

Should the Deep Crust be our Primary Astrobiological Target for Mars? Observations from Leighton Crater and Other Sites

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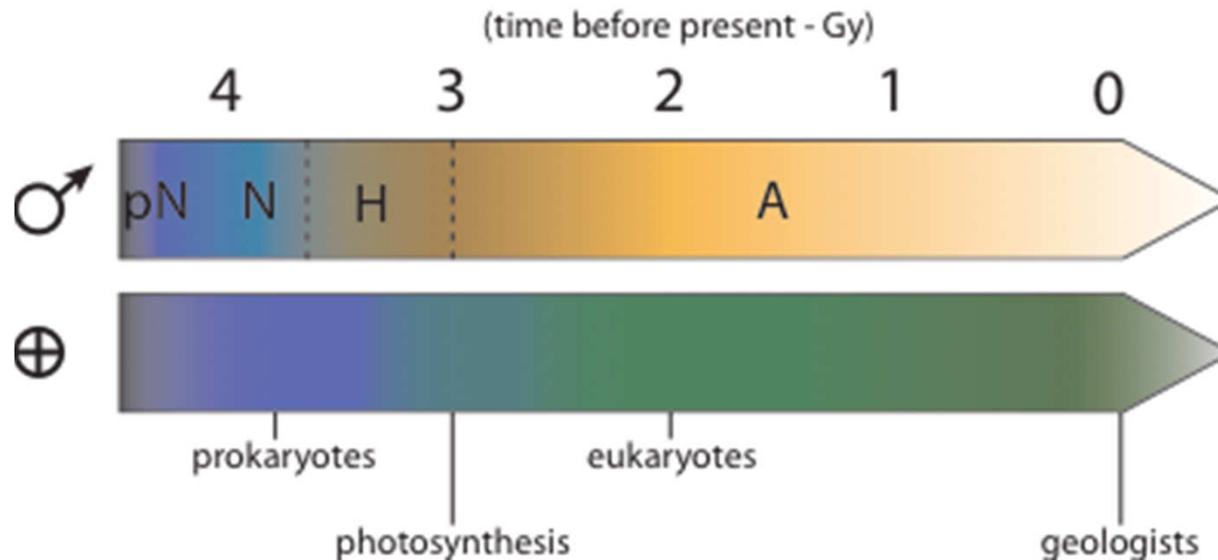
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FRANK CHUANG

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What are we looking for?

