Microfossil taphonomy in clay-rich rocks in Proterozoic environments analogue to the Noachian on Mars.

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Siliciclastic sedimentary rocks are a rich but relatively understudied archive of early life on Earth. In particular, phyllosilicate rich rocks such as mudstones have proven to be effective in the preservation of organic walled microfossils. Understanding the exceptional preservation of organic walled microfossils in mudstones is of particular significance to the search for life on other rocky planets such as Mars. As the presence and composition of phyllosilicates can be determined through remote sensing techniques, this knowledge provides a valuable tool in the search for signs of ancient life in both terrestrial and Martian mudrocks.

Several Mars missions are currently focused on the detection of life signatures in mudstones deposited in crater paleolakes (Perseverance) and fluvio-deltaic to basinal settings (Exomars). However, it is currently unknown if the species of phyllosilicates present in the primary sediment affect preservation of organic walled microfossils. Further, effects of depositional settings within a basin on the preservation of organic walled microfossils are also poorly understood.

To investigate these questions, we conducted an extensive investigation of the exquisitely preserved ~1.4 Ga Greater McArthur Basin (GMB), northern Australia. The GMB was a long lived stable cratonic basin, partially restricted from the global ocean, and fed by at least one large delta system with sediment derived from the erosion of basaltic hinterlands under an arid climate. Thanks to abundant drill core material, the GMB provides an easily accessible analogue for an early Martian crater lake with deltaic to basinal deposits.

We examined an extensive sample set of mudstones extracted from 7 drill cores from the GMB. These cores represent temporally and spatially adjacent depositional settings which provide a proximal to distal transect of contemporaneous depositional environments across the basin.

Here we present early fossil, mineralogical, and sedimentological data which illustrate the quantification of clay species, and the abundance, diversity, and preservation quality or taphonomy of organic walled microfossils extracted from those samples. Finally, we present a schematic depositional model for the basin and discuss the possible links between preservation, environment, and clays.