

RETHINKING THE PALEOPROTEROZOIC GREAT OXIDATION EVENT: A BIOLOGICAL PERSPECTIVE. John W. Grula, The Observatories of the Carnegie Institution of Washington, 813 Santa Barbara Street, Pasadena, CA 91101, jgrula@obs.carnegiescience.edu.

Competing geophysical/geochemical hypotheses about how Earth's surface became oxygenated – organic carbon burial, hydrogen escape to space, and changes in the redox state of volcanic gases – are examined and a more biologically-based hypothesis is offered in response. It is argued that organic carbon burial cannot be the main source of oxygen accumulation in a mainly anoxic world where anaerobic metabolisms are predominant. Thus, for the Paleoproterozoic Great Oxidation Event (GOE) ~ 2.4 Gyr ago, an increasing flux of O₂ due to its production by an expanding population of cyanobacteria is parameterized as the primary source of O₂. Various factors that would have constrained cyanobacterial proliferation and O₂ production during the Archean are discussed and it is argued that a long delay between the appearance of cyanobacteria and oxygenation of the atmosphere is to be expected. Destruction of O₂ via CH₄ oxidation was a major O₂ sink during the Archean, and the

GOE is explained to a significant extent by a large decline in the methanogen population and corresponding CH₄ flux which, in turn, was caused primarily by partial oxygenation of the surface ocean. The partially oxygenated state of these waters also made possible a large expansion of the aerobic methanotroph population. This further contributed to the large reduction in the CH₄ flux by increasing the consumption of CH₄ diffusing upwards from the deeper anoxic depths of the water column as well as any CH₄ still being produced in the upper layer. The reduction in the CH₄ flux lowered the CH₄ oxidation sink for O₂ at about the same time the metamorphic and volcanic gas sinks for O₂ also declined. As the O₂ source increased from an expanding population of cyanobacteria – triggered by a burst of continent formation ~ 2.7-2.5 Gyr ago – the atmosphere flipped and became permanently oxygenated.