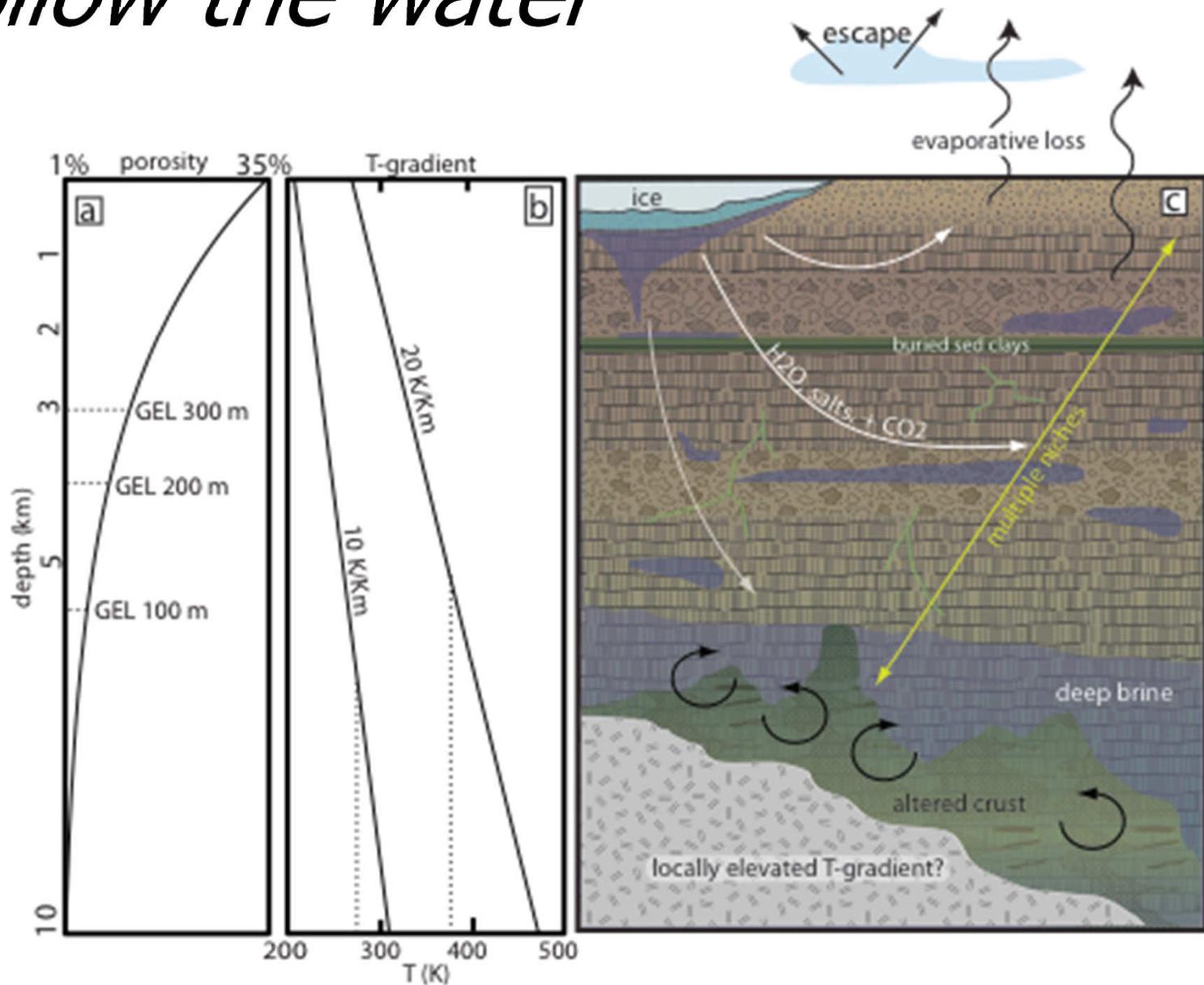


Prokaryotes: The unseen majority, Whitman et al. PNAS (1998)

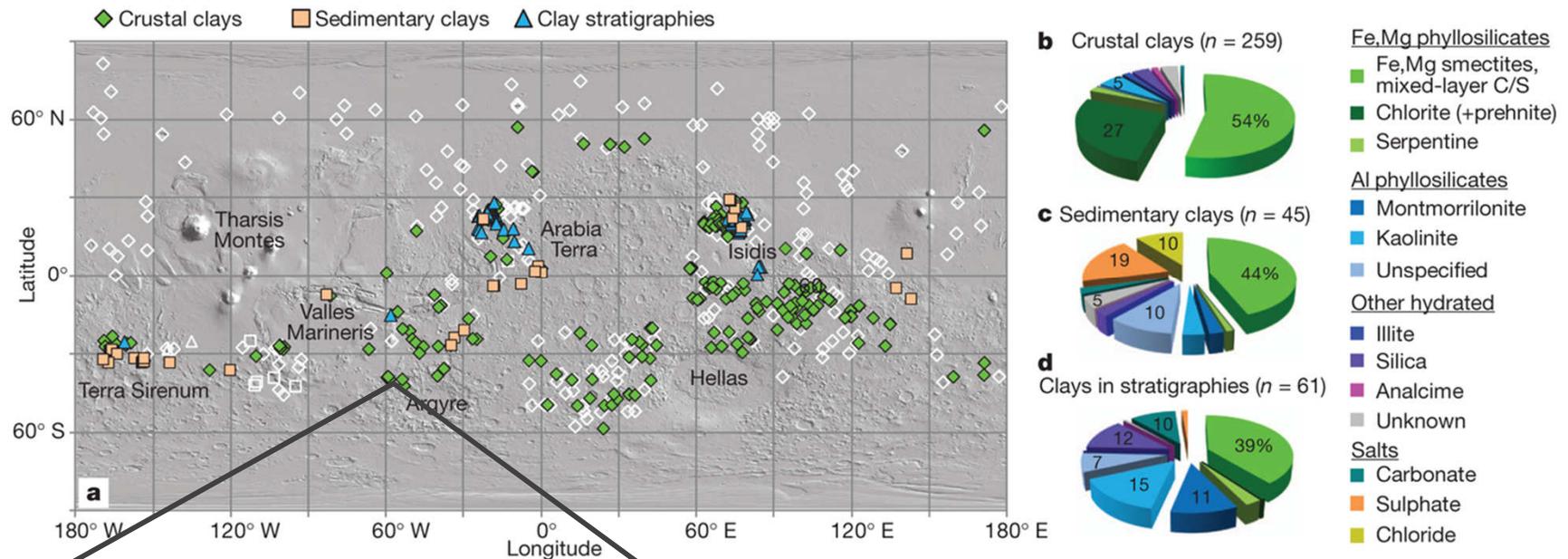
! Prokaryotes comprise 50% of the organic carbon on Earth.

