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Microstructure and geochemistry of Late Proterozoic biomineralisations by deep microbial life: fibrous calcite veins from Arkaroola, South Australia

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The metabolism of a variety of microbes is known to induce the precipitation of minerals, in particular calcite and opaline silica. This can, for example, be observed in hot springs, such as those in Yellowstone and Waikiki. Water-filled pores between sediment grains are filled with cement during diagenesis and this cementation can also be driven by microbial activity. If microbes at or near the Earth's surface play a role in precipitation of minerals, it is likely that microbes that live deeper down inside rocks do the same. The present existence of microbial life down to several kilometres is well established. However, the type(s) of biomineralisation it may produce is largely unknown.

Antitaxial fibrous calcite veins from Arkaroola, South Australia, were found to contain fossil microbes, encased within the vein calcite [1]. The microbes lived inside the developing veins at a depth of 4-6 km in the late Proterozoic ($\sim$585 Ma). The fact that the microbes lived inside the veins during calcite precipitation strongly suggests that they – at least in part – played a role in that precipitation. The calcite veins are therefore partly or wholly biomineralisations. These are currently by far the oldest known biomineralisations formed by deep microbial life.

To determine whether the microbial activity left a chemical fingerprint in the calcite we analysed the vein calcite and the adjacent carbon-rich shale with XRF [2] and LA-ICPMS. These analyses showed enrichment of Cu close to the vein compared to the

distant host rock and mobilisation of Ca, Fe, Mg, Mn, P, S, Sr, Y, Sc, Pb, Zn, Cu, and Mo, some of which may result from microbial activity.

The calcite veins have a particular fibrous texture, also known from microbial pore cementation, which is common in gypsum veins, but may also occur in quartz veins, such as the Palaeoproterozic quartz (tiger's eye) veins from the banded-iron formations in the Hammersley Ranges. It is therefore possible that the fibrous texture is indicative of a microbial origin, which may help us in finding more, and older, remains of deep microbial activity.

[1] Bons, P.D. & Montenari, M. (in press). The formation of antitaxial calcite veins with well-developed fibres, Oppaminda Creek, South Australia. Journal of Structural Geology.

[2] Elburg et al. 2002. The origin of fibrous veins: constrains from geochemistry. Geol. Soc, London, Spec. Publ. 200, 103-118.