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Living phosphatic stromatolites in a low-phosphorus environment: Implications for the use of phosphorus as a proxy for phosphate levels in paleo-systems

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Abstract

In the geological record, fossil phosphatic stromatolites date back to the Great Oxidation Event in the Paleoproterozoic, but living phosphatic stromatolites have not been described previously. Here, we report on cyanobacterial stromatolites in a supratidal freshwater environment at Cape Recife, South African southern coast, precipitating Ca carbonate alternating with episodes of Ca phosphate deposition. In their structure and composition, the living stromatolites from Cape Recife closely resemble their fossilized analogues, showing phosphatic zonation, microbial casts, tunnel structures and phosphatic crusts of biogenic origin. The microbial communities appear to be also similar to those proposed to have formed fossil phosphatic stromatolites. Phosphatic domains in the material from Cape Recife are spatially and texturally associated with carbonate precipitates, but form distinct entities separated by sharp boundaries. Electron Probe Micro-Analysis shows that Ca/P ratios and the overall chemical compositions of phosphatic precipitates are in the range of octacalcium phosphate, amorphous tricalcium phosphate and apatite. The coincidence in time of the emergence of phosphatic stromatolites in the fossil record with a major episode of atmospheric oxidation led to the assumption that at times of increased oxygen release the underlying increased biological production may have been linked to elevated phosphorus availability. The stromatolites at Cape Recife, however, form in an environment where ambient phosphorus concentrations do not exceed 0.28 μM, one to two orders of magnitude below the previously predicted minimum threshold of >5 μM for biogenic phosphate precipitation in paleo-systems. Accordingly, we contest the previously proposed suitability of phosphatic stromatolites as a proxy for high ambient phosphate concentrations in supratidal to shallow ocean settings in earth history.

KEYWORDS
microbialites , phosphate cycle, phosphatic stromatolites

