Busting the Boring Billion: Oxygen's Role in Stifling and Stimulating the Early Rise of Complex Life

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Surges in biospheric oxygen were long assumed to have triggered the rise of animals 600 to 700 million years ago. Over the past ten years, the popularity of this hypothesis has waned in favor of biological controls, namely the protracted evolutionary pace of genetic innovation required for complex life. More recently, however, fundamentally new reconstructions of Earth's early oxygen history have surfaced, re-asserting the possible influence of environmental drivers. The latest evidence reveals a billion years of mostly stifling conditions for life in the oceans, leading up to a dramatic rise in oxygen content of both the oceans and atmosphere around 800 million years ago, positioning biospheric oxygen once again as a strong contender for stimulating eukaryotic complexity, including the rise of animals.

This talk will explore the evidence for a dearth of oxygen in the deep ocean and atmosphere during the mid-Proterozoic and the likelihood of generally low, heterogeneous, and unstable oxygen conditions in the surface ocean—the critical setting in any consideration of early complex life. These conditions will be viewed within the framework of possible nutrient throttles that maintained these low redox states, while at the same time allowing for at least transient increases in oxygen around a generally low baseline. Such dynamic behavior is expected and seems to be recorded in the geochemical record of the mid-Proterozoic. Key elements for discussion will be a growing body of diverse inorganic and organic geochemical and paleontological data for dramatic biotic and chemical change around 800 million years ago, including possible relationships to tectonic drivers and climate before, during, and after this event. The talk will end with a brief allusion to the tantalizing relevance of the mid-Proterozoic in the exploration for life on extra-solar planets.

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