The Jixian System and Xiamaling Formation: Windows to the mid-Proterozoic through the lens of an evolving continental margin

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In contrast to its reputation as a period of extended stasis, the mid-Proterozoic (1.8-0.8 billion-years-ago; Ga) played host to some of the most important biological transitions in the history of life on Earth. For example, the earliest clear evidence of eukaryotic life comes from fossils of this period. Despite their seemingly early appearance, however, eukaryotic diversity remains low throughout the mid-Proterozoic until rising exponentially just before its close.

Recent work on chromium isotopes in black shales and iodine concentrations in carbonates has painted a picture of the mid-Proterozoic world with a very low O_2 ocean/ atmosphere and shallow, unstable chemoclines in productive environments. This has led some to hypothesize that low O_2 played a role in protracting eukaryotic diversification and further that their rapid rise to ecological dominance in the Neoproterozoic was a response to permissive environmental changes. Nevertheless, it remains possible that environmental O_2 was much more dynamic than the resolution of long time-series can adequately capture.

The North China Craton preserves a record of this critical time, with strata spanning ~1.8-1.4 Ga. The uppermost formations in this sequence are particularly relevant as they were deposited in the aftermath of the breakup of Nuna—an event analogous in many ways to the breakup of Rodinia. These rocks do contain tantalizing geochemical hints of a potential spike in biospheric O_2 at a time when local acritarch diversity was increasing, though, their depositional history is wrought with complexity. This study incorporates new and published data to disentangle local and global signals in this record and places relevant data into a broader spatiotemporal framework. Multiple lines of evidence point to the possibility of a transient increase in surface ocean O_2 at ~1.4 Ga. Though, this study contributes to that body of evidence, more data from other similarly aged formations will be required to adequately constrain the amplitude, duration, and evolutionary significance of such an oscillation.