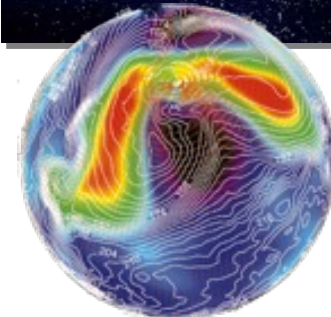
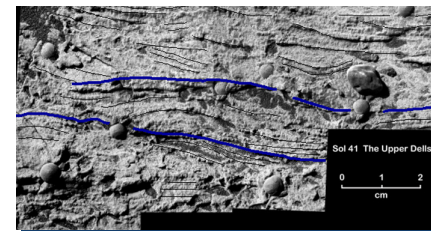
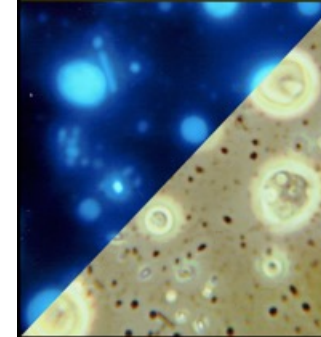


Astrobiology and Mars: Current Discoveries and Programs

Prof. G. Scott Hubbard,
Department of Aeronautics and Astronautics
Stanford University
Former Director of NASA Ames
NASA's first Mars Program Director and
Founding Director of NASA's Astrobiology Institute

ICES Biennial
Space Panel II
September 30, 2026

- Interdisciplinary study of life in the universe created in 1995
- Three fundamental questions
 - > How does life begin and evolve?
 - > Does life exist elsewhere in the universe?
 - > What is life's future on Earth and beyond?
- Astrobiology seeks to define habitable environments and biosignatures

