Arsenic-based metabolisms in a 3.4 Ga old ecosystem

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Cherts of the 3.4 Ga old Strelley Pool Formation (WA) preserve a variety of microfossils of different morphologies and texture-specific C- and S-isotope compositions, which have been attributed to different microbial metabolisms. To better understand the biogeochemistry of these proposed microbial metabolisms, we performed multi-technique imaging and tomography analysis of similar microfossils using a state-of-the-art scanning hard X-ray nanoprobe [1]. This provides data by which to characterize the morphology, cell-wall structure, chemical composition and specific organo-metallic bounding of individual microfossils embedded in cherts, in situ, and at (sub)μm-scale resolution in 2D and 3D. This approach allows us to tie physiological inference from trace metal distribution patterns directly to fossil biomass, highlighting the interplay between microbial metabolisms and bio-availability of trace metals. We found that As is linked to microfossil carbonaceous walls and that Fe, Cr and Zn are either partitioned in the microfossil hollow interiors or in the surrounding cherty matrix. These data are best explained by the occurrence of a complete metabolic As cycle, extending the geological record of As-based metabolisms back more than by 750 Ma. Alternatively, this trace metal distributions may be recording a metabolic As detoxification process, potentially mediated by sulfate-reduction and/or elemental sulfur-disproportionation pathways.

[1] Somogyi et al (2015), *J. Synchrot. Radiat.* 22, 1118-1129.