosphohedyphane) has been identified. Iron, Si-rich inclusions and apatite nanocrystals also occurred. The investigated monazite was affected by fluid interactions. The presence of nanostructures containing Pb is the result of an enhancement of Pb mobility due to a dissolution-reprecipitation process. Despite of the fact that Pb is compatible in the monazite structure, it is still mobilized at the nano- and micro-scale and might affect U-Th-Pb geochronology.

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[1] Kusiak et al., 2015, PNAS, 112 (16) 4958-4963. [2] Seydoux-Guillaume et al., 2003, Geology, 31, 973–976. [3] Turuani et al., 2023, CMP, 178:31.