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On the trail of oxygenic photosynthesis in ancestral Cyanobacteria on early Earth.

MICHELLE M GEHRINGER[1], JOANNE S BODEN[2], SADIA SAYED TAMANNA[3] AND PATRICIA SANCHEZ-BARACALDO[4]

[1]Univesity of Kaiserslautern-Lautern
[2]University of St. Andrews
[3]University of Kaiserslautern-Landau
[4]University of Bristol

Presenting Author: mmgehringer@yahoo.com

The geological record offers evidence of phototrophic mats / stromatolites dating back to at least 3.2 Ga [1], with the origin of Cyanobacteria estimated between 3.5 [2] & 3.4 [3] Ga. However, oxygenation of the atmosphere by early cyanobacterial oxygenic photosynthesis occurred ca 2.4 Ga, during the Great Oxygenation Event (GOE). Data as to how early Cyanobacteria responded to the anoxic and iron-rich Archean marine environment with respect to homeostasis, growth, iron uptake and mineral formation generated under simulated Archean conditions is presented, thereby providing insight into what factors may have contributed to the uncoupling of the emergence of Cyanobacteria and oxygenation of the early Earth atmosphere.

Iron is essential for photosynthetic pigment biosynthesis, however, high Fe(II) availability on early Earth may have inhibited early Cyanobacteria by encasing them in rust and inducing **oxidative stress**. Our results demonstrate that deep branching species that are actively photosynthesising are not encrusted by rust under Archean ocean Fe(II) concentrations [4]. Reduced growth rates under repeated Fe(II) exposure are offset against increased photosynthetic activity when compared to modern oxygen-rich conditions. Evidence that the early branching *Pseudanabaena* sp. PCC7367 has enhanced ability to inactivate oxygen free radicals, is also presented. The distribution of iron receptors across the Cyanobacterial genomic tree challenges our understanding of Cyanobacterial growth in the iron rich, anoxic oceans of early Earth [5].

These data present a more detailed insight into the wide-ranging adaptability of the ancient Cyanobacterial lineage and falsify several of the factors previously suggested to have limited the spread of cyanobacteria prior to the GOE. We propose that the lack of stable environments during the early Archean may have contributed to the uncoupling of the emergence of Cyanobacteria and oxygenation of the early Earth atmosphere [6].

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