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Managing Our Photosynthetic Bias in the Exploration for Biosignatures on Mars

Joe Michalski

Dept of Earth Sciences & Laboratory for Space Research

University of Hong Kong

www.clays.space

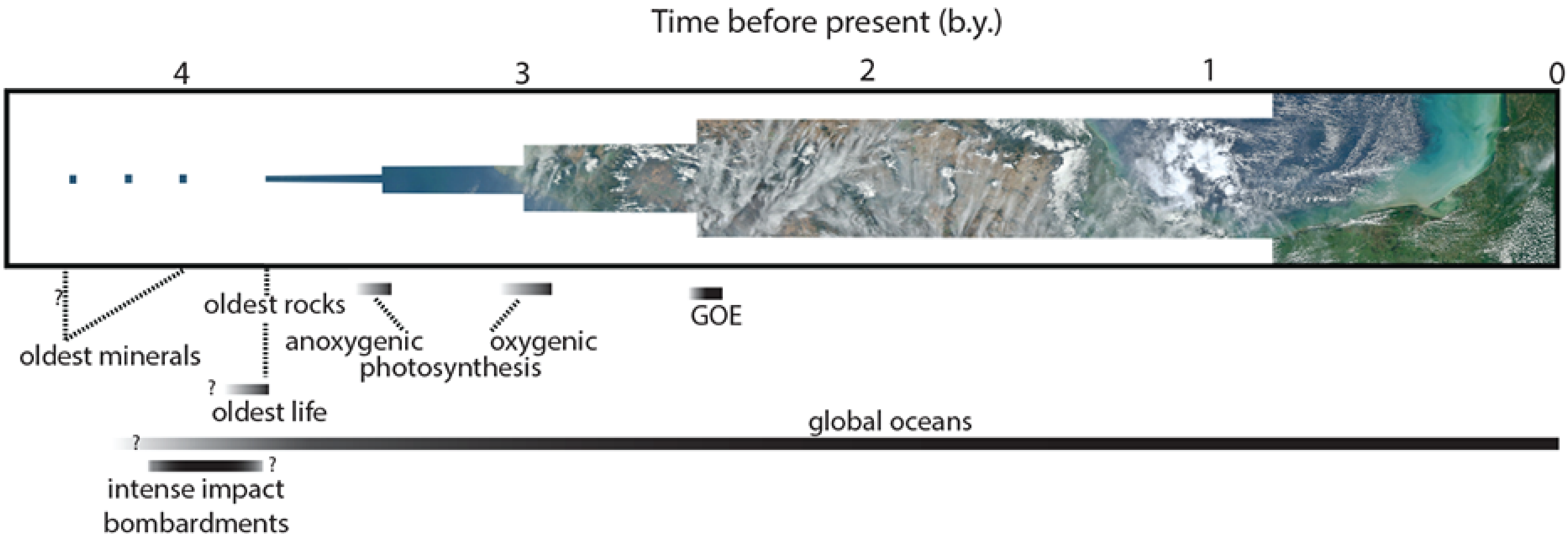
香 港 大 學

THE UNIVERSITY OF HONG KONG

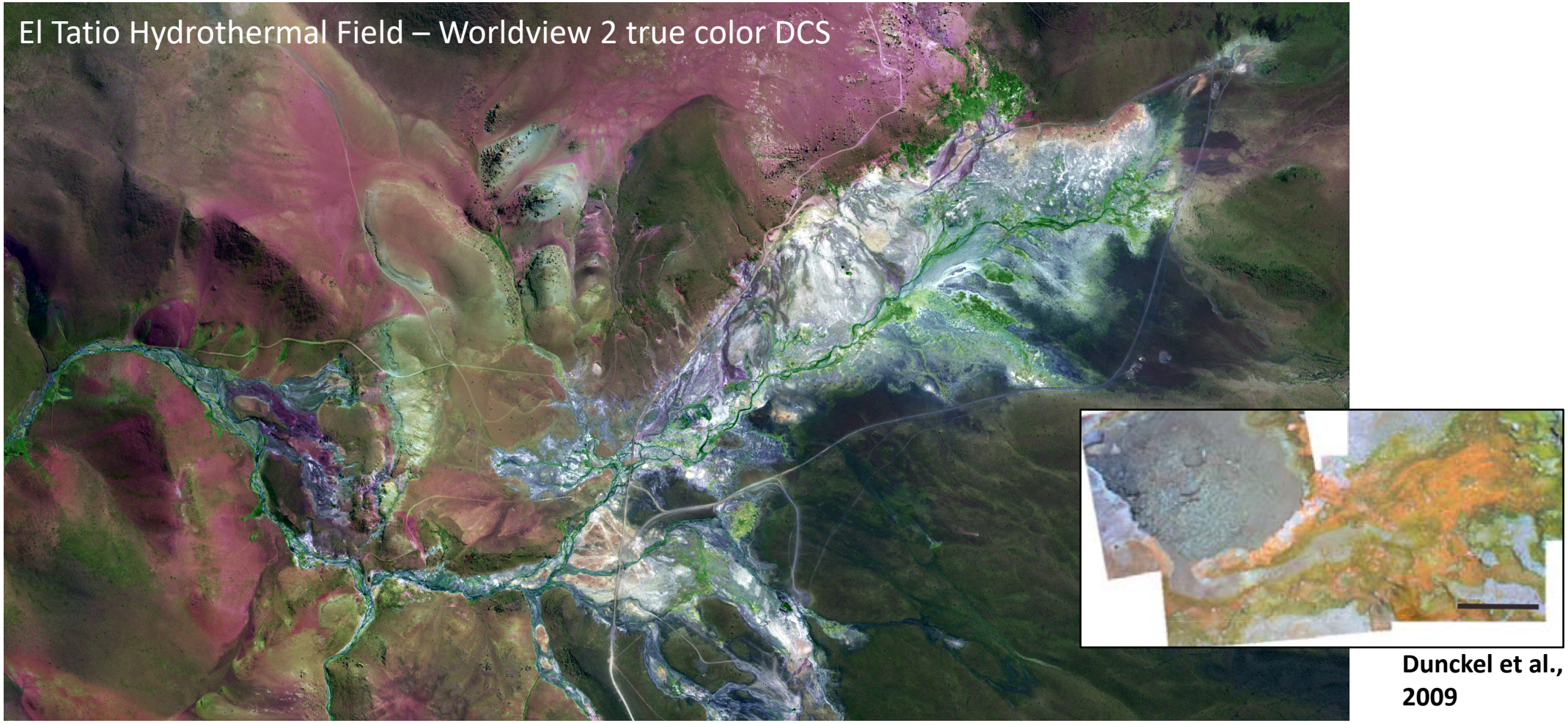
Laboratory for Space Research

Planetary Spectroscopy & Mineralogy Laboratory

A few comments about the history of life on Earth

