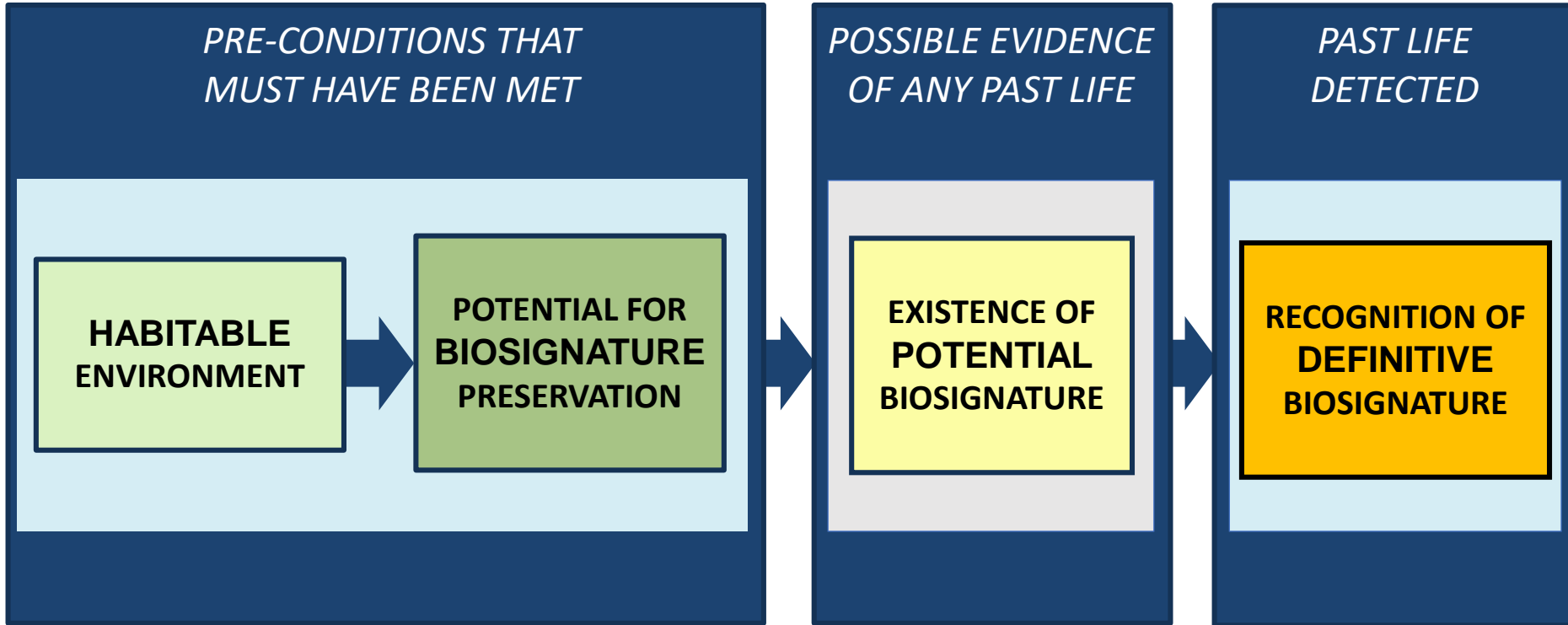




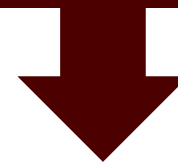
**Biosignatures of Past Life are Relevant
to the Search for Extant Life**