! Prokaryote biomass in the deep crust is 10-15x greater than that of the oceans, soils, and surface combined

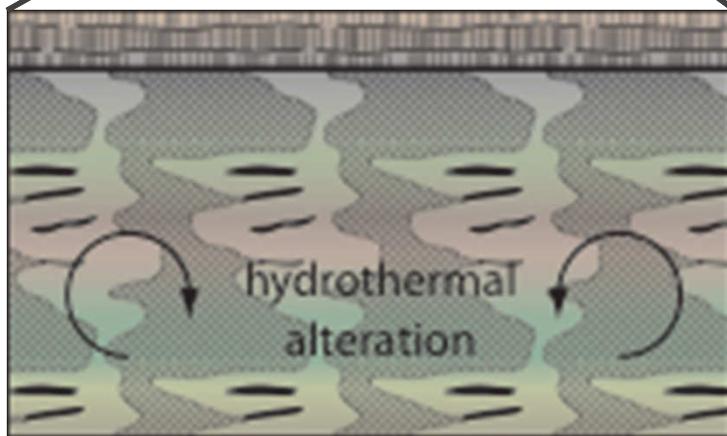
"Follow the water"



Summary of alteration on Mars

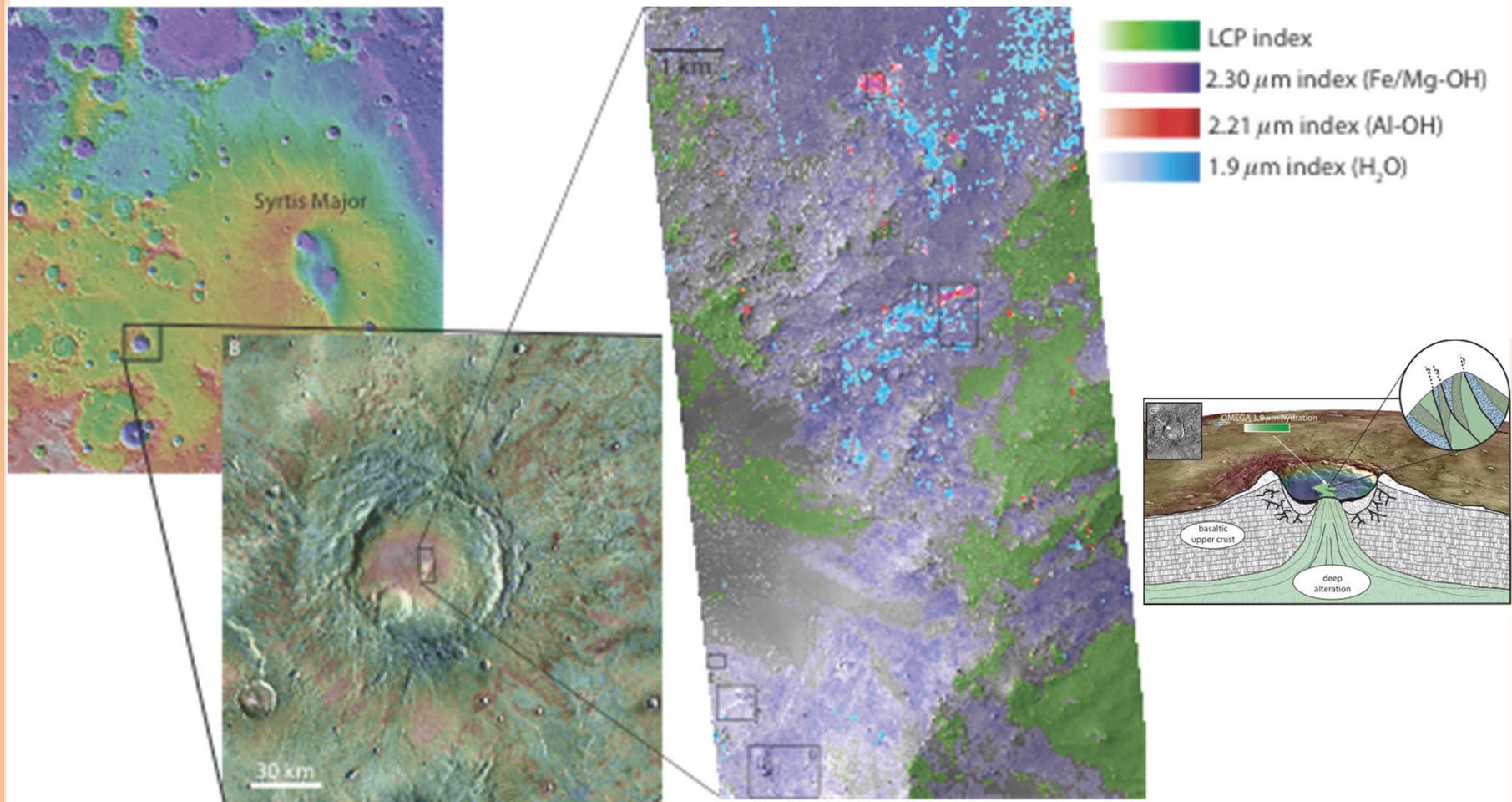


Ehlmann et al., Nature 2011



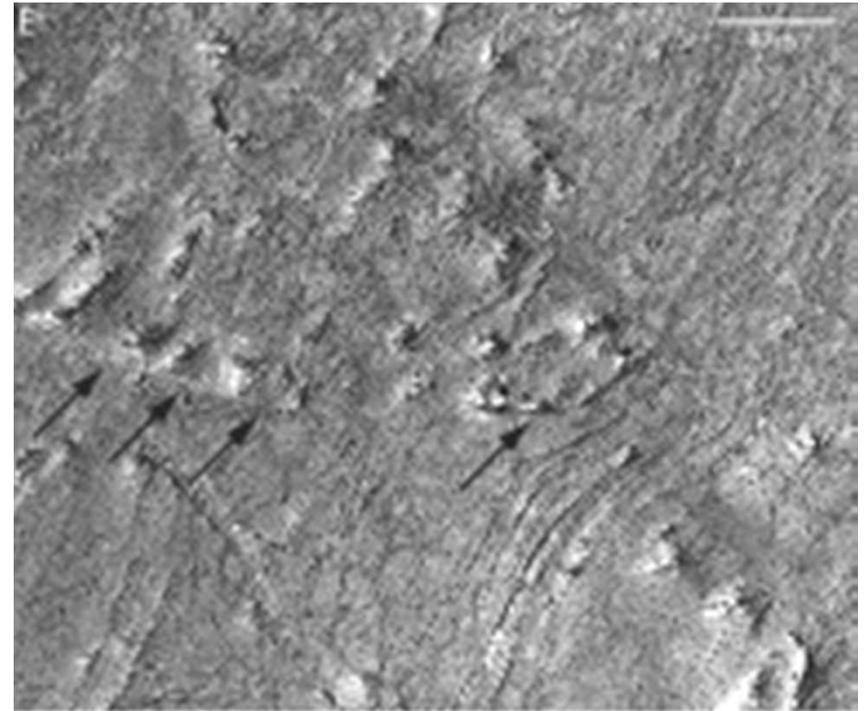
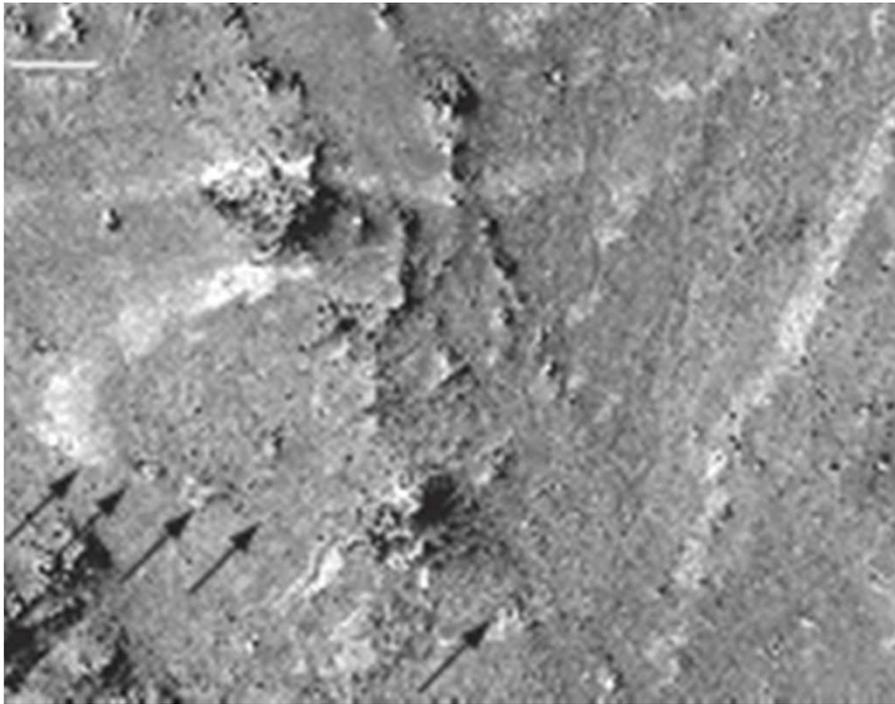
- ✧ Thermal bottleneck
- ✧ Why leave home?
- ✧ Vast habitat
- ✧ Vast alt at 4-6 km depth

