

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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Introduction

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-precipitation 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-ICP-MS trace element analysis. This work presents results from the manuscript recently submitted to Lithos (Tramm et al., 2021)

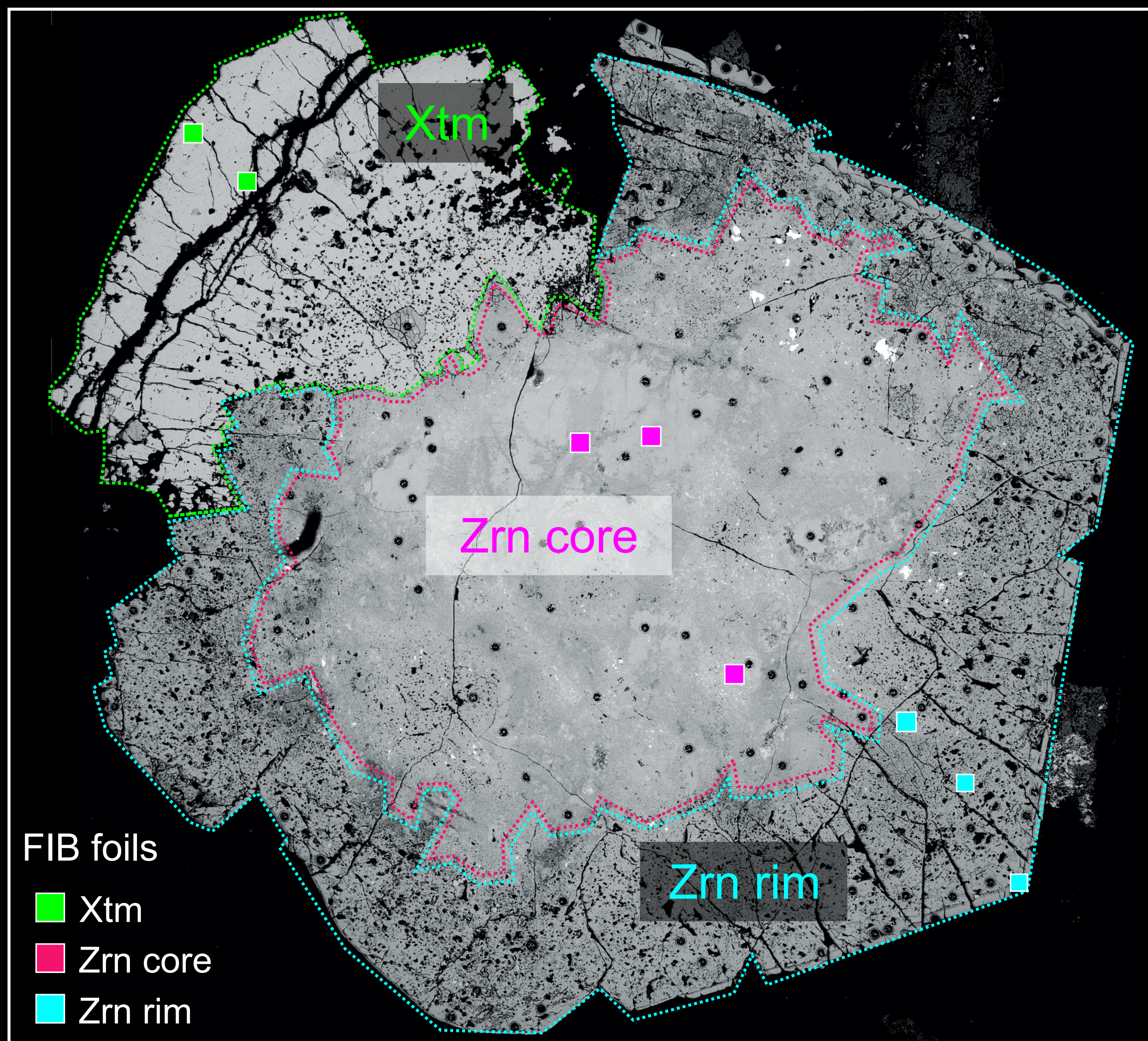


Fig. 1. Overview of the zircon-xenotime intergrowth including the positions of the focused ion beam (FIB) foils.

