Baddeleyite + zircon association as a tracer of metamorphic overprint

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According to the experimental [Lumpkin, 1999; Gervasoni et al., 2017] and field observations [Melluso et al., 2012; Scharer et al., 2011] baddeleite is the primary high-temperature (1400-900°C) zirconium mineral of the mafic and alkaline silica-undersaturated melts and its U/Pb age should characterize the time of the host-rock crystallization. However the joint presence of zircon (ZR) and baddeleyite (BD) in same rock or in a single spatial mineral association are possible [Scharer et al., 2011]. This is often determined by the formation of BD crystals on ZR under the influence of carbonate fluids in the process of desilification of the silicate matrix or by the formation of ZR coronite structures over BD in the case of increase of silica activity during evolution of magmatic melts or regional metamorphism of gabbroids.

For this study BD and ZR were separated from up to 5-m dolerite dikes, cutting Neoarchean Jalonvaara-Ilomantsi greenstone belt within the Ladoga Svekofennian geoblock (Baltic Scield). These minerals are either ca 30-μm inclusions inside the rock-forming minerals or in interstitions. BD composes the central parts of the grains as irregular angular relict residues. ZR exist as entire grains as well as a thin rims on BD and mendings in BD cracks. Both minerals have a homogeneous structure in CL. BD have low U (20–93 ppm), Th (1–65 ppm), and Th/U ratios (0.02–0.16) and concordant U/Pb SIMS SHRIMP age of 2068±35 Ma. ZR rims also show low U and Th (15-74 and 4-79 ppm, correspondingly), moderate Th/U (0.12-0.92), while the $^{206}Pb/^{238}U$ age varies from 2122±39 to 1801±31 Ma. Entire ZR are 50-μm short-prismatic grains without zoning (in CL), have moderate U (177–407 ppm), Th (11–190 ppm) and the varying Th/U (0.05–0.58), and the upper intersection of discordia corresponds to an age of 1806±17 Ma.

REE patterns suggest metamorphic origin of entire ZR grains with (Lu/La)n: 10-80, upward LREE: (Sm/La)n 4-7, no Eu and weak Ce anomalies while ZR rims over BD inherite all magmatic marks: (Lu/La)n: 1500-4500, (Sm/La)n 10-20, prominent Eu and Ce anomalies (0.2-1.5 and 1.7-3.5).

Thus, the gabbro-dolerite dyke complex corresponds to the early Karelian activity stage of 2068±35 Ma with superimposed metamorphism of the epidote-amphibolite facies at ca 1800 Ma.