LEIGHTON CRATER



Michalski and Niles, Nature Geo, 2010

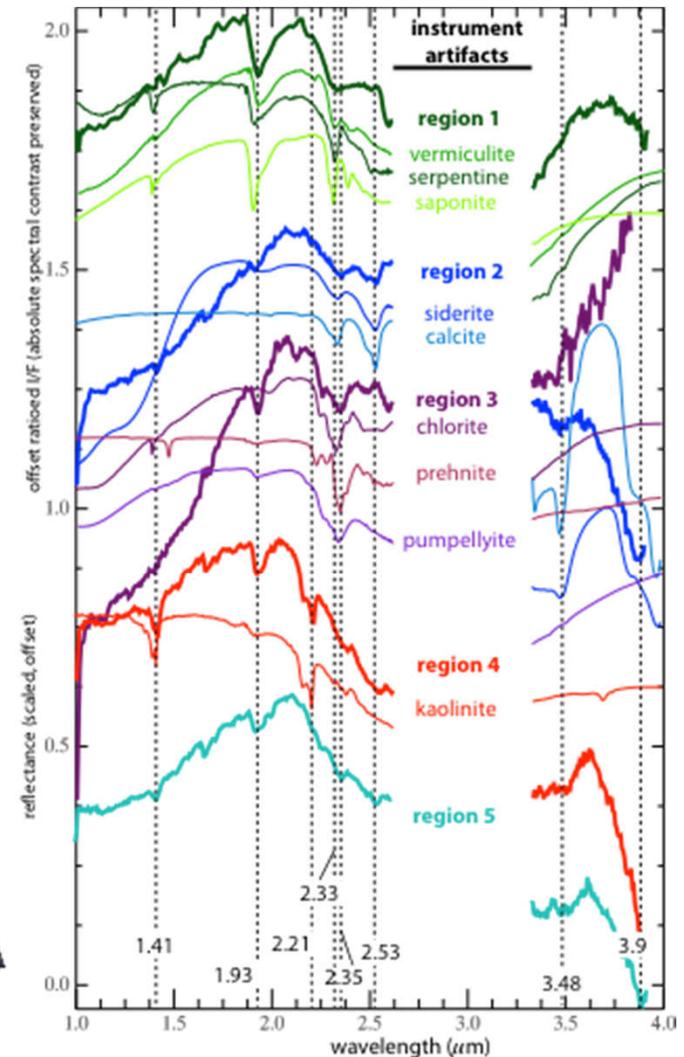
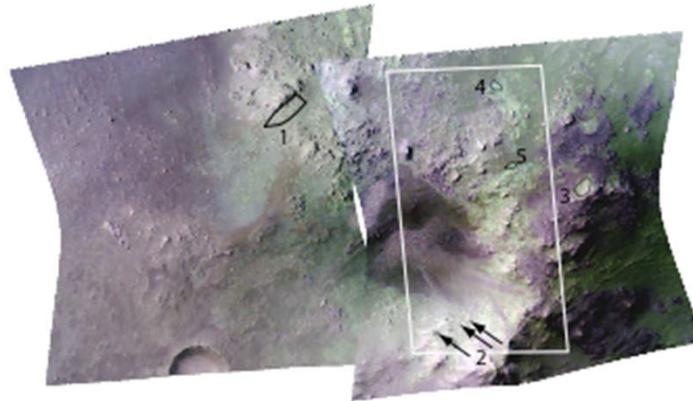
Hydrothermal textures in Leighton Crater