Fig. 2. HAADF overview of the xenotime and examples of present inclusions of (b) coffinite-thorite solid solution and uraninite, and (c) a rare case of $Pb_3(PO_4)_2$. (d) HAADF overview of the zircon metamict core and examples of present inclusions of (e) galena embedded in fluorapatite and (f) uraninite. (g) HAADF overview of the highly porous (dotted lines) altered rim of zircon including the dominant inclusions of (h) Fe-silicates and (i) uraninite. Abbreviations: Ap = fluorapatite, Cfn = coffinite, Gn = galena, Mnz = monazite, Thr = thorite, Urn = uraninite, Xtm = xenotime, Zrn = zircon, Zrn* = (Th, U)-rich zircon

The light rare earth element - index excludes Eu and Ce anomalies!
 $LREE-I = Dy/Sm + Dy/Nd$ (Bell et al., 2016)

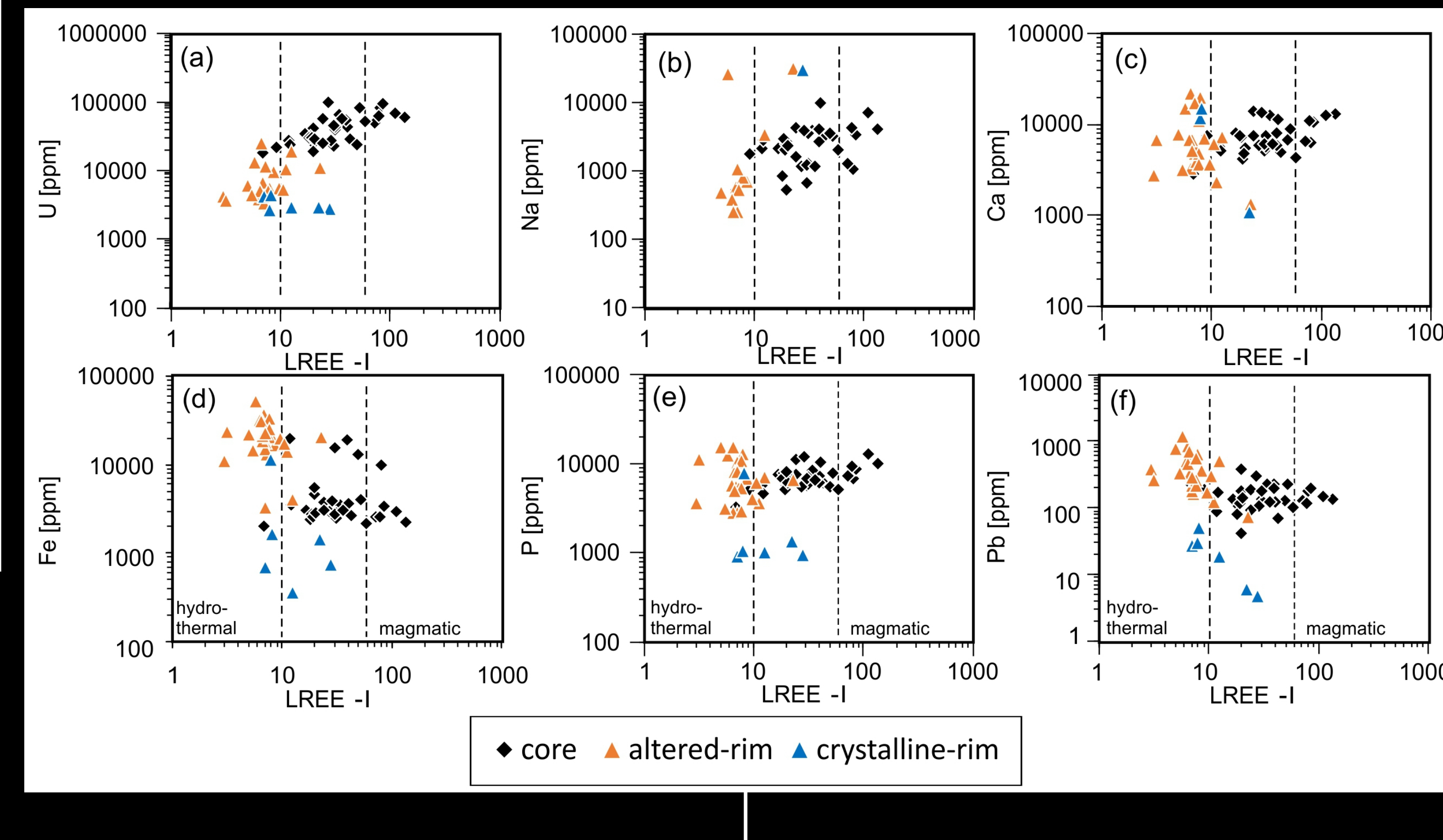


Fig. 3. LREE-I vs. LA-ICP-MS data of the zircon core, its altered-rim and the outermost crystalline-rim. Classified fields of magmatic zircon ($LREE-I > 60$) and hydrothermal zircon ($LREE-I < 10$) according to Bell et al. (2016, 2019).

