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# The rapid recovery of marine productivity after the Sturtian Snowball Earth glaciation

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Eukaryotic algae for the first time became the predominant primary producers during the non-glacial interlude (660-650 Ma) between the Sturtian and Marinoan snowball Earth glaciations, reflecting a transition from a prokaryote-dominated to a eukaryote-dominated biological pump. Such a sharp transition in biosphere requires a recovery of primary productivity from the rather infertile snowball Earth oceans. Thus, it is critical to reconstruct the change of surface ocean productivity and marine redox landscape, the latter of which directly affects the nutrients cycles. Although abundant black shale deposited in the slope of Yangtze Block during the non-glacial interlude, i.e., the Datangpo Formation, the enrichment of organic matter in a (semi-)restricted deep water basin makes no direct inference about the surface ocean productivity. Instead, the shallow water deposit would provide direct constraints on the surface ocean productivity. In this study, we report pyrite sulfur isotope ($\delta^{34}S_{pyrite}$) and pyrite content ([pyrite]) of the Datangpo Formation from the Guitouwan section deposited in the outer-shelf of Yangtze Block. The Datangpo Formation is composed of pebbly siltstone at the base, recording the deglacial process, and calcareous mudstone/siltstone at the top, representing the normal marine deposition. A one-dimensional diffusion-advection-reaction (1D-DAR) model is applied to simulate the process of syndepositional pyrite formation with dissimilatory sulfate reduction (DSR) occurring in sediment porewater. In contrast, $\delta^{34}S_{pyrite}$ and [pyrite] cannot be simulated if seawater $H_2S$ is the only major S source. The modeling results indicates the seafloor was suboxic and organic matter supply was limited during the deglacial process. In contrast, the DAR model cannot be applied to the samples from the upper section, suggesting the development of sulfidic condition. that cannot simulate syndeposition pyrite formation in the upper part of section, suggesting the development of oceanic euxinic. This interpretation is consistent with the occurrence of superheavy pyrite (with the maximum $\delta^{34}S_{pyrite}$ values up to 60‰). To sustain a sulfidic condition, a large flux of organic matter was required. Therefore, the marine primary productivity might have been recovered soon after the Sturtian glaciation, and the persistent sulfidic condition also favored P recycling to the surface ocean, probably stimulating the blooming of eukaryotic algae.