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The wealth of petrochronological information captured in titanite from Archean granitoids: example from the Western Dharwar Craton (India)

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Titanite is a key mineral for the study of basement rocks because of its capability to record magmatic, metamorphic, and metasomatic events through its textures, geochemical and isotope compositions [1]. In this contribution, we have analyzed titanite from three selected Archean granitoids of the Western Dharwar Craton (WDC, India, [2]) which formed at 3430, 3320, and 3150 Ma to understand their post-crystallization history. Studied samples were previously characterized for their mineralogy, whole-rock geochemistry, and zircon U-Th-Pb ages. Our titanite study consisted in optical microscope characterization, SEM-BSE imaging, trace element measurements, and U-Th-Pb dating by LA-ICP-MS. All analyses were done within textural context of thin sections.

Our results reveal a large diversity of textures from unzoned and homogeneous to highly patchy interiors that we grouped according to 7 types, not represented in all studied samples. Textures revealed magmatic and metamorphic events but also pronounced interactions with fluids. Trace element concentrations are very variable, as notably illustrated by flat to strongly fractionated REE patterns, which coincide with identified textural types. The same is not always true for U-Th-Pb ages which recorded major events of igneous crystallization at 3430 Ma, metamorphic events at 3150 and 3050 Ma, and a metasomatic episode at 2500 Ma. One sample appears to have lost its original magmatic crystallization when titanite ages are compared to zircon ages. Modeling of U-Th-Pb isotope system behavior in titanite, compared to common-Pb corrected data, further demonstrates that some crystals experienced pronounced elemental mobility, not restricted to Pb, during multiple stages of their host-rock evolution. These conclusions could not be deduced from common-Pb-uncorrected data distribution in Tera-Wasserburg plots and we, therefore, re-emphasize the need to correct titanite U-Th-Pb isotope data for common Pb, which we argue here is most accurately done using ^{208}Pb-correction [3]. The last identified event appears relatively young (<1000 Ma) and may be consistent with pronounced fluid circulation related to Proterozoic events that occurred in Southern India but are poorly documented in the WDC basement record.

[1] Volante et al. (2024), Geological Society of London; [2] Jayananda et al. (2023), Earth Science Reviews; [3] Williams (1998), Reviews in Economic Geology.