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TEM and LA-ICP-MS constraints on fluid-induced alteration of a zircon-xenotime intergrowth in pegmatite from Piława Górna (the Góry Sowie Block, SW Poland)

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An intergrowth of zircon and xenotime, formed at ca. 2.09 Ga, was significantly altered after incorporation as a restite into pegmatite at ca. 370 Ma (Piława Górna, Góry Sowie Block, SW Poland; Budzyń et al., 2018). Alteration involved fluid-induced coupled dissolution-reprecipitation processes, which resulted in compositional alteration and development of patchy zoning and porosity in the xenotime and the rim of zircon. Diffusion-reaction processes affected the metamict core of zircon and resulted in nano- to microscale patchy zoning and submicron-scale porosity. This study evaluates the alteration processes with respect to structural and compositional characteristics by using TEM and LA-ICPMS trace element analysis.

Nanoscale observations revealed nanoporosity in the metamict core of zircon and a continuation of patchy zoning on a submicron level, which resulted from heterogeneous metamictization correlating with variation in U and Th contents. The altered xenotime and the zircon rim are dominated by microporosity filled with a variety of secondary phases such as U, Th, Pb and Fe rich oxides and silicates. In rare cases, secondary PbS formed nano inclusions in zircon, occasionally surrounded by amorphous apatite. Aside of known substitution mechanisms in xenotime, such as thorite and cheralite components, a correlation of Zr with LREE and Si contents indicates substitution of the zircon component. Furthermore, the zircon-xenotime interface revealed dissolution pits, filled with secondary zircon that formed at the expense of primary xenotime via coupled dissolution-reprecipitation reactions. This indicates local penetration of the fluid-mineral reaction front into xenotime. Major (Si, Zr and P) and trace elements, including U, Th and Pb, which are geochronologically relevant, have been mobilized in the metamict core of zircon due to alteration induced by an alkali-rich fluid with high activities of F, Na and Ca. The altered xenotime and porous rim of zircon were affected by alteration induced by a fluid containing Fe, which resulted in precipitation of Fe-rich phases, such as Fe-oxides and silicates often accompanied by relevant contents of Pb. In conclusion, nanoscale structural observations and LA-ICP-MS trace element data support the complex geochronological implications of the altered zircon-xenotime intergrowth, emphasising the necessity of understanding alteration processes of zircon and xenotime taking into account element transport and thus the disturbance of their

geochronological clock.

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