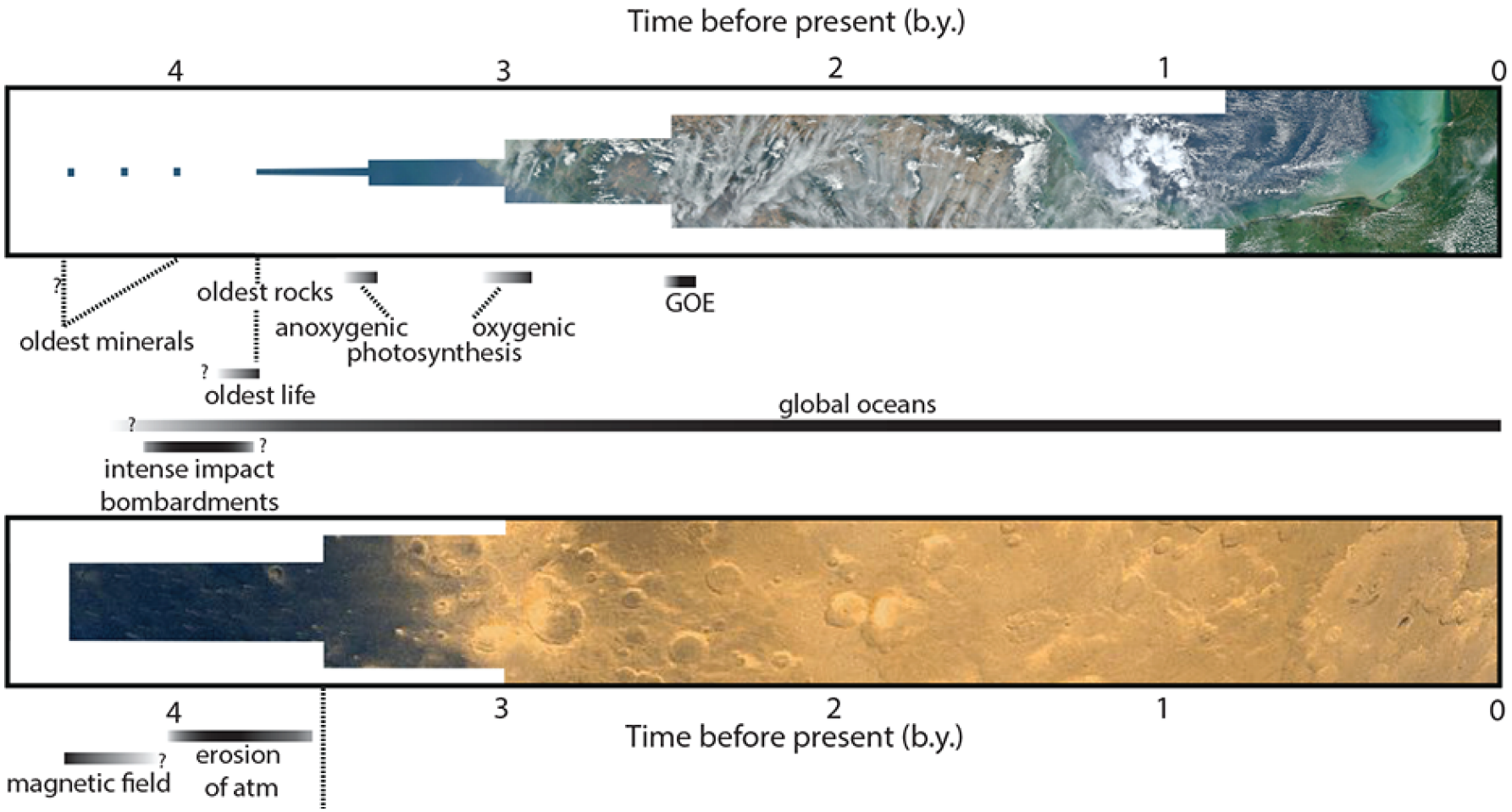


Photosynthesis: A success story



Dunckel et al., 2009

Comparing Earth and Mars



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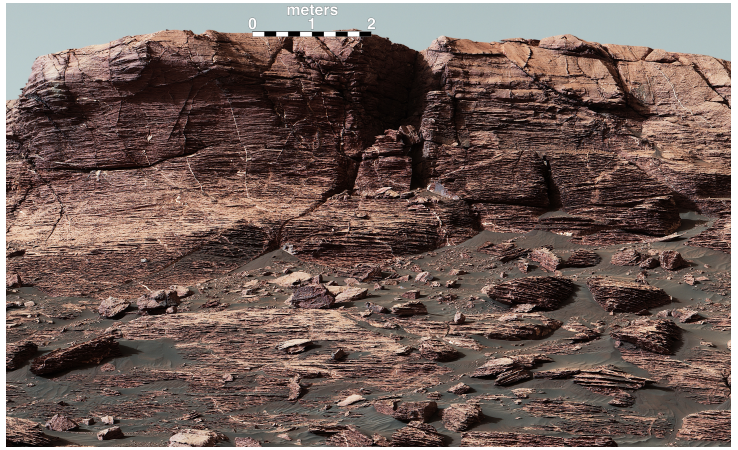
[Michalski et al., Nature Geo. 2018]