**David Des Marais
NASA – Ames Research Center
Moffett Field, CA. 94035**

Scientific Process for Detecting Martian Life



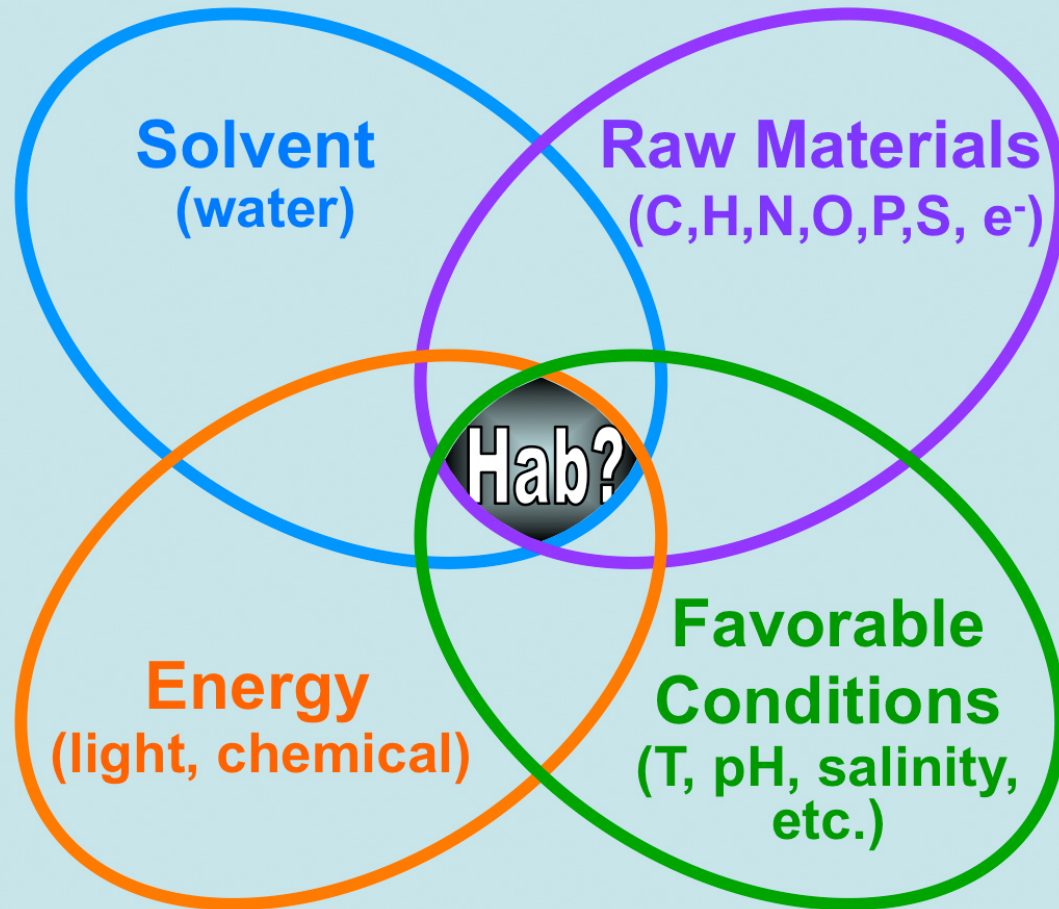
Proposed Mars 2020 Rover



Mars Sample Return

Labs on Earth

Requirements for Habitability (Hab)