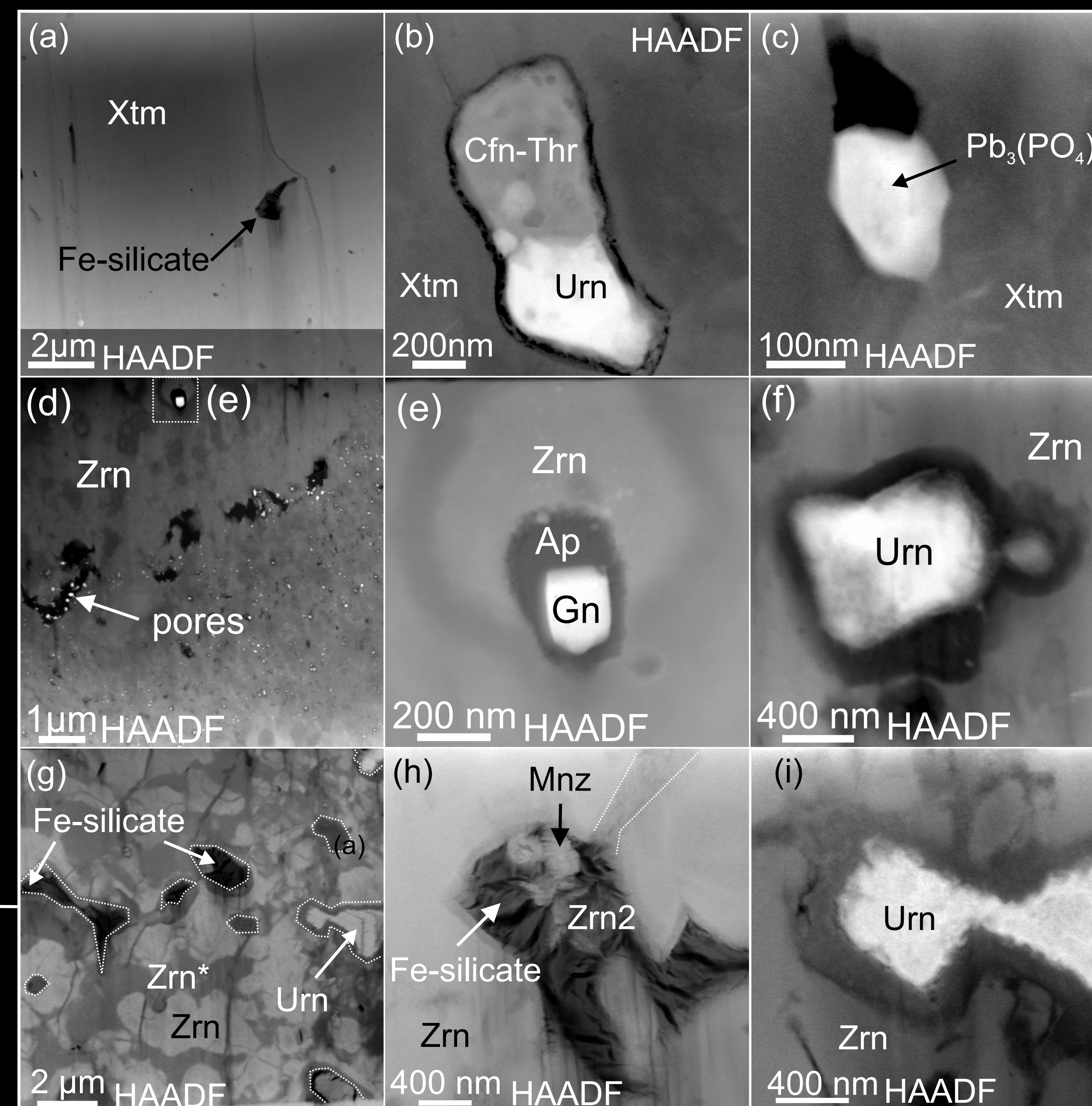


Fig. 4. (a) Sketch of the processes that altered the zircon-xenotime intergrowth. (b) Estimated element transportation based on observed nano-inclusions with TEM and trace element microanalysis using LA-ICP-MS

Summary

Nanoscale observations reveal nanoporosity in the metamict core of zircon and a continuation of patchy zoning. 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. Major (Si, Zr and P) and trace elements, including U, Th and Pb 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 rim of zircon were affected by alteration induced by a fluid containing Fe, resulting in the precipitation of Fe-rich oxides and silicates. Nanoscale structural observations and LA-ICP-MS trace element data support the complex geochronological implications of the altered zircon-xenotime intergrowth.