Michalski and Niles, Nature Geo, 2010

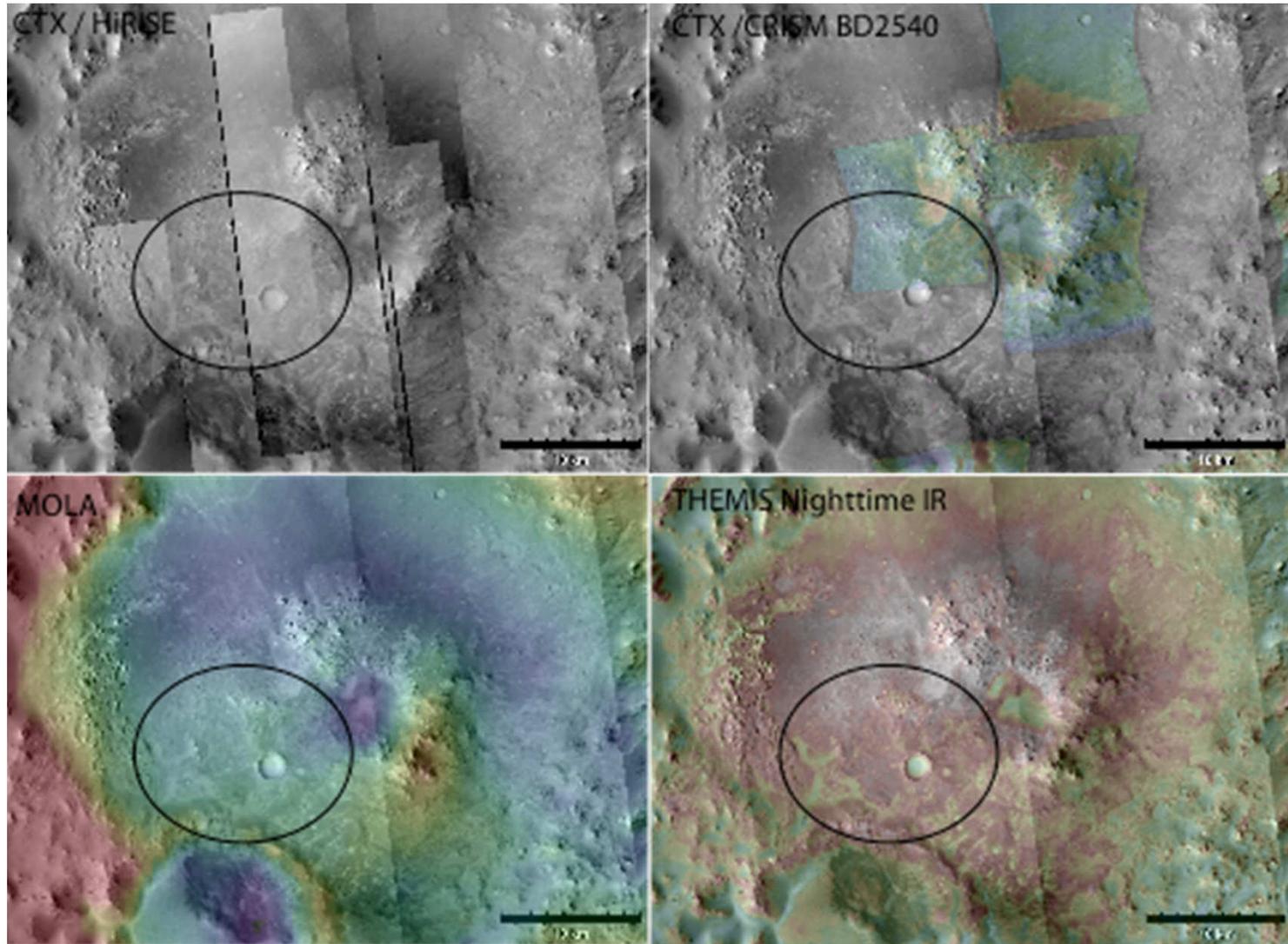
DETECTION OF CARBONATES

- Central peak contains evidence for carbonates, chlorite, chlorite/smectite-vermiculite-chlorite/serpentine, pumpellyite, and kaolinite