adapted from graphic
by Tori Hoehler

Biosignature - Definition

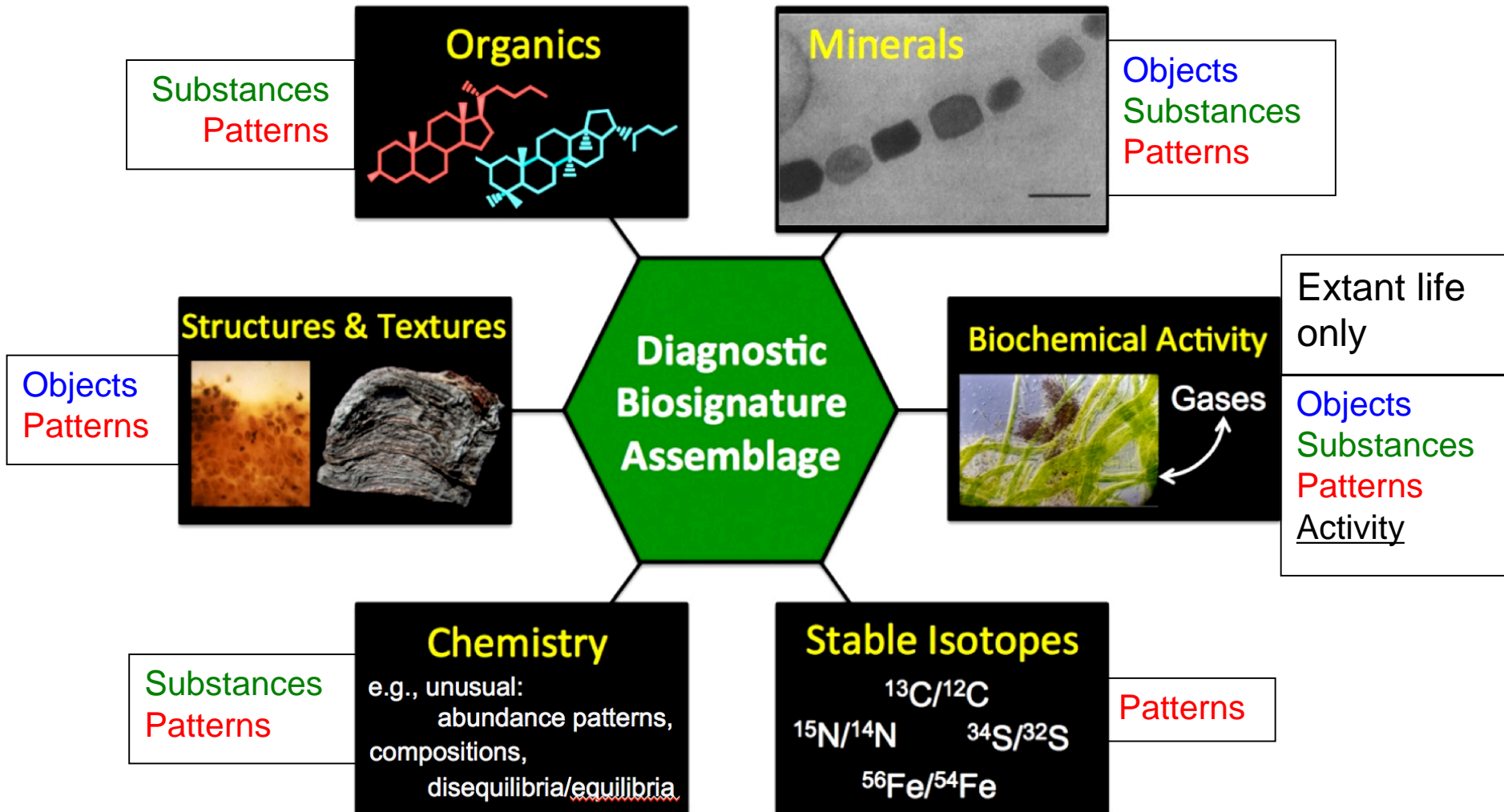
A biosignature is an **activity**, **object**, **substance**, and/or **pattern** whose origin specifically requires a biological agent.

The usefulness of a biosignature is determined not only by the probability that life produced it, but also by the improbability that nonbiological processes produced it.

Biosignature types:

