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What if oxygenic photosynthesis isn't that old?

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Oxygenic photosynthesis is the most important bioenergetic innovation in the history of our planet; while it is widely appreciated that the rise of oxygen ca. 2.3 billion years ago (i.e. Earth's Great Oxygenation Event) owes it's sources of dioxygen to this metabolism, there is a substantial and longstanding debate about its evolutionary timing, with estimates ranging across more than one-and-a-half billion years of early Precambrian time.
Since the inception of Precambrian paleontology, photosynthetic Cyanobacteria (then blue-green algae) were considered among the earliest cells to appear in Earth surface environments. Here I present a suite of complementary observations that we have generated over the past five years for the origin and evolution of oxygenic photosynthesis from both the geological record [redox proxy data and models] and the biological record [structural biology of the reaction centers, and new constraints from the recent discoveries in the Cyanobacteria phylum of two clades of nonphotosynthetic close sister taxa to the photosynthetic Cyanobacteria (Oxyphotobacteria): the Melainabacteria and Sericytochromatia] that illustrate why this early adopted, and commonly held, premise is likely incorrect.
Data from both geological and biological archives illustrate that this metabolism, despite its biogeochemical prominence, is a relatively late discovery in the context of Earth's history. This suggests that stem-group Oxyphotobacteria arose close in time to the rise of oxygen, and demands that we take seriously the possibility that the rise of oxygen ca. 2.3 billion years ago was more or less directly caused by the evolution of oxygenic photosynthesis.