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Dynamic biogeochemical carbon cycle in response to massive manganese carbonate deposits during Cryogenian interglacial period

JIAYI AI[1], SANDRA SILJESTRÖM[2], NINGNING ZHONG[3], JIANFA CHEN[4], TIEGUAN WANG[1], QIU NANSHENG[1] AND SIMON GEORGE[5]

[1]State Key Laboratory of Petroleum Resources and Prospecting, College of Geosciences, China University of Petroleum-Beijing
[2]RISE Research Institutes of Sweden
[3]College of Geosciences, China University of Petroleum-Beijing
[4]College of Geoscience, China University of Petroleum (Beijing)
[5]Macquarie University, Australia

Presenting Author: jiayiai_hdr@163.com

The Cryogenian interglacial manganese (Mn) carbonate deposits hosted in the Lower Member of the Datangpo Formation (DTP-1) black shales in South China have been interpreted to form predominantly through microbially-mediated processes (Yu et al., 2019). In this study, we suggest that massive metallogenesis of Mn as carbonate phase may have a potential impact on Neoproterozoic carbon cycle by serving as a special sink of bio-essential element phosphorous (P) and as a unique storage of inorganic carbon. The association of P with particulate Mn occurred upon the initial massive precipitation of MnO_x during pulsed oxygenation events during deglaciation. The fixation of P in authigenic Ca-Mn-carbonate phase during subsequent conversion of Mn oxides in organic-rich sediments might have facilitated retention of P in sediments, resulting in less efficient P recycling and thus slackened recovery of marine primary production. Positive excursion of nitrogen isotopic composition of Mn-rich samples ($\delta^{15}N_{kerogen}$ = +5.89 ~ +9.83‰, average = +7.96‰) is likely attribute to heavier seawater NO_3^- because of nonquantitative denitrification under relatively low input of organic matter. These likely have impeded rapid accumulation of O_2 in atmosphere-ocean system right after Sturtian glaciation. The Sedimentary Mn carbonate deposition in a notable scale may prevent the CO_2 produced by aerobic oxidation of organic carbon diffusing back to the surface system. Namely, it can be regard as a special microbial carbon pump, converting burial/dissolved organic carbon to recalcitrant/inactive inorganic carbon. This process would provide an additional contribution for increased pO_2/pCO_2, paving the way for rapid rise of eukaryote algae, as evidenced by increasing steroid diversity (Brocks et al., 2017), in later stage of interglacial period.

References

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