Activity **Objects** **Substances** **Patterns**

Biosignature Categories



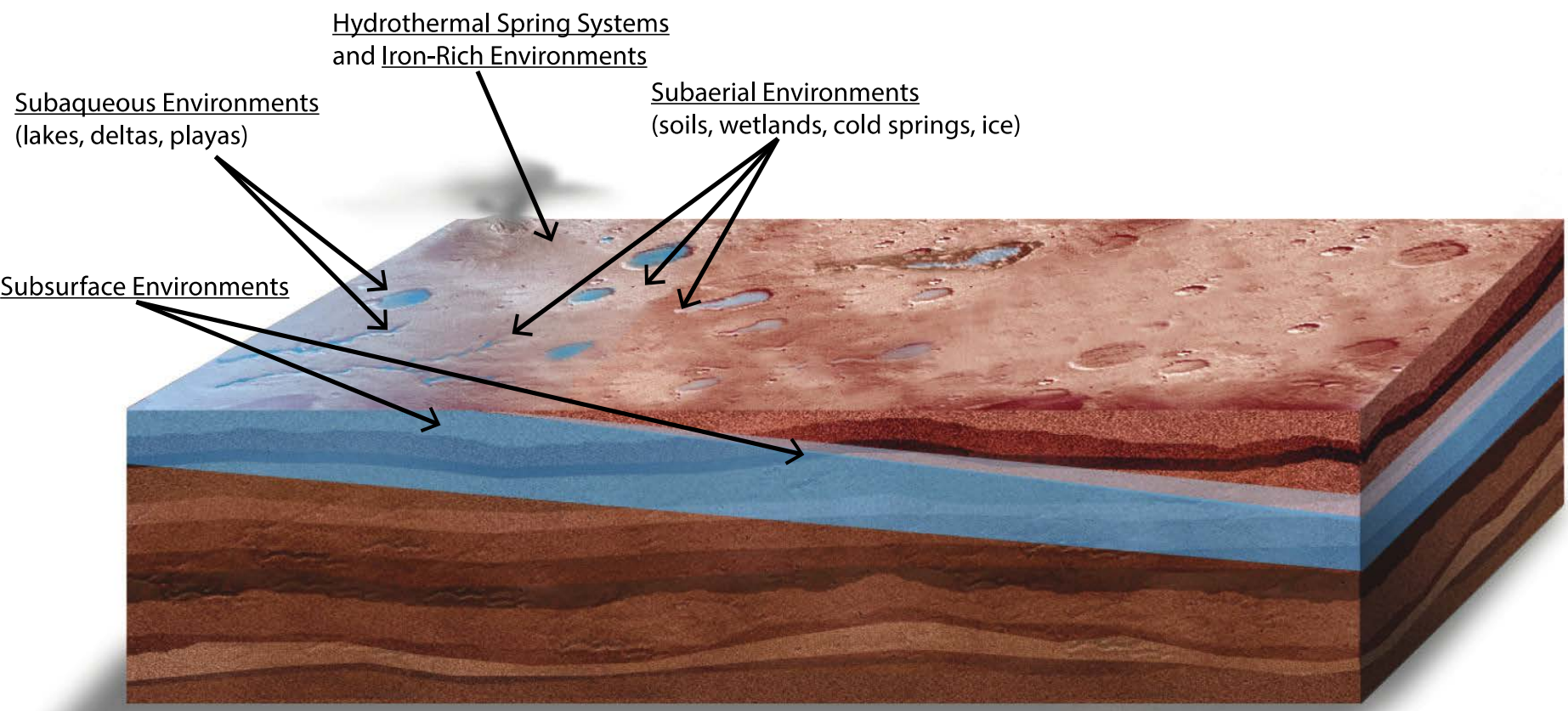
Minerals & Rocks that Preserve Fossil Records

Residence Time	Least Stable	Dominant Process Controlling Loss
$<1 \times 10^4$ yrs	Ice	Climatic warming
$<1 \times 10^6$ yrs	Halides, sulfates	Dissolution
$<2 \times 10^8$ yrs	Metallic sulfides	Oxidation
$<3.5 \times 10^8$ yrs	Clay-rich shales Water-laid pyroclastics Marine carbonates Metallic oxides	Metamorphism Recrystallization Dissolution
$<3.8 \times 10^8$ yrs	Phosphates Silica	Deep burial Recrystallization Metamorphism
	Most Stable	

Biosignature Occurrences

A key challenge is to identify and visit sites where any biosignatures are both accessible and sufficiently abundant to be detectable.

The temporal and spatial distribution of any biosignatures of extant life will be highly heterogeneous due to the processes that control habitability and preservation.



