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Decoding palaeodepositional setting and redox conditions from the microbialites of the Archean Gamohaan Formation, South Africa.

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The atmosphere was anoxic in the Archean, but some studies controversially suggest that oxygenic cyanobacteria evolved early and generated small amounts of free oxygen in Neoarchean shallow-marine settings. Trace and rare earth element plus yttrium (REE + Y) compositions can help to identify pockets of free oxygen that may have existed prior to the 2.4 Ga Great Oxidation Event (GOE). One such record of Precambrian redox conditions can be found in the microbialites from the shallow-water Gamohaan Formation of the ~2.65 Ga Campbellrand Subgroup, Transvaal Supergroup, South Africa. These microbialites represent an optimal place to search for signals of oxygenation because they were deposited close to the GOE and were formed by microbial communities, which may have been the sources of oxygen.

In this study, the microbial roll-up horizons of the Gamohaan Formation were analyzed using optical microscopy, SEM, and XRD, and showed variably sized subhedral to euhedral pyrite and microcrystalline carbonate, quartz and clay mineral phases, along with larger calcite crystals and submicron dolomite. *In situ* LA ICP-MS analysis of 82 spots on eight samples revealed heavy REE-enriched REE patterns, positive Y anomalies, and suprachondritic Y/Ho ratios indicative of marine precipitates. However, shale-normalized Ce anomalies, which are a proxy for the presence of oxygen, were not observed.

The absence of negative Ce anomalies suggests that there were no significant oxygen levels present locally prior to the GOE, and any potential transient atmospheric oxygenation events were either not recorded by the Gamohaan microbialites or were not sufficient to produce negative Ce anomalies. Further comparison with studies that do report negative Ce anomalies can identify areas where free oxygen was present before the GOE or preservational biases between different facies. Overall, this study provides valuable insights into the redox conditions of the Precambrian era and underscores the importance of interpreting geochemical data in the context of the depositional setting.