An episode of rising oxygen level at Mesoproterozoic

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Free atmospheric oxygen is the most important life-sustaining gas, deduced to influence the rise and evolution of aerobics breathing life, such as the eukaryotic algae and animals. It is speculated that oxygen was not increased to sufficient levels for animal respiration until the Neoproterozoic Eon, 1,000 million to 542 million years ago, thus procrastinating emerged time of algae rise and animal. Recently, the studies from geochemical evidence of the Xiamaling Formation (~1400 Ma), North China Craton, show that there are sufficient oxygen to satisfy the early-evolved animal breathing.

In unit 1 of the Xiamaling, the alternating black and green-gray shales with very distinct geochemical characteristics display alternations between oxic and anoxic depositional environments. We combined our TOC and HI results to calculate the differences in carbon mineralization and carbon preservation by comparing with modern oxygenated and anoxic depositional environments. By using a simple diagenetic model, we concluded that the enhanced carbon mineralization under oxygenated conditions in unit 1 of the Xiamaling required a minimum of 4 to 8% PAL of oxygen[1].

The patterns of trace metal enrichments in unit 3 of the Xiamaling reveal oxygenated bottom waters during deposition of the sediments, and biomarker results demonstrate the presence of green sulfur bacteria in the water column. Thus, an ancient oxygen minimum zone was deduced. And according to this marine structure, we develop a simple, yet comprehensive model of marine carbon-oxygen cycle dynamics, declaring a high oxygen level of above 4% PAL[2], which consistent with the results from our geochemical results.

Thus, we suggest that the bottom water near the seafloor should have already oxidized in 1,400 million years ago. And there should be have sufficient atmospheric oxygen for animals long before the evolution of animals themselves. The rising levels of Neoproterozoic oxygen should not be contribute to the relatively late appearance of animal life on Earth.

Reference:
[1] Zhang S, et al. The oxic degradation of sedimentary organic matter 1400 Ma constrains atmospheric oxygen levels. Biogeosciences 2017, 14(8): 2133-2149
[2] Zhang S, et al. Sufficient oxygen for animal respiration 1,400 million years ago. PNAS 2016, 113(7): 1731-1736