Subaqueous Environments
(lakes, deltas, playas)

Hydrothermal Spring Systems
and Iron-Rich Environments

Subaerial Environments
(soils, wetlands, cold springs, ice)

Subsurface Environments

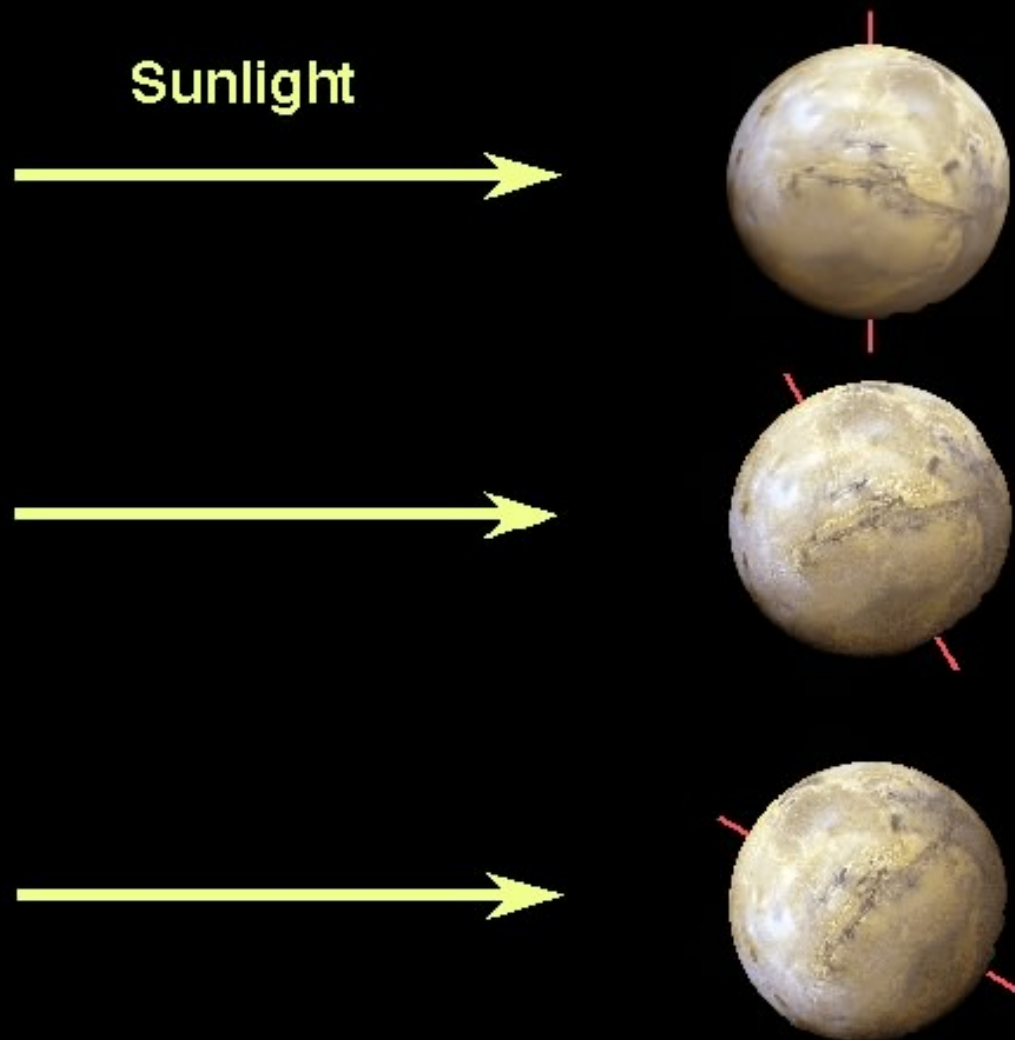
4.5

3.8?