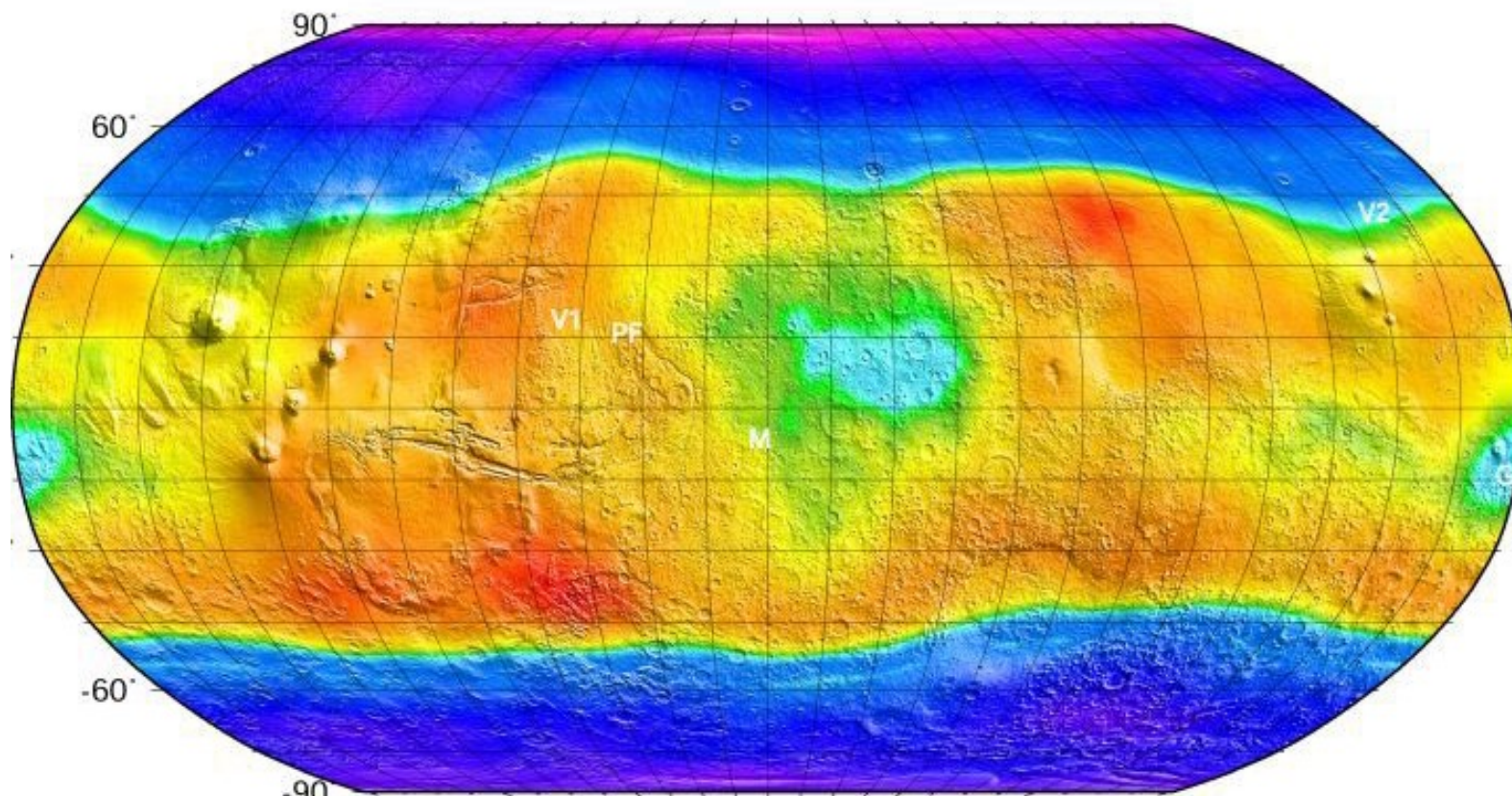


The Water Picture from Mars Odyssey



2001 Mars Odyssey Gamma Ray Spectrometer

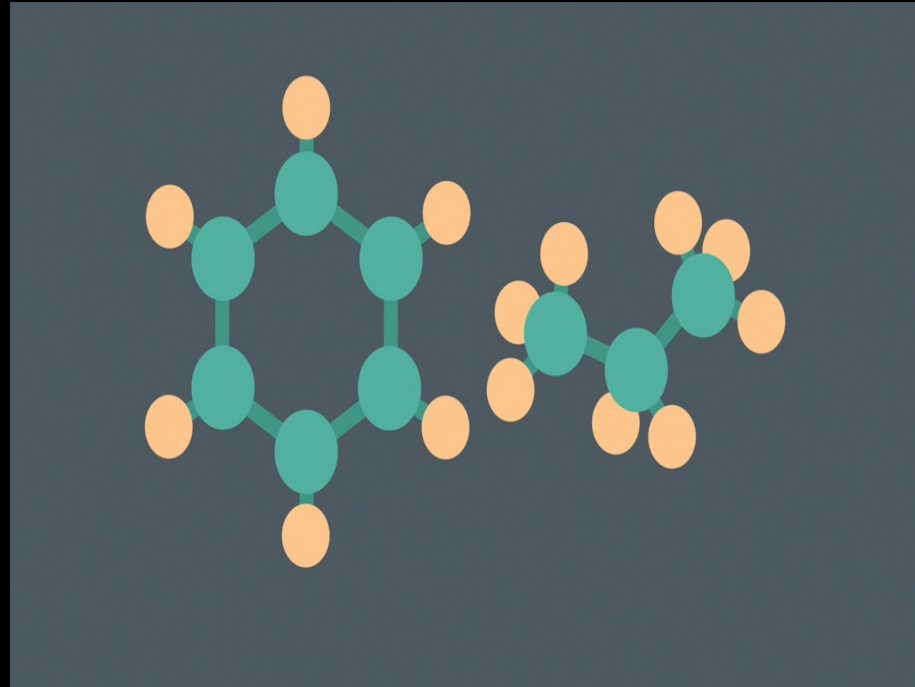
H₂O Low  H₂O High



Measurements show strong evidence of
