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Nanoscale variations in the structure and composition of altered metamict zircon from the Georgeville pluton, Nova Scotia

A.J. Anderson (1), R. Wirth (2) and D. Rhede (2)

(1) Department of Earth Sciences, St. Francis Xavier University, Nova Scotia, Canada, (2) GFZ-Potsdam, Telegrafenberg, D-14473, Potsdam, Germany (aanderso@stfx.ca / Fax: 902 867 2414)

The structure and composition of metamict zircon from a highly evolved epizonal A-type granite in the Antigonish Highlands, Nova Scotia, was studied using transmission electron microscopy (TEM), selected area electron diffraction (SAED), high resolution electron microprobe analysis (FE-EMPA), and laser ablation-inductively coupled plasma mass spectrometry (LA-ICPMS). Individual zircon crystals are variably altered and consist of up to four domains that can be distinguished on the basis of texture and composition. Altered relicts of magmatic zircon are enriched in Y, Th, U and rare earth elements and consist of a single crystal with dispersed islands of amorphous material. The dissolution and reprecipitation of the magmatic zircon adjacent to microfractures produced zircon and zirconium oxide nanocrystals in an amorphous matrix with abundant Th-silicate inclusions and nano- to micro-sized pores. Many of the Th-silicate inclusions occupy pore spaces. This indicates that Th, U and Y in the inclusions were deposited after the reprecipitation of zircon. Element maps indicate that Th, U and Y are enriched around pores spaces and around the conduits that connect pore spaces. Microfractures in the porous textured zircon are incompletely filled with amorphous Hf-rich $ZrSiO_4$ and minor amounts of Th-silicate or thorianite. In contrast to the pore spaces, there is no increase in Th, U and Y adjacent to the microfractures. The partial dissolution of trace element-enriched metamict zircon was followed by a redistribution of U, Th, Y and rare-earth-elements between an aqueous fluid and the neoformed zircon and Th-silicate. Most of these high-field-strength el-

ements were incorporated into the reprecipitated phases; however preferential loss of some rare-earth-elements disrupted the trace element and Nd isotopic signature of the original magmatic zircon.