- Evidence for carbonates rests in the co-occurrence of absorptions at 2.35, 2.53, 3.4, and 3.9 μm .



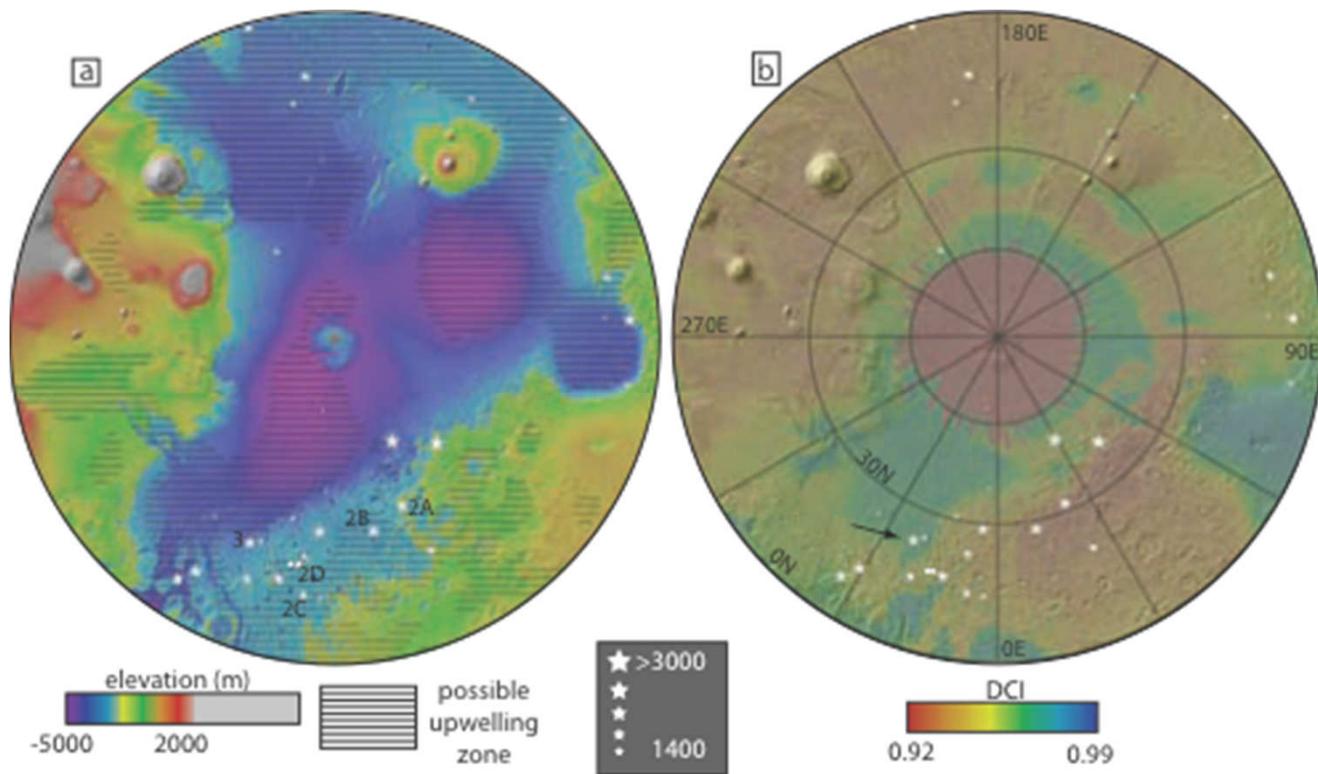
The landing site

Is it accessible? Yes.