underground water ice

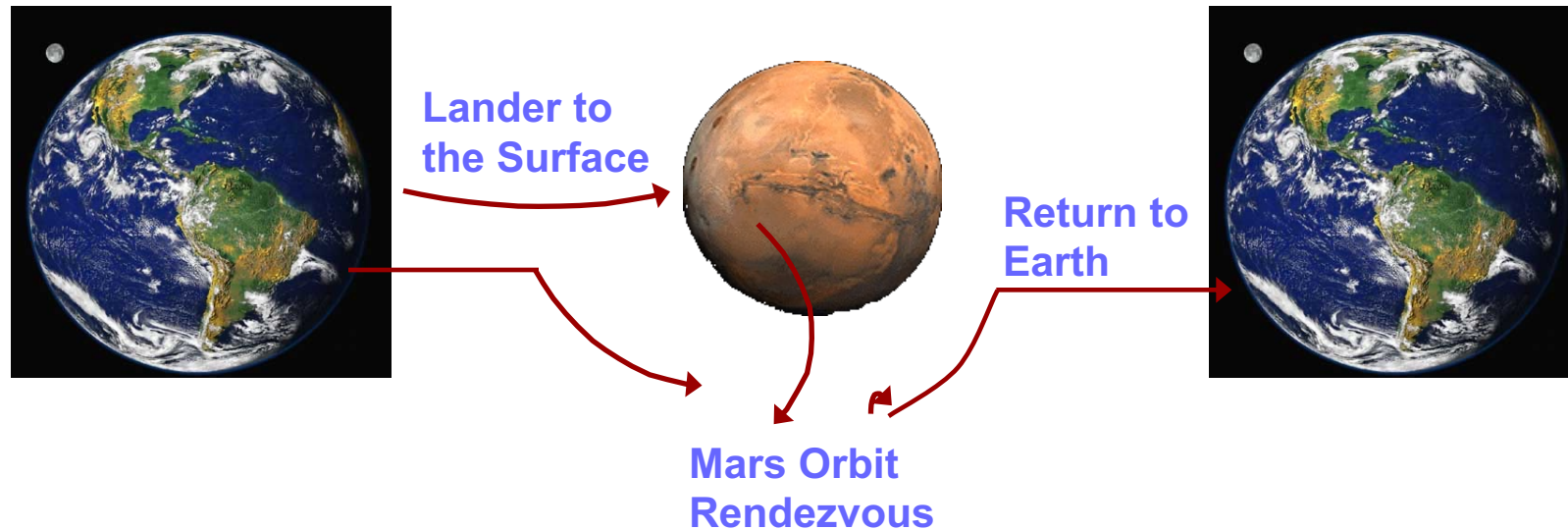
Stanford University Department of Aeronautics and Astronautics

Curiosity data shows diverse organic structures evolving at high temperatures organic matter → macromolecules