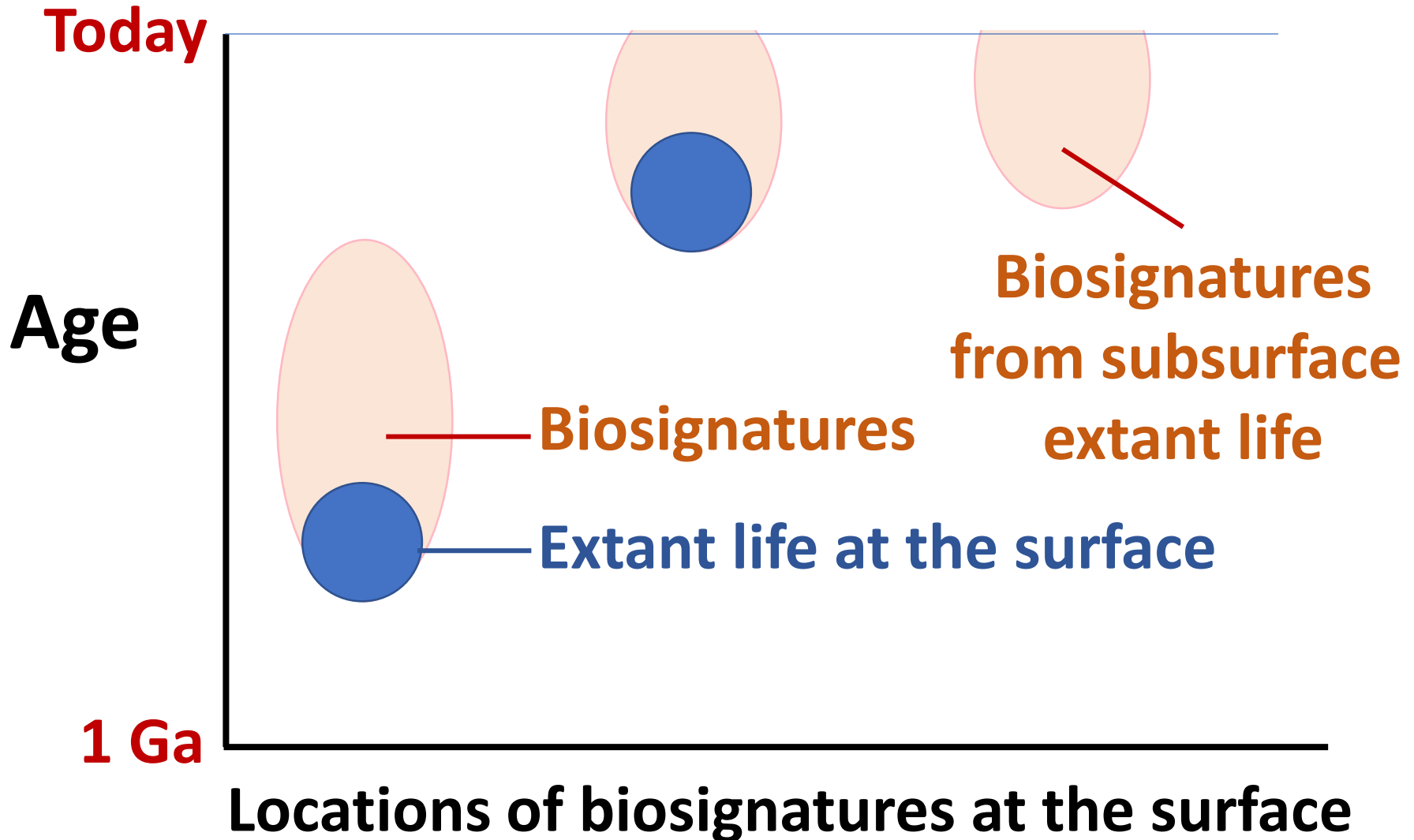
Today

Billions of Years Ago

Obliquity changes can exert major effects upon the abundance and global distribution of water in the surface environment



Arrays of biosignature types increase the probability for detecting extant life - hypothetical examples:



Hydrothermal sites on Mars are ideal to search for evidence of life (Walter & Des Marais, 1993)



Bumpass Hell, Lassen V.N.P.



Home Plate, Gusev crater, >3.5 b.yr. ago (artist conception)

“Oases”: sources of near-surface water

Reduced chemical species provide sources of energy for life

Range of conditions sustains large diversity of biota

Mineral deposits preserve evidence of environments and life

Sites of ancient spring deposits have been found on Mars



young crater

Biosignatures Revealing Extant Life

If the origin of a biosignature can be confirmed to be geologically recent, then it probably indicates that life still exists somewhere. This scenario applies if, for example, the biosignature was delivered from a habitable environment located elsewhere. Or the biosignature might have been created at the sample site under a geologically recent environment that was more habitable than it is today.