Stalagmite records of tropical Pacific climate since the Last Glacial Maximum

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Long, high-resolution, well-dated paleoclimate records from the western tropical Pacific are scarce, obscuring the response of tropical Pacific climate to changes in global boundary conditions, abrupt climate changes, and external radiative forcing. Here we present three absolutely-dated stalagmite oxygen isotopic records from Northern Borneo that track fluctuations in Western Pacific Warm Pool hydrology over the last 27,000 years. Over 70 U-series dates and 11 isochrons provide excellent chronological control for the over 1200 stable isotope measurements. Our results suggest that rainfall in northern Borneo during the Last Glacial Maximum was similar to present. However, a pronounced maximum in stalagmite $\delta^{18}O$ values occurs ~16.3 thousand years ago, consistent with dry conditions in the WPWP during the Heinrich 1 abrupt climate change event. The deglaciation is also marked by a 1000-yr-long oxygen isotope plateau centered at 13.2 thousand years ago that coincides with the Antarctic Cold Reversal, but there is no evidence for the Younger Dryas event observed in many other deglacial records. A broad minimum 5,000 years ago reflects the sensitivity of Warm Pool hydrology to spring/fall precessional insolation forcing. The new records demonstrate dynamic linkages between northern and southern high-latitude climate and tropical Pacific convection, and highlight the sensitivity of tropical Pacific convection to external radiative forcing.

Multiple redox states in the Archean-Proterozoic hydrosphere

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The late Archean deep water environments of Western Australia's Hamersley Group Marra Mamba Iron Formation and Mount McRae Shale are characterised by extremely light organic carbon and relatively enriched, even positive, carbonate carbon $\delta^{13}C$ values consistent with the presence of methanogens (Schidlowski, 2001). Positive mass independently fractionated (MIF) sulfur isotope values are found in fine-grained pyrite disseminated throughout these organic rich mudstones, while negative sulfur MIF is seen in rare pyrite nodules. This suggests that the fine-grained pyrite was formed abiotically, whilst the formation of the nodules was microbially mediated (Farquhar and Wing, 2003).

Multiple pyrite morphologies are not common in the Hamersley Group's late Archean shallow water Wittenoom Formation; however, positive sulfur MIF in fine-grained pyrite in these dolostones suggests the absence of sulfate reducing microbes. The lack of very light organic carbon and positive carbonate carbon $\delta^{13}C$ values implies that late Archean shallow water environments were too oxic to support anaerobic metabolisms, potentially in favour of more oxygen tolerant species.

Paleoproterozoic sulfur MIF in the Dales Gorge Member and Whaleback Shale of the Brockman Iron Formation Group shows good correlation between fine-grained and nodular pyrite in the same sample, with both demonstrating either negative or zero MIF, regardless of depositional environment. Furthermore, organic and carbonate carbon $\delta^{13}C$ trends toward more modern values. This suggests that after the Archean-Proterozoic boundary, both deep and shallow water environments were sufficiently oxic for sulfate reducing microbes and thus marks the transition to a more uniformly oxidised hydrosphere capable of supporting aerobic life.

References

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