On Earth typical organic constituents of *kerogen* are algae and woody plant material

Recommended in 2013 and 2023 Mars Sample Return is Critical



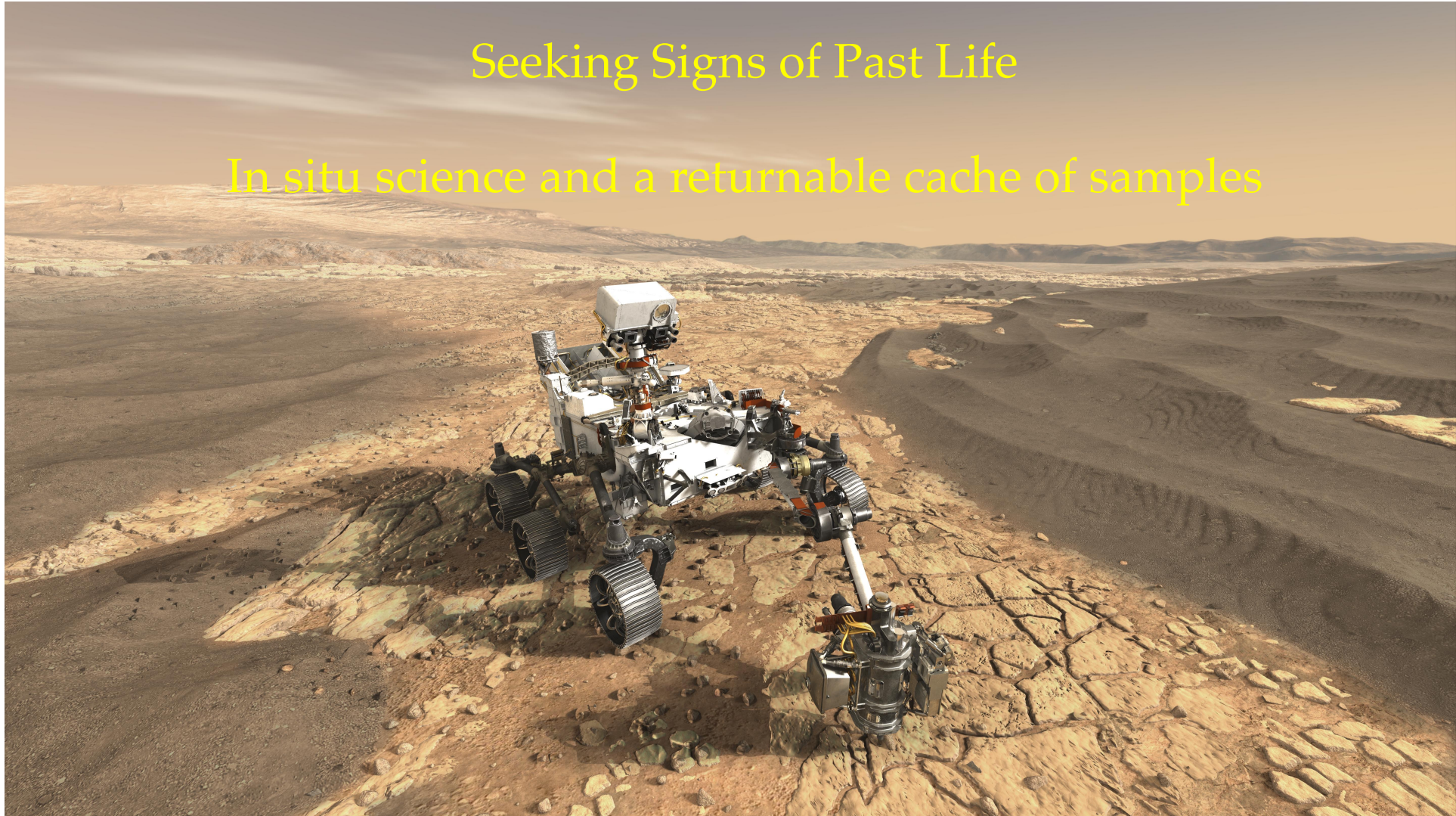
Why:

