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Geobiology of an early Archean microbial mat facies (Strelley Pool Formation, Western Australia)

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Early Archean rocks from the Pilbara Craton (Western Australia) provide important insight into early life on Earth (e.g. stromatolites, putative microfossils, geochemical signatures) [1]. Problematically, however, some of the observed features could also be explained by non-biological processes [1]. Further lines of evidence are therefore required to make a good case for the presence of microbial life. Here we describe a new type of microbial mat facies from the 3.4 Ga Strelley Pool Formation [2]. The microbial mat facies directly overlies stromatolitic carbonates from the same formation. It consists of laminated, very fine-grained black cherts with white quartz layers and lenses, the latter being interpreted as primary fenestrae (Fig. 1). Further characteristics are stromatolitic layers and wind-blown crescentic ripples. Within the black cherts, carbonates, organic material, and framboidal pyrite are spatially associated, as observed by microscopy, Raman spectroscopy, and time of flight—secondary ion mass spectrometry (ToF-SIMS). Nano secondary ion mass spectrometry (NanoSIMS) revealed the presence of distinct spheroidal carbonate bodies up to several tens of µm that are surrounded by organic material and pyrite. These aggregates are interpreted as biogenic. Comparison with Phanerozoic analogues indicates that the microbial mat facies was formed in a shallow marine environment. Carbonate precipitation and silicification by hydrothermal fluids occurred during sedimentation and earliest diagenesis. While the shallow water environment and the $\delta^{13}C$ signature of bulk organic matter (-35.3‰) are in line with photoautotrophs, highly abundant framboidal pyrite and sulfur isotopic signatures ($\delta^{34}S$ = +3.05‰; $\Delta^{33}S$ = 0.268‰, $\Delta^{36}S$ = -0.282‰) are consistent with the presence of microbial sulfate reducers. Taken together, the evidence strongly support a microbial mat origin of the black chert facies [2]. The results thus confirm the presence of microbial mat systems in the 3.4 Ga Strelley Pool Formation, and may also help to

identify potential biosignatures in other Paleoarchean rocks.

Figure 1: New type of microbial mat facies from the 3.4 Ga Strelley Pool Formation [2].

References:

[1] Van Kranendonk (2006) Earth-Sci. Rev. 74, 197-240.
[2] Duda et al. (2016) PloS ONE 11(1):1-18