alternative earths team overview

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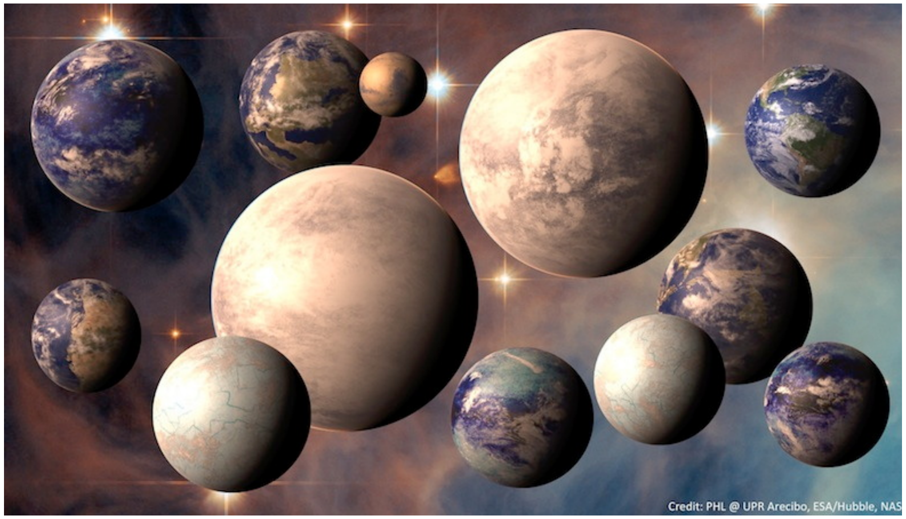
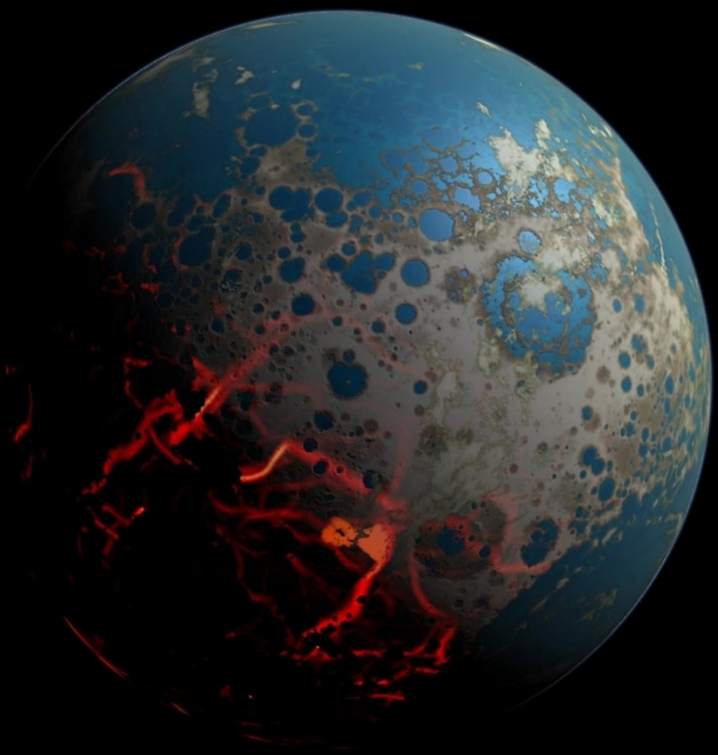
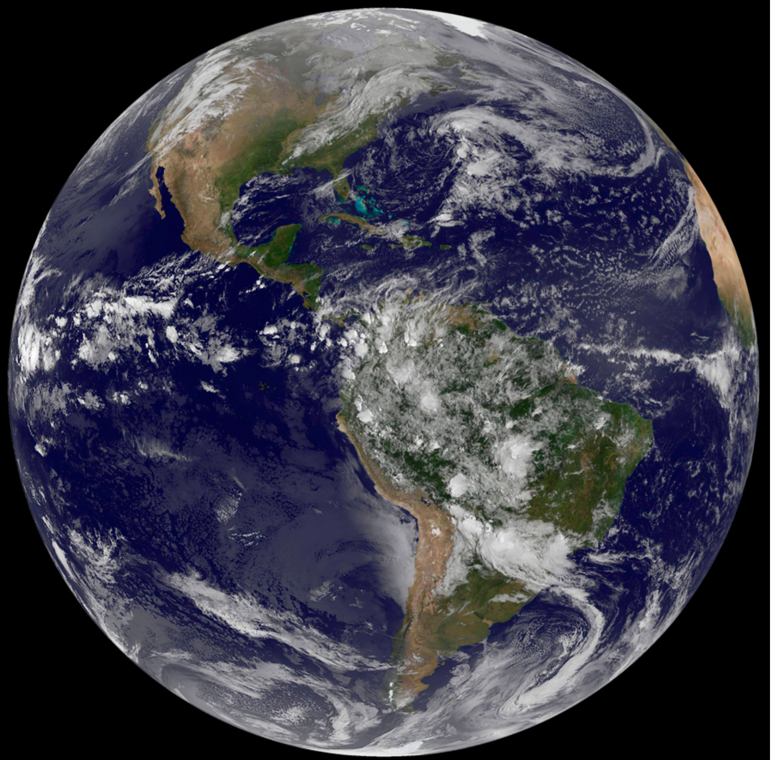
Exploring four billion years of persistent habitability on a dynamic early Earth…