- Next logical step – most science return for the investment
- Samples can be analyzed by multiple labs
- Investigations by 100's of researchers
- Advanced instrument utilized that is too large, complex or recent for space hardware
- Alternate measurement routes can be followed

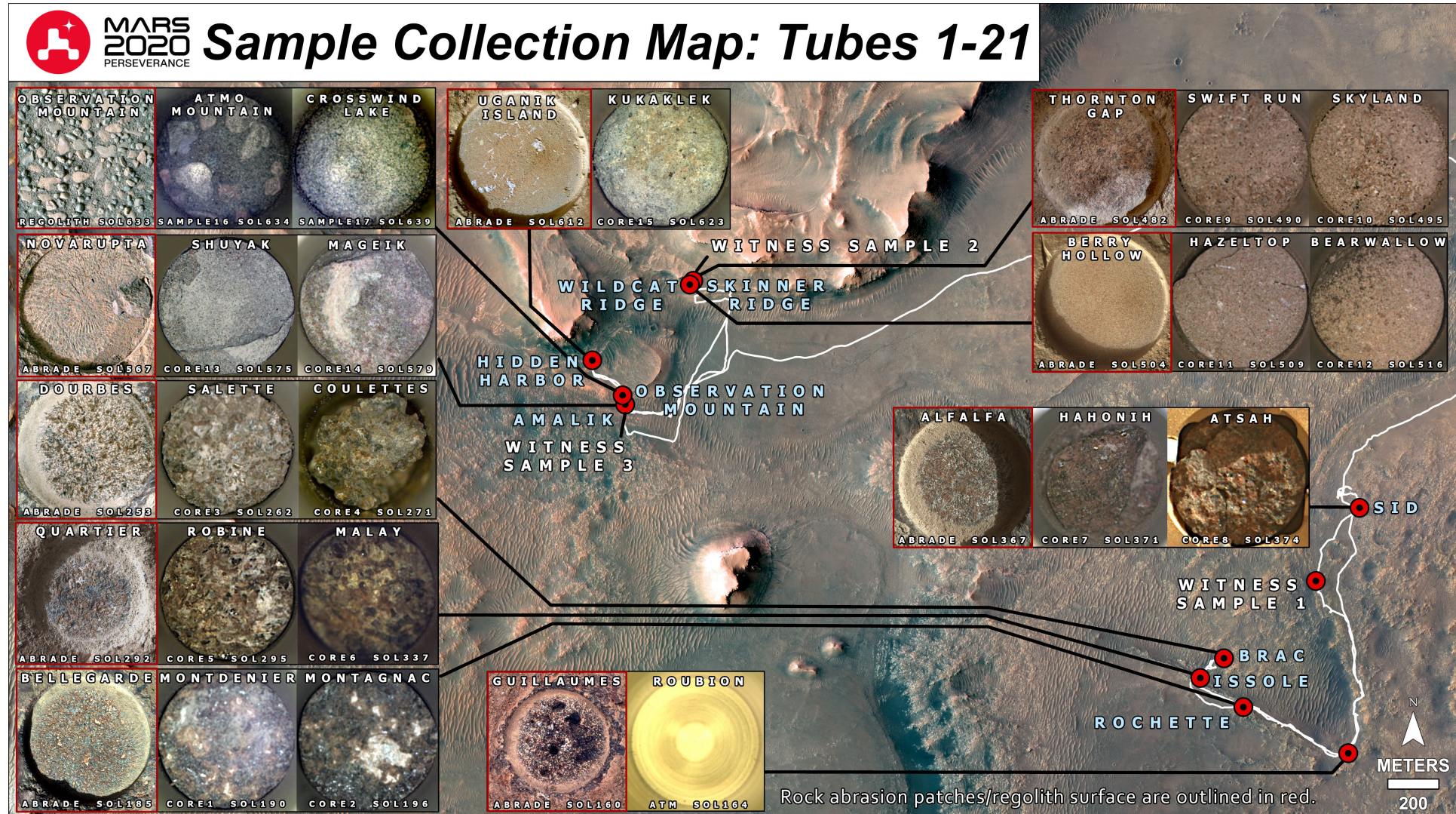


Seeking Signs of Past Life

In situ science and a returnable cache of samples



Perseverance Samples Thus Far



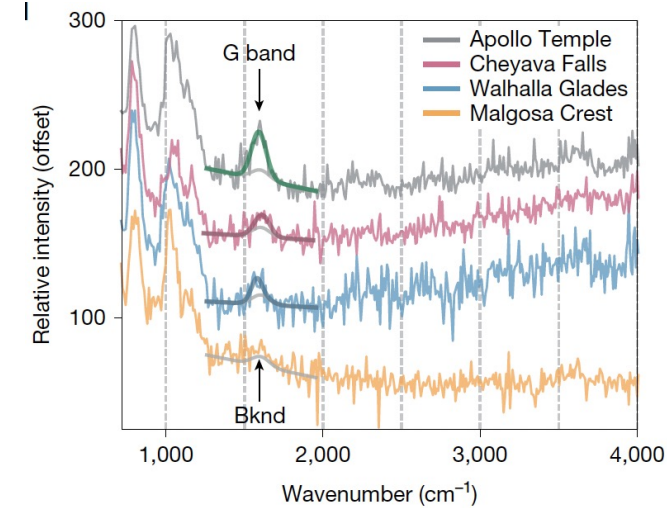
Recent Detection Of Possible Biosignatures From *Perseverance* Rover



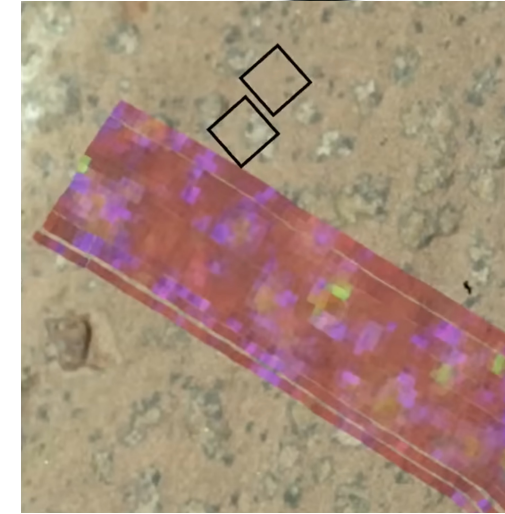
“Chevaya Falls” region of Jezero Crater



“Leopard spots” and “poppy seeds” that are regions of altered rock



Raman spectra of different components showing “G band” indicative of organic molecules



Compositional information, showing mud rich in Fe (red), Fe and P in layered rims (purple), and Fe and P combined into minerals

- On Earth, these features would be compelling indications of alteration by microbes
- On Mars, there are enough unknowns in the environment and history of the samples that alternative explanations are viable
- Determination of whether life was involved will require analysis of the returned sample on Earth