Let’s be honest with ourselves, Part 1

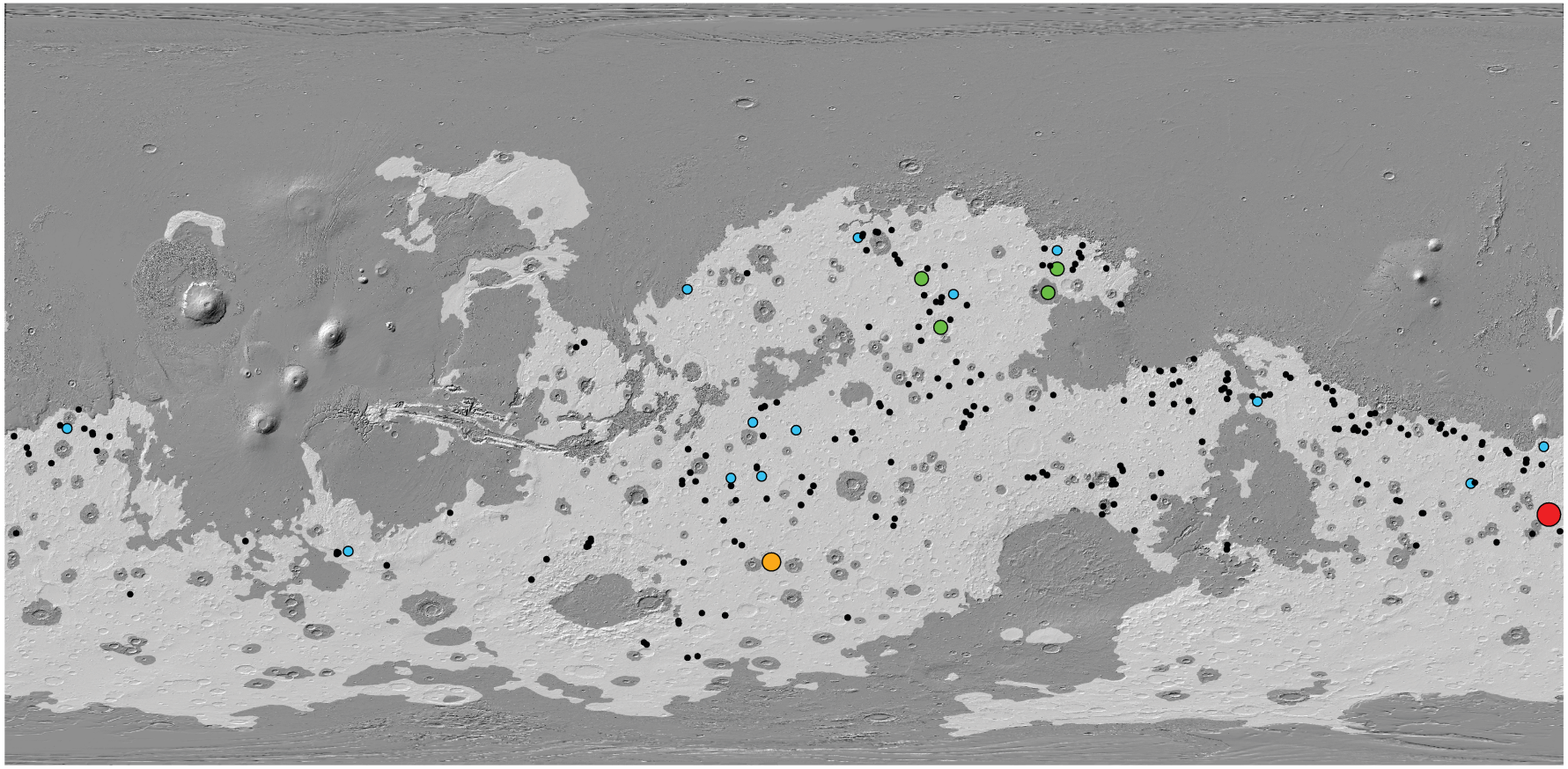
- We don’t know what this planet would be like in the absence of photosynthesis
- By the time oxygenic photosynthesis evolved on Earth, Mars had been cold, dry and radiated for about 1 billion years
- Ask yourself: “Dear Self, would my favourite site still be my favourite site in the absence of photosynthesis?” Love, self.
- Ask yourself: “Dear Self, if we think that life originated in hydrothermal settings on Earth, why in the heavens are we not searching for life in hydrothermal settings on Mars?” Love, self.

The sedimentary paradigm for Mars

- As a community, we have been operating on a Mars exploration model driven by sedimentology
- We know that biosignatures are rarely preserved on Earth and to maximize our chances of detection, we want sed rocks with sequestered organics
- This logic is rooted in a photosynthetic bias