…to guide NASA's mission-specific search for life on distant worlds.



Our Mission to Early Earth





20 scientists from 11 institutions, including three international collaborators

PRINCIPAL INVESTIGATOR

Timothy W. Lyons, Dept. of Earth Sciences, University of California, Riverside

INSTITUTIONAL PRINCIPAL INVESTIGATORS (and working group leaders)

Noah J. Planavsky, Dept. of Geology and Geophysics, Yale University

Christopher T. Reinhard, School of Earth and Atmospheric Sciences, Georgia Tech

CO-INVESTIGATORS

Ariel D. Anbar, School of Earth and Space Exploration, Dept. Of Chemistry and Biochemistry, Arizona State University

Andrey Bekker, Mary L. Droser, Gordon D. Love, Andy Ridgwell, Dept. of Earth Sciences, University of California, Riverside

Ruth E. Blake, David A. D. Evans, Jun Korenaga, Dept. of Geology and Geophysics, Yale University

Christopher L. Dupont, Microbial and Environmental Genomics Group, J. Craig Venter Institute,

Jennifer B. Glass, Yuanzhi Tang, School of Earth and Atmospheric Sciences, Georgia Tech

Bradley M. Tebo, Division of Environmental and Biomolecular Systems, Oregon Health and Science University

COLLABORATORS

James F. Kasting, Dept. of Geosciences, Pennsylvania State University

Cin-Ty A. Lee, Dept. of Earth Sciences, Rice University

INTERNATIONAL COLLABORATORS

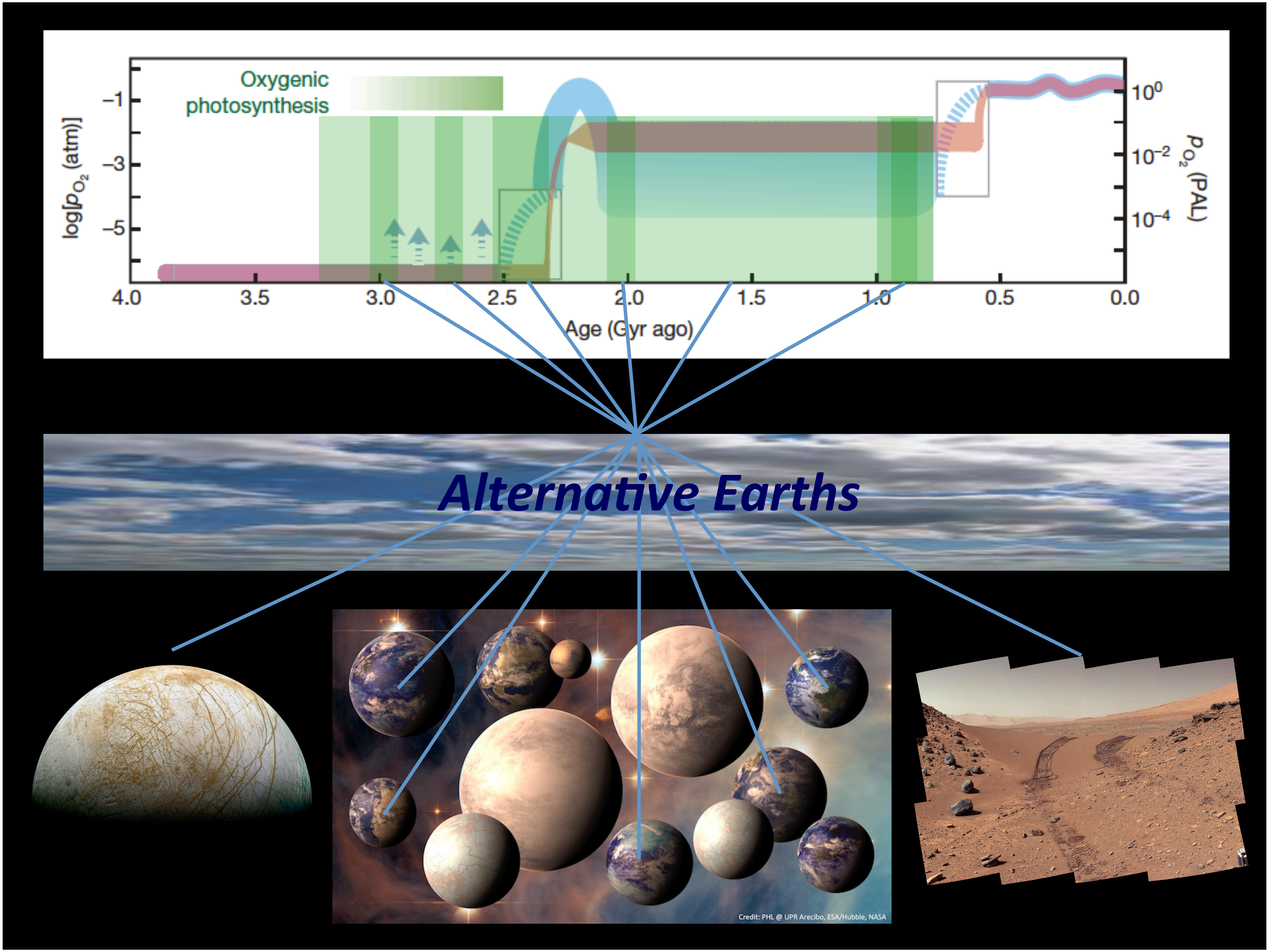
Donald E. Canfield, Dept. of Biology, University of Southern Denmark

Emmanuelle J. Javaux, Université de Liége, Belgium

Niels Peter Revsbech, Aarhus University, Denmark

How has Earth remained persistently inhabited through most of its dynamic history, and how did those varying states of inhabitation manifest in the atmosphere?

What would Earth look like if analyzed remotely over its long history?



Oxygenic photosynthesis
log[p_{O_2} (atm)]
–1
–3
–5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Age (Gyr ago)
10^0
10^{-2}
10^{-4}
p_{O_2} (PAL)
Alternative Earths
Credit: PHL @ UPR Arecibo, ESA/Hubble, NASA

Alternative Earth 1 — In the mid-late Archean (3.2 to 2.4 billion years ago) we are searching the rock record for the earliest atmospheric and oceanic traces of oxygenic photosynthesis and the reasons behind their timing.

