TEM study of thorite inclusions in monazite: A different behaviour to natural irradiation

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Study of radioactive minerals, such as monazite, zircon, thorite, uraninite is of great interest for both U-Pb age dating and nuclear waste storage of high activity elements. Because of their high actinide (U and Th) contents, these minerals receive intense self-irradiation doses during their geological history. A large (centimetric) single crystal of monazite from Norway (Arendal monazite) revealed many thorium silicate (probably thorite) inclusions. Estimated theoretical self-irradiation doses received by this monazite are in the range of 5-11 x 10^{19} α-decay/g. In order to compare the behaviour of monazite and thorite to irradiation, Transmission Electron Microscope (TEM) analyzes were performed on both minerals. They revealed very different structure for monazite and thorite, and the presence of an amorphous zone between them. The still perfectly crystalline monazite shows mottled diffraction contrasts, typical for this mineral [1, 2], remainder of irradiation damages. In contrast, thorite is fully amorphous with an unusual spherical, bubble-like structure. These spheres are in the range of 10 to 200 nm diameter. The zone between these two phases was probably amorphized due to irradiation induced by alpha-decay of Th and U. It could be a preferential alteration zone and act as high-diffusive pathway for elements.

References

[1] Seydoux-Guillaume A.M., Wirth R., Nasdala L., Gottschalk M., Montel J.M. and Heinrich W. (2002). *Phys. Chem. Minerals*, **29**, 240-253.

[2] Seydoux-Guillaume A.M., Wirth R., Deutsch A. and Schärer U. (2004). *Geoch. Cosmochim. Acta*, **68**, 2517-2527.

Monazite petrogenesis in the Nelson contact aureole, southern British Columbia

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Monazite petrogenesis in the Nelson contact aureole is the result of allanite breakdown. The monazite takes one of two forms depending on the presence or absence of garnet in the contact metamorphic assemblage. Garnet distribution in the area varies as a function of post-tectonic tilting of the contact aureole and batholith, which resulted in a series of contrasting pressure-sensitive prograde mineral assemblage sequences developed in the same lithology. Three transects across the aureole were sampled to examine monazite response to the different major phase assemblage sequences. In low pressure, garnet-absent rocks, allanite breakdown to monazite begins downgrade of major phase isograds (cordierite, andalusite) and results in localised monazite growth as pseudomorphous clusters. Cluster monazites are homogeneous in composition and both their morphology and composition change little with increasing grade in the aureole. In higher pressure, garnet-bearing rocks, allanite without monazite coexists with garnet at low grade, but begins to breakdown to monazite at higher grade in the the garnet zone but downgrade of major phase isograds (staurolite, andalusite). Above the staurolite and andalusite isograds, allanite is completely absent from the assemblage, and monazite is found to be the dominant LREE phase. In these garnet-bearing rocks, monazite occurs as randomly distributed, lone grains with no textural relationship to the original allanite. Fluids liberated during the breakdown of hydrous phases (chlorite, micas, apatite) to form andalusite and/or staurolite may have acted as a flux to distribute LREEs more widely within the rock upon allanite breakdown.

Despite these textural differences, both types of monazite have very similar chemistry and an indistinguishable age by electron microprobe chemical dating (circa 170 Ma). This is within the range of isotopic ages determined by others for the Nelson Batholith, between 159 and 173 Ma.