STROMATOLITE FRAMEWORK BUILDERS OF A CRYOGENIAN REEF

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The development of a carbonate reef on the eastern margin of the Adelaide Geosyncline in a period bracketed by two mid-Neoproterozoic (Cryogenian) global glaciations reflects the concurrence of extrinsic factors, including: low (~ 8°) palaeolatitudal position, palaeotopographic situation at a rift margin, relative sea level shallowing following prolonged basin wide post-glacial transgression, and likely reestablishment of seawater carbonate saturation following post-glacial carbonate sequestration as 'cap carbonate' immediately succeeding the earlier Sturtian glaciation. Conditions conducive to carbonate precipitation, deposition and preservation, therefore, facilitated initiation and sustained growth of an ~350 m thick carbonate reef with a framework dominated by a variety of stromatolite forms.

Detailed field mapping along with cross-sectional exposure through the internal architecture of Arkaroola reef in the northern Flinders Ranges, South Australia, reveals a spatially and temporally variable stromatolite assemblage. The range of forms reflects ecological succession from microbial biostrome colonization through to a climax community of domal, columnar and digitate stromatolite forms. Growth of wrinkly-laminated, m-thick, microbial biostromes, 10s to 100s m in extent, initiated development of a stable carbonate substrate on underlying thick muds. These biostromes mark the windward margin of an incipient reef, with spatial arrangements similar to spur and groove structures of modern windward reef margins. Once stabilised, a robust reef framework developed, first through growth of 1-3 m-scale domical and linked columnar stromatolites forming large stacked bioherms of many metres topographic relief at the reef front. This biological modification of local environmental conditions lead to an ecological succession of stromatolite forms in response to substrate stabilization, wave-energy baffling and aggradationally driven shallowing. The spatial and stratigraphic distribution of a range of centimetre-to decimetre-scale columnar, domal and digitate stromatolites, in conjunction with intraclastic, peloidal and oolitic grainstone and packstone facies characterises development of a reef flat and leeward lagoon. Variability of stromatolite forms across the reef morphology indicates ecological adaptation of function and structure responding to local differences in factors such as light, nutrient supply, hydrodynamics, water clarity and tidal exposure.

Microbial (stromatolite) growth in a range of forms overwhelming controlled carbonate production resulting in both a biogenic framework and eroded and redistributed bioclast deposits across the reef. The range of stromatolite forms and their facies distribution within the reef is consistent with biological control on ecosystem development and stabilisation as seen in Phanerozoic and modern reef ecosystems. The Arkaroola reef exhibits analogous ecological succession in a late Proterozoic stromatolite evolutionary realm. Furthermore, Arkaroola reef records a period of relative climatic and sea level stability in a geological period notable for severe climatic upheaval.