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Filamentous cyanobacteria in reefal facies of the Neoproterozoic Arkaroola reef complex, Flinders Ranges, South Australia

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The Neoproterozoic Balcanoona Formation is extensively distributed in the northern Flinders Ranges, South Australia. The Balcanoona Formation represents back reef, reef flat, reef margin and forereef facies of larger peritidal platform–slope–basin reef complexes that developed during a Cryogenian subtropical interglacial period. The reef margin facies include dolostones that have been variously described as stromatolitic and non-stromatolitic which creates opportunity to search for direct and indirect evidence for biogenicity. A suite of microanalysis-techniques including conventional microscopy, scanning electron microscopy with energy dispersive spectroscopy (SEM-EDS) and NanoSIMS have been used to identify and characterise the dolostones and microbial components.

Direct signs of former microbial features include relics of extracellular polymeric substances (EPS) and exceptionally well preserved calcified filamentous cyanobacteria. The amorphous and mucilaginous EPS appears both filamentous and as sheaths and show strong resemblance to EPS in modern day biofilms. Locally, the EPS-coated surfaces have circular to teardrop-type moulds (1 micron across) that suggest former presence of heterotrophic bacteria. EPS is closely associated with clay aggregates and micro-crystalline dolomite rhombohedra.

Calcified filaments are segmented tubes where each segment is typically ~5–10 microns long and 5 microns across; branching nodes are also preserved. Proximity of the microbial relics to microcrystalline dolomite rhombs and clay aggregates suggest these phases may have been microbially mediated. Locally, calcified filamentous tubes are associated with larger dolomite crystals. These filaments are surrounded by a thin (submicron) fine granular clay coating and resemble the cyanobacteria *Girvanella*.

EPS coating has been identified in all facies of the reef, however, remnants of filamentous cyanobacteria are best preserved and most abundant in reef margin and upper forereef samples. This suggests that they were contributors to reef construction and that their preservation may have been influenced by reef facies-specific diagenetic processes particularly early precipitation of dolomite cements.

Keywords: microbial, Neoproterozoic, microcharacterisation