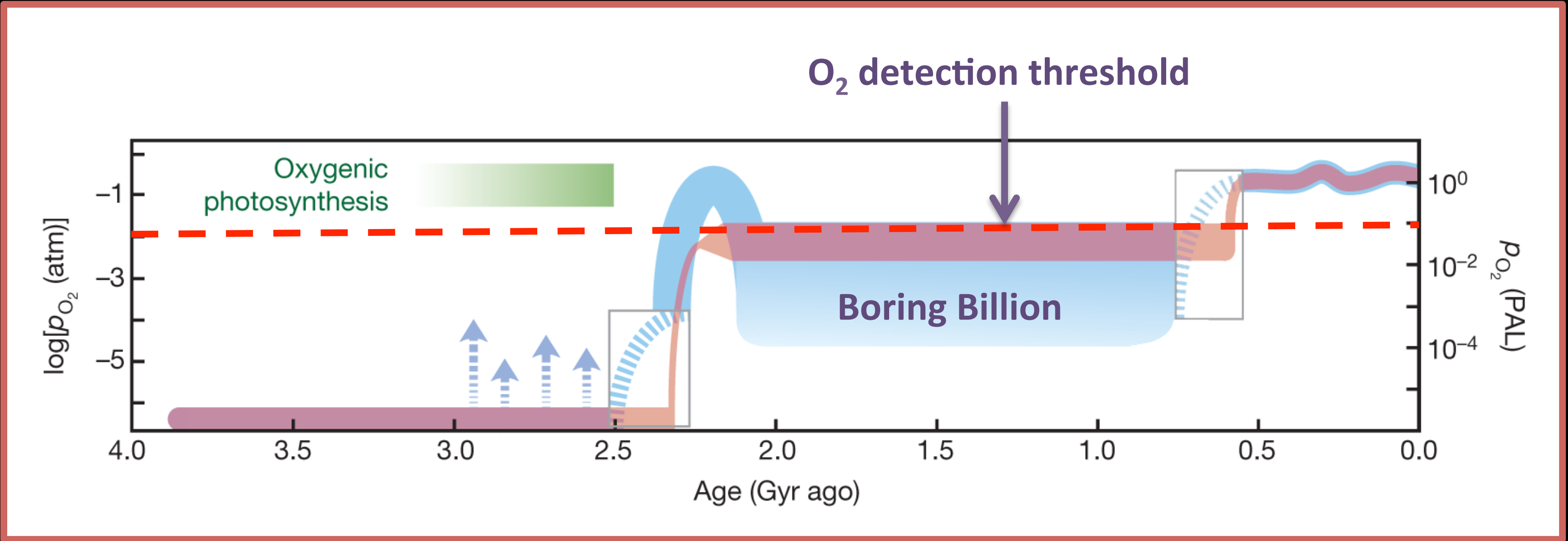
Alternative Earth 2 — In the mid-Paleoproterozoic (2.2 to 2.0 billion years ago) we are investigating whether Earth's surface experienced a unidirectional oxygen rise or instead rose to near-modern levels, then crashed dramatically.

Alternative Earth 3 — In the mid-Proterozoic (1.8 to 0.8 billion years ago), we are exploring the interplay among oxygen, the rise and increasing complexity of eukaryotes, and conditions that set the stage for the eventual rise of metazoans.

Over the course of Year 1, we also nurtured our natural synergism with the Origins of Complexity NAI Team. The result is a new time interval of primary interest:

Alternative Earth 4 — In the late Proterozoic (0.8 to 0.5 billion years ago), our central goal is to work with the Origins of Complexity NAI Team to better understand how the rise of complex life shaped planetary-scale biosignatures.