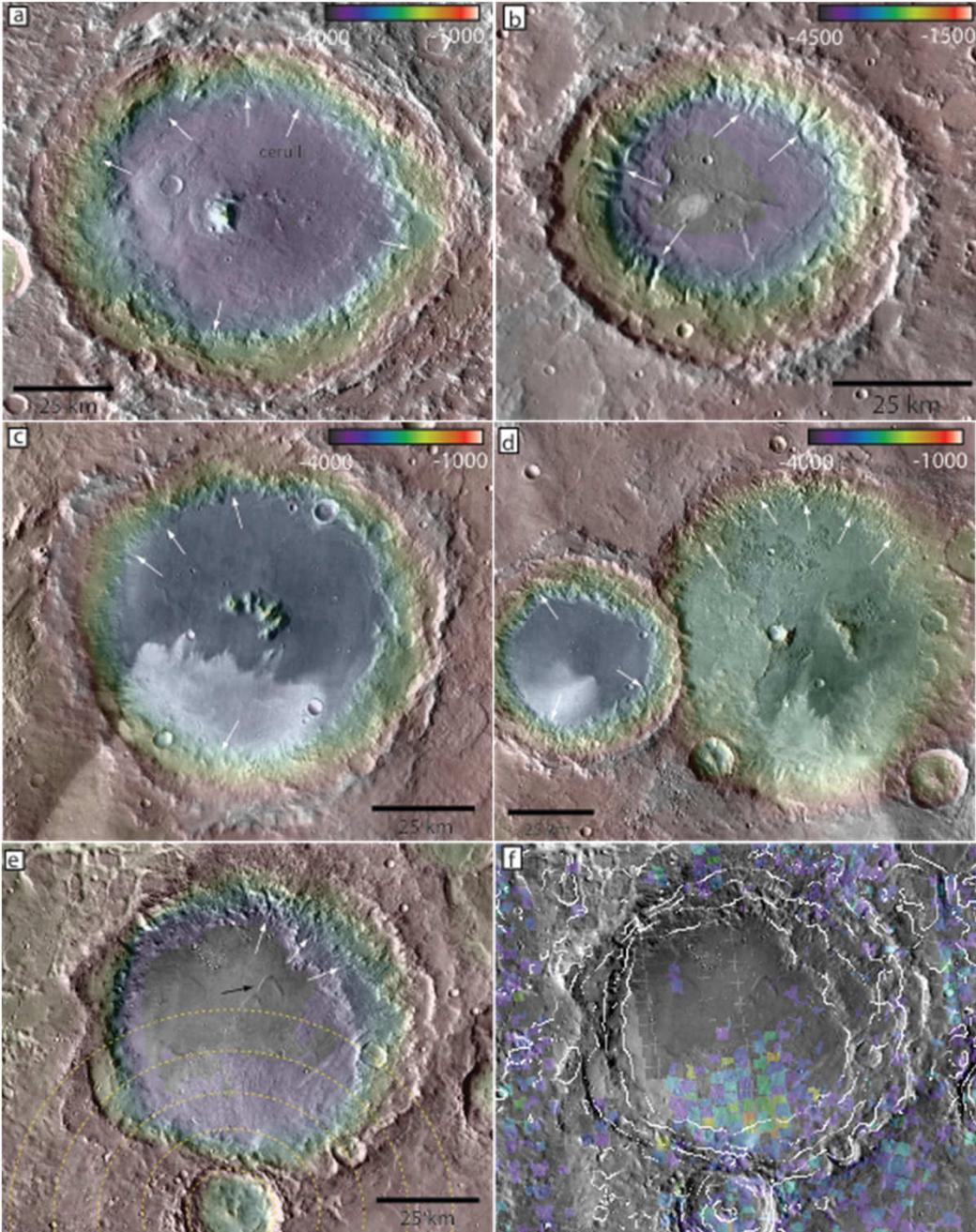


What about other sites?

- Groundwater upwelling should occur in the deepest basins!