Lakes on Mars



● < 1 x 10^3 km^3 ● 1-10 x 10^3 km^3 ● 10-50 x 10^3 km^3 ● 5-10 x 10^4 km^3 ● >1 x 10^5 km^3

estimated lake volume

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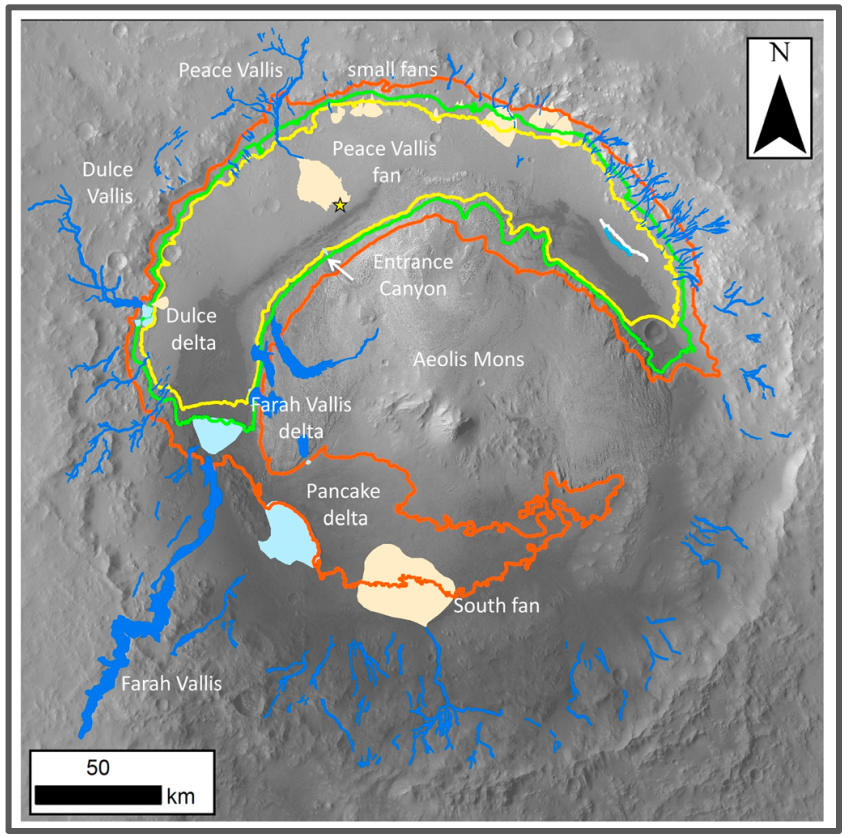
[Fasset and Head, 2008]

Timing of Gale crater lake(s)

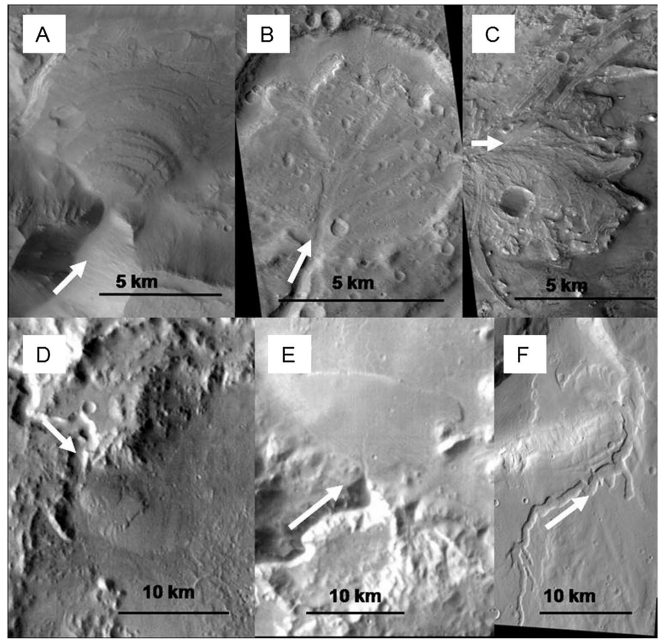
- Gale Crater contained multiple episodes of transient lakes
  [Grotzinger, 2009]
- Duration of lake(s) was approximately 10^4-10^5 years
  [Palucis et al., 2016]

