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Dynamic Evolution of Marine Chemistry Linked to Wax and Wane of the Glaciations in a Restricted Basin over the Cryogenian Non-Glacial Period

CHENYI TU[1], CHARLES W. DIAMOND[2], EVA E. STÜEKEN[3] AND TIMOTHY W. LYONS[1]

[1]University of California, Riverside
[2]University of California Riverside
[3]University of St Andrews

Presenting Author: ctu017@ucr.edu

The Cryogenian Period of the Neoproterozoic was characterized by two Snowball Earth glaciations, which were potentially tied to the diversification of eukaryotes and culminated with the appearance of animals. The break-up of Rodinia in the early Neoproterozoic resulted in emergence of numerous rift basins with dynamic chemical evolutions likely controlled by the waxing and waning of the two global climate upheavals and associated eustatic change and nutrient cycling. The Nanhua Basin, as a marginal restricted basin in South China, provides a unique window to the key cause-and-effect relationships with implications for the radiation of complex life. We focus on an exceptional shale sequence—the Datangpo Formation consisting of a lower black shales and upper gray shales/siltstones—which captures the complete Cryogenian non-glacial interval. Highly coupled total organic carbon (TOC) and total sulfur concentrations in combination with iron speciation and pyrite sulfur data suggest TOC-rich, euxinic deep-water deposition for the lower black shales but TOC-lean, persistently oxic conditions for the upper gray shales/siltstones associated with relatively shallow-water deposition. We argue that this dramatic shift in water chemistry was primarily governed by the extent of restriction for the Nanhua Basin as a consequence of eustatic variation tied to the glaciation events. Specifically, the highstand in the wake of the Sturtian corresponded with elevated nutrient fluxes delivered from the open ocean and the resultant highly productive, euxinic conditions, while the lowstand linked to the onset of the Marinoan was accompanied by reduced nutrient supplies that led to low productivity and ventilated settings. We will explore trace metal distributions to further shed light on the local redox dynamics and the hydrological variations, along with nitrogen isotopes with the goal of tracking time-varying nutrient cycling for this basin. This study will inform better understanding of the intrinsic relationships among glaciations, eustatic change, nutrient availability, and redox dynamics within the Earth system over this critical climate transition.