SEARCHING FOR THE EARLIEST GEOLOGICAL RECORDS OF OXYGENIC PHOTOSYNTHESIS

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The origin of oxygenic photosynthesis is one of the most dramatic evolutionary events that the Earth has ever experienced. At some point in Earth's first two billion years (Ga), primitive phototrophs acquired the ability to harness sunlight, oxidize water, and release O_2, all the while converting CO_2 to organic carbon with unprecedented efficiency. During the Great Oxidation Event (GOE) around 2.5 to 2.3 Ga ago, O_2 began accumulating permenantly in the atmosphere, a process that forever changed the chemistry of Earth's surface and marine environments. Earth's modern biosphere owes its existence to this planet-defining metabolism, and understanding its origin is a paramount challenge in Earth system science.

Here I will present several trace element sedimentary records, preserved in ancient marine chemical sediments, that reinforce the paradigm of the first atmospheric accumulation of free O_2 at the Archean-Proterozoic boundary. Crucially, a growing body of geochemical data suggests that the first production of free O_2 predates its permanant atmospheric accumulation by several hundred million years or more. I will present some of this data as well as mechanistic models for the earliest production of free O_2 during the Archean and its immediate consumption by oxidative weathering reactions. These suggest an important role for early O_2 production in surface-bound (benthic) photosynthetic ecosystems in shallow marine and terrestrial settings. I will conclude by presenting recently published as well as unpublished data that targets robust signals of free O_2 in some of Earth's most ancient terrestrial and shallow-water marine environments dating between 2.8 and 3.2 Ga.