Earth's Oxygenation

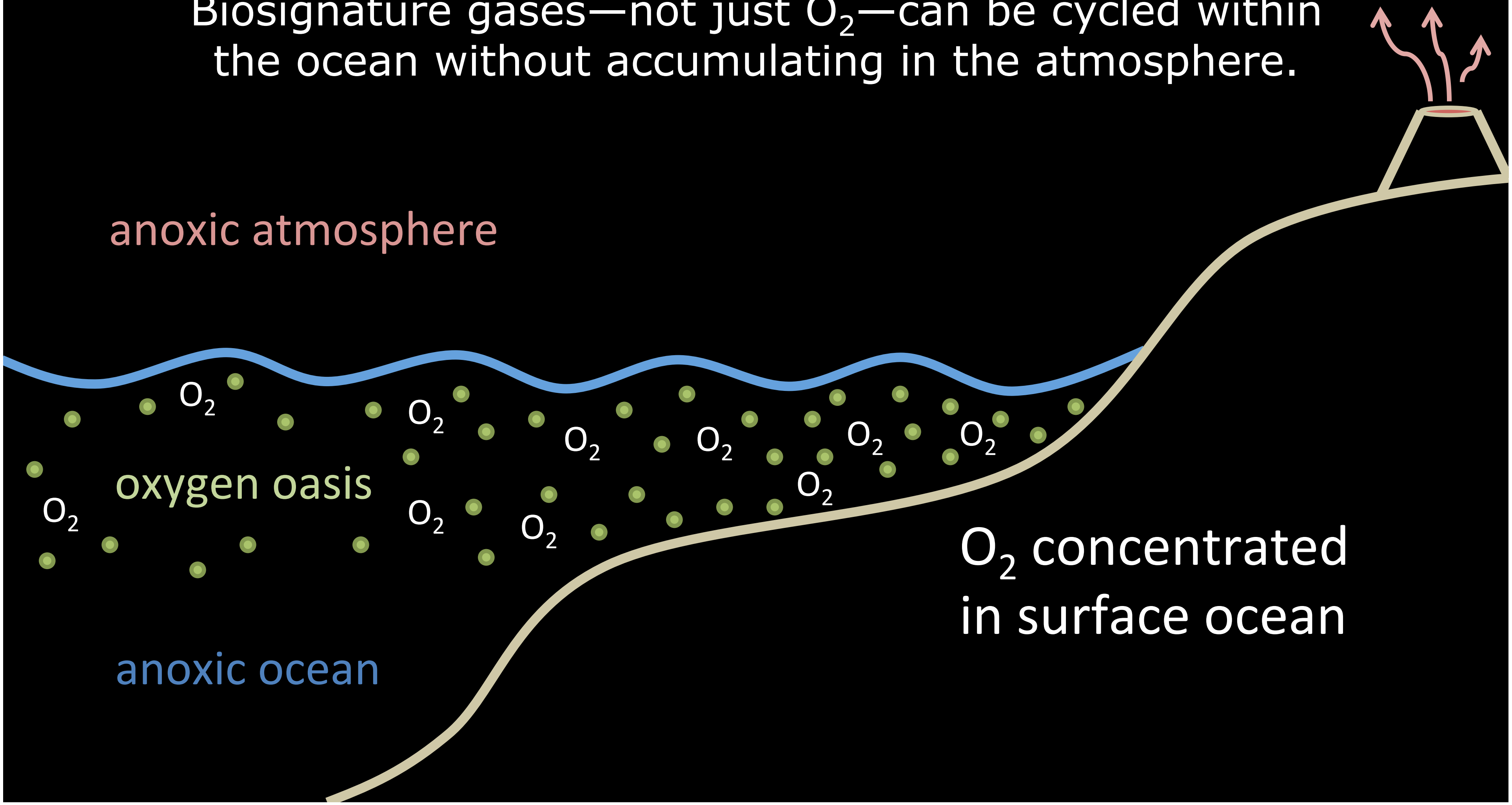


✧ Biogenic O_2 may have predated remotely detectable atmospheric O_2 by more than two billion years!

✧ O_2 may not be a reliable biosignature for Earth-like planets around sun-like stars.

Earth's atmosphere has been an unfaithful reflection of surface chemistry and biology

Biosignature gases—not just O_2—can be cycled within the ocean without accumulating in the atmosphere.



COMING UP NEXT…

Atmospheric O_2 During Earth's Middle Age
Chris Reinhard (Institutional PI, Georgia Tech)

The Methane Greenhouse: Another False Negative
Stephanie Olson (Graduate Student, UC Riverside)

Nitrous Oxide Production in Ferruginous Seas
Jennifer Glass (CoI, Georgia Tech)

Q&A

Mid-Proterozoic Oxygen Landscapes
Chris Reinhard (Institutional PI, Georgia Tech)

Tracking the Rise of Eukaryotes, Part 1: Lipid Biomarker Records
Gordon Love (CoI, UCR)

Tracking the Rise of Eukaryotes, Part 2: Geochemical Proxies & Genomic Perspectives
Christopher Dupont (CoI, J. Craig Venter Institute)

Stabilizing Low pO_2—Nutrient and Tectonic Controls
Noah Planavsky (Institutional PI, Yale)

Challenges & Opportunities in the Modeling of Exoplanets
Andy Ridgwell (CoI, UC Riverside)

Q&A