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# Probing the Archean sub-seafloor hydrothermal environment for early traces of life

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Hydrothermal fluid-rock interactions in volcanic glass of the ancient sub-seafloor have been proposed to sustain early microbial life. Mesoarchean pillow lavas from the Kaapvaal and Pilbara cratons have been investigated to seek evidence of an ancient chemolithoautotrophic deep biosphere. Microtextures of Archean titanite ($CaTiSiO_5$) in metavolcanic glass have been argued to form via microbial tunnelling of seafloor volcanic glass that was subsequently chloritized and the tunnels infilled by titanite growth. Here we investigate this hypothesis using a combination of chlorite mineral chemical analysis by EPMA (electron probe micro-analysis) to document the environment of formation, and FIB-TEM (focussed ion beam-transmission electron microscopy) to characterize the ultrastructure and growth mechanisms of the microtextures. Data from pillow lavas of the 3.35 Ga Euro Basalt from the Pilbara Craton, Western Australia is first presented [1]. Petrographic imaging reveals a range of titanite morphotypes along with early anatase growth forming chains and aggregates of coalesced crystallites in a sub-greenschist facies assemblage. Mapping of FIB lamellae cut across the microtextures confirm that they are discontinuous chains of crystallites that are highly variable in cross-section and contain abundant chlorite inclusions, excluding an origin from the mineralization of previously hollow microtunnels. Comparison of chlorite mineral compositions to DSDP/IODP data reveals that the Euro Basalt chlorites are similar to recent seafloor chlorites. We argue for an abiotic origin for the Euro Basalt microtextures formed by spontaneous nucleation and growth of titanite and/anatase during seafloor-hydrothermal metamorphism. Our findings argue that the Euro Basalt microtextures are not comparable to microbial microtunnels from the recent oceanic crust, and we question the microtextural evidence for life in these Archean lavas.

The Archean sub-seafloor hydrothermal environment nonetheless remains a potentially habitable environment in which robust biosignatures need to be identified. Further elemental and isotopic data is presented from c. 3.45 Ga pillow lavas of the Hooggenoeg Formation of the Barberton Greenstone Belt South Africa, to explore alternative evidence for life in the Archean sub-seafloor.

[1] McLoughlin, N., et al. (2020). *Geobiology*, *18:* 525-543.