An approach to understand the mode of formation of titanite microtube texture in Tumbiana formation stromatolite, Pilbara Craton, western Australia

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Titanite filled microtubes protruding from healed fractures have been observed in metamorphosed basaltic glass as old as 3.5 Ga (Banerjee et al., 2006). Their rooting in fractures, morphological similarities with modern microtubes, and the in-situ detection of carbonaceous linings were suggested to support a biogenic origin. These titanite microtubes are considered evidence of early life thriving in the oceanic crust during the Archean. However, such titanite microtubes were re-investigated by Lepot et al. (2011) on a pyroclastic tuff in the Tumbiana formation (2.72 Ga) and suggested an abiotic origin by observing the structure, chemistry, and their root zone. In this study, with the help of detailed petrography, mineral chemistry, and EBSD, five morphological types of titanite were observed without any root zone in a stromatolite segment in the Tumbiana Formation, where two types were always associated with carbonaceous material. Raman spectra of these carbonaceous materials correspond to 300 ˚C. The Fe/Al ratio of titanites shows an off-trend to common titanite composition compared to the global occurrences (Kowallis et al., 2022). The EBSD data suggests that the titanites have not been subjected to any deformation and titanites with microtubular texture show an aggregation of grains with distinct crystal orientation. However, coarser irregular titanites have low-angle boundaries with preferred crystal orientation. In addition, the $\delta^{13}C$ value of the carbonaceous material (bulk) in the stromatolite is highly depleted (−39.6 to −47.3 ‰). The possible reasons for the origin of different types of titanites and if any signature for microbial activity is preserved will be discussed in the presentation.

Keywords: Titanite microtubes, Mineral chemistry, EBSD, Stromatolites, Pilbara craton