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3.43 billion-year-old stromatolite reef from the Pilbara Craton of Western Australia: Ecosystem-scale insights to early life on Earth

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Abstract

The 3.43 billion-year-old Strelley Pool Chert, Pilbara Craton, Western Australia, contains compelling evidence of Early Archaean life in the form of kilometre-sized remnants of an ancient stromatolitic carbonate platform. Reviewing and building on earlier studies, we examine the fossilized remains of the platform to seek ecosystem-scale insights to Earth's early biosphere, examining the evidence for biosedimentation, and the importance and effect of different environmental processes on biological activity.

Both vertical and lateral trends show that stromatolite abundance and diversity are greatest in the area

Keywords

1. Introduction
2. Geologic setting
3. Stromatolite biogenicity
4. Stromatolites and palaeoenvironments

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Both vertical and lateral trends show that stromatolite abundance and diversity are greatest in the area interpreted as an isolated, partially restricted, peritidal marine carbonate platform, or reef, where there is virtually no trace of hydrothermal or terrigenous clastic input. In contrast, stromatolites are poorly developed or absent among hydrothermal, volcanoclastic or terrigenous clastic sedimentary facies, and are absent in deeper marine settings that are laterally equivalent to shallow marine stromatolitic facies. Hydrothermal veins, some of which were previously interpreted as vents that exhaled fluids from which the stromatolitic structures precipitated, are shown to postdate the stromatolites. On the platform, stromatolite facies associations varied between different palaeoenvironments, but some stromatolite types occurred across different palaeoenvironments, highlighting the combined influence of biological and environmental processes on stromatolite formation. The regional distribution of stromatolites in the palaeoenvironment suggests a biological response to variations in water depth, sediment influx and hydrothermal activity with stromatolite formation favoured by relatively 'normal' shallow marine environments with low clastic/chemical sedimentation rates and no direct input from high temperature hydrothermal systems. The lithology, structure and fabrics of the stromatolites, and their close association with abundant evaporite crystal pseudomorphs, indicate that evaporitic precipitation was probably the dominant non-biological process that contributed to stromatolite formation. The study supports a biological interpretation for the origin of the stromatolites, and reveals compelling evidence for the conditions that favoured biological activity on the early Earth and formation of macroscopic biosignatures that could be preserved for most of Earth's history.

Keywords

Stromatolites; Microbialites; Morphology; Biogenic; Reef; Carbonate platform; Rocky shoreline; Evaporites; Early Archaean; Pilbara; Strelley Pool Chert; Kelly Group; North Pole Dome; Panorama Greenstone Belt; Dolomite; Carbonate; Chert; Rare earth elements

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Cherts with putative biosignatures

3.240 Ga (Kangaroo Caves Fm.)

Gorge Creek Group

Sulphur Springs Group

3.325-3.315 Ga (Wyman Fm.)

3.346 Ga

Kelly Group

3.35 Ga (Euro Basalt)

Strelley Pool Chert

3.458-3.426 Ga (Panorama Fm.)

Warrawoona Group

3.471-3.463 Ga (Duffer Fm.)

3.477 Ga (McPhie Fm.)

3.496 Ga (Enderby Fm.)

KEY

- Shale
- Sandstone/conglomerate
- Banded iron formation
- Chert
- Felsic volcanic rocks

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