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Microfacies of mappable Archean biomats, Moodies Group, Barberton Greenstone Belt, South Africa

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The ca. 3.22 Ga-old Moodies Group, Barberton Mountain Land, South Africa, arguably includes the world's oldest regionally mappable biofacies. There, abundant smooth, wavy, domal or cuspate, interwoven or parallel-stratified laminae of isotopically light kerogen (Noffke et al. 2006) in shallow-water or coastal environments show a microtopography of several cm, deform cohesively, trap and bind grains, and were surficially rapidly silicified. In order to investigate the microfacies and habitat of these extensive biomats, we measured stratigraphic sections, sampled for petrography and composition, and documented sedimentary structures throughout.

Seven stratigraphic sections allow the reconstruction of a coastal depositional system with an thickness of approx. 240 m along an > 11 km long outcrop belt. The system can be subdivided in (from base to top deepening) terrestrial coastal, low-angle shoreline, subtidal and shoreface facies. Biomats are most densely (mm- to cm-) spaced in the shoreface unit whereas they are least common in the basal terrestrial unit in which single-pebble trains and thin gravel conglomerates occur. Biomats (mean 4 mm thick) reach their greatest individual thickness (up to 0,8 cm) and dominate the spectrum of sedimentary structures in the subtidal unit where they form black, internally laminated chert bands. Most chert bands overlie lenses of elongate, well-sorted, coarse-grained sandstone but are in turn sharply overlain by medium- and fine-grained sandstone, suggesting cyclic current activity. Clustered or regularly spaced (sub-)vertical fluid escape structures penetrate and ductily deform densely spaced interwoven biomats. They occur most widely in the shoreface facies, show a mean height of 49 cm, are commonly offset horizontally, and reach up to 230 cm. The margins of several shallow (max. 1 m deep) and up to 8 m wide channels erosively truncate wrinkled biomats of the terrestrial coastal facies. Channel fill includes dominant medium- to coarse-grained sand and subordinate palm-sized planar (apparently brittle) biomat fragments mixed with granule and pebble lag at the channel base. Channel dimensions and erosivity may suggest a subaerial setting and imply that biomat growth either predated a temporary base-level drop or grew on land, presumably in a flat coastal setting.

The micromorphology, large lateral extent, and depositional architecture of the biomats indicate a well-developed, adaptable, resistant microbial ecosystem along a medium-energy coast and offer a remarkable window in the conditions under which early life on Earth developed.