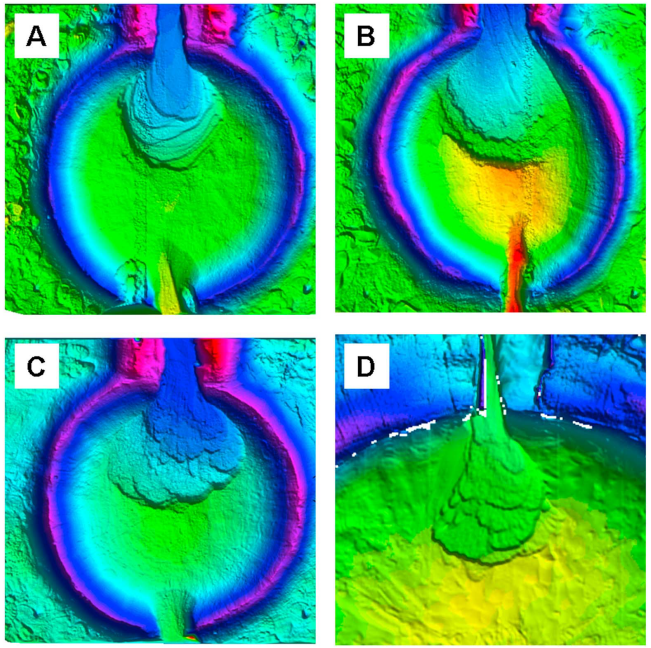


[Palucis et al., 2016]

Timing of delta formation

- Numerical modeling and flume experiments show that Martian deltas are not consistent with sustained aqueous activity
- Timing of events was likely 10^4-10^5 years maximum [De Villiers et al., 2013]





[De Villiers et al., 2013]

Timing is everything

- There is not consensus on details of ancient climate, but it was probably largely cool and dry [see Wordsworth et al. 2015 for a summary]
- There is no need for sustained warm climate to explain observations in terms of geomorphology (10^5-10^6 years) [Fasset and Head, 2011]

Earth or Mars?

Lakes on Mars

→ Episodic wetting is not the same thing as a sustained prebiotic soup

Let’s be honest with ourselves, part 2

- Are we really telling ourselves that life originated in transient lakes on Mars?
- Is Mars really “just add water?”
- Are we saying that life originated elsewhere on Mars and colonized transient lakes?

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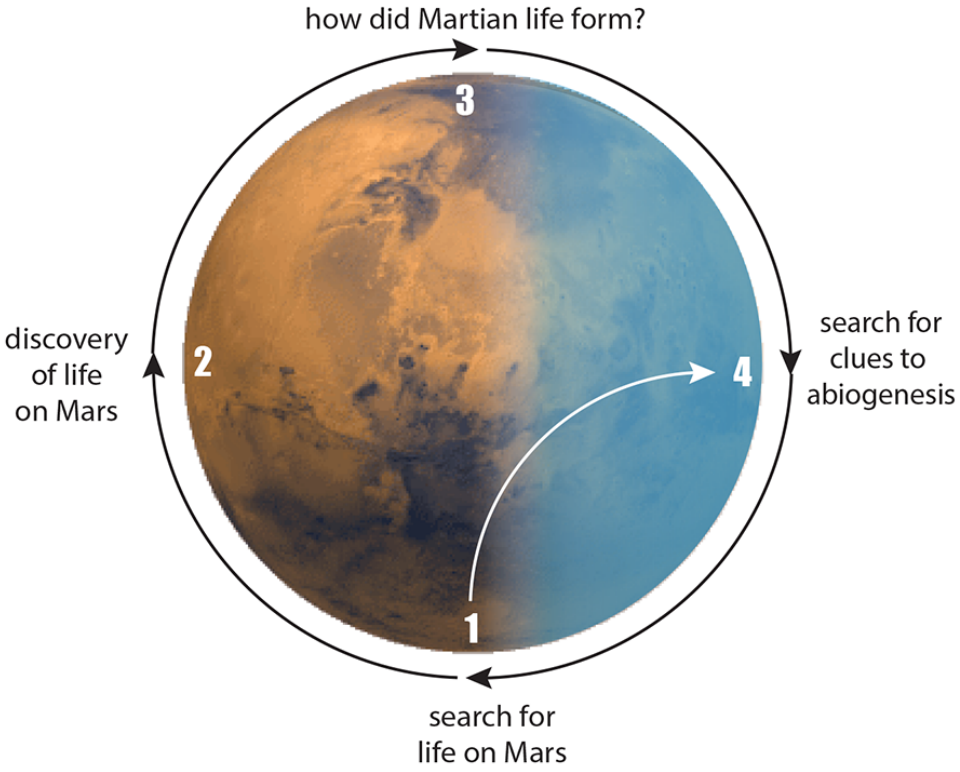
Let’s explore something we don’t understand

- It is OK to explore something that you do not already understand
- If you think “…that life originated elsewhere on Mars and colonized transient lakes…” THEN JUST GO TO THE GOOD STUFF FIRST