

Chapter 2

Paper:

Allwood, Abigail C., Malcolm R. Walter, Balz S. Kamber, Craig P. Marshall, and Ian W. Burch.
"Stromatolite reef from the Early Archaean era of Australia." *Nature* 441, no. 7094 (2006): 714-718.

Questions:

1. **The interpretation of some of the oldest evidence for life on Earth is highly controversial. Why?** ANSWER: When body fossil evidence is not available we have to use indirect evidence. Stromatolites constitute indirect evidence for early life. However, it is difficult to establish whether stromatolite structures were formed by the earliest life (that is, biogenically) or whether they were formed by purely physical processes (that is, abiogenically). This has led to controversy.
2. **Stromatolites have been interpreted as 'biogenic: produced by biological processes' and as 'abiogenic: produced by non-biological processes'. Briefly outline the main argument put forward in support of both hypotheses.** ANSWER: The biogenic hypothesis is often supported by a demonstration of complex morphological structures in stromatolites and high concentrations of rare earth elements caused by microbial mediated trapping of sediment grains. The abiogenic hypothesis is usually supported by demonstration of repeated structures such as laminae within stromatolites having the same thickness (referred to as isopachous). Mathematical models have also shown that structures with morphology similar to that of stromatolites can be produced by abiotic cementation in marine environments.
3. **What are the primary aims of this study?** ANSWER: To investigate the origin of the Strelley Pool Chert stromatolite structures and assess whether they were formed by abiotic or biotic mediated processes.
4. **What is the interpreted palaeoenvironmental setting of the basal member of the Strelley Pool Chert Formation (M1)? What is the evidence for this interpretation?** ANSWER: The M1 member of the Strelley Pool Chert is interpreted as being deposited in a rocky coastal shoreline setting during a transgression (when sea level was rising in relation to the shoreline). This interpretation is based on the following: (1) the member contains many large boulders which have a widespread but discontinuous distribution, (2) the sedimentology indicates a high energy deposition but with short sediment transport distance, (3) there is evidence for shoreline erosion features such as palaeocliffs, fissures and cavities, (4) evidence for locally muddy areas with desiccation cracks similar to a muddy intertidal area.
5. **The M2 member of the Strelley Pool Chert (SPC) is interpreted as being formed in a marine environment. What evidence is provided to support this interpretation?** ANSWER: The

sedimentology of the M2 member shows an absence of any terrestrially derived sediment and is made up of finely laminated dolomite-chert. The contact between the M1 and M2 is very sudden, leading the authors to conclude that the M2 must have been formed by sudden drowning of the land by a shallow sea.

6. **What member are the stromatolites found in? How many stromatolite types are described?** Answer: The stromatolite structures are found predominantly in M2 where six different stromatolite morphologies are described with another in M3.
7. **It is argued that hydrothermal activity was initiated during time of deposition of the M4 member of the SPC. What sedimentological evidence is used to support this?** ANSWER: Hydrothermal activity is indicated by the presence of distinctive sediment types which are only formed through interaction of magma and water. The indicative sedimentary types in the M4 include black chert veins through the Member. These are terminated by regions of 'phreatomagmatic brecciation' which is a zone of rock consisting of large broken fragments cemented together in a fine matrix, which results from the interaction of magma and water or ash and water. Other rock types include silicified tuffaceous mudstones, indicating the presence of both volcanic ash and hydrothermal silica rich waters. The rare earth element profile also indicates hydrothermal activity.
8. **Name seven stromatolite facies that are illustrated and described in the paper.** ANSWER: Encrusted laminates, small crested/conical laminates, cusped swales, large complex cones, egg carton laminates, wavy laminates and Iron rich laminates.
9. **Name three common stromatolite taxa.** ANSWER: *Irregularia*, *Conophyton* and *Thesaurus*.
10. **Are there any modern living analogues of microbial reef communities in shallow marine environments?** ANSWER: In Shark Bay Australia there are actively growing stromatolite building microbial communities situated in shallow hyper saline marine environments. The high salinity prohibits grazer organisms and therefore allows microbial colonies to slowly accrete stromatolite reefs.
11. **What is your personal opinion of the abiogenic versus biogenic hypotheses? What other lines of evidence could be explored to further our understanding on the origin of stromatolites in general? Do you think the authors have put forward a convincing set of data and arguments which support the biogenic origin of the Strelley Pool Chert stromatolites and rule out that they were formed by non-biological processes?** ANSWER: Student's personal opinion.

