Nickel as tracer of oxygenic phototrophy in the fossil record

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Photosynthetic organisms are key constituents of modern ecosystems. Their appearance is an essential step in the co-evolution of life and Earth and the establishment of modern food webs. The origin and timing of prokaryotic and eukaryotic oxygenic photosynthesis is not well constrained due to a lack of reliable markers of this metabolism and of its source organisms. Important work has been done to characterize the Precambrian fossil rock record but none of these approaches permits to detect the presence of chlorophyll, an essential criterion to recognize phototrophy.

Here we show, by combining morphological, ultrastructural, spectroscopic and geochemical analyses at high-resolution, the earliest evidence of preserved Ni-porphyrins (degraded chlorophyll) within *Arctacellularia tetragonala,* an organic-walled multicellular branching microfossil from the Mbuji-Mayi Supergroup (Congo basin, DRCongo, ca. 1 Ga). This discovery supports the evolution of eukaryotic photosynthesis and the supergoup Archaeplastida by 1 Ga, consistent with the fossil red algal record. For the first time we were able to identify Precambrian microfossils not only in terms of morphology, which can be inconclusive because of possible convergence, but based on their metabolism and metallome.

Further work on Precambrian microfossils will improve our understanding of the timing of evolution and pattern of diversification of prokaryotic and eukaryotic phototrophs and of the importance of their role as primary producers in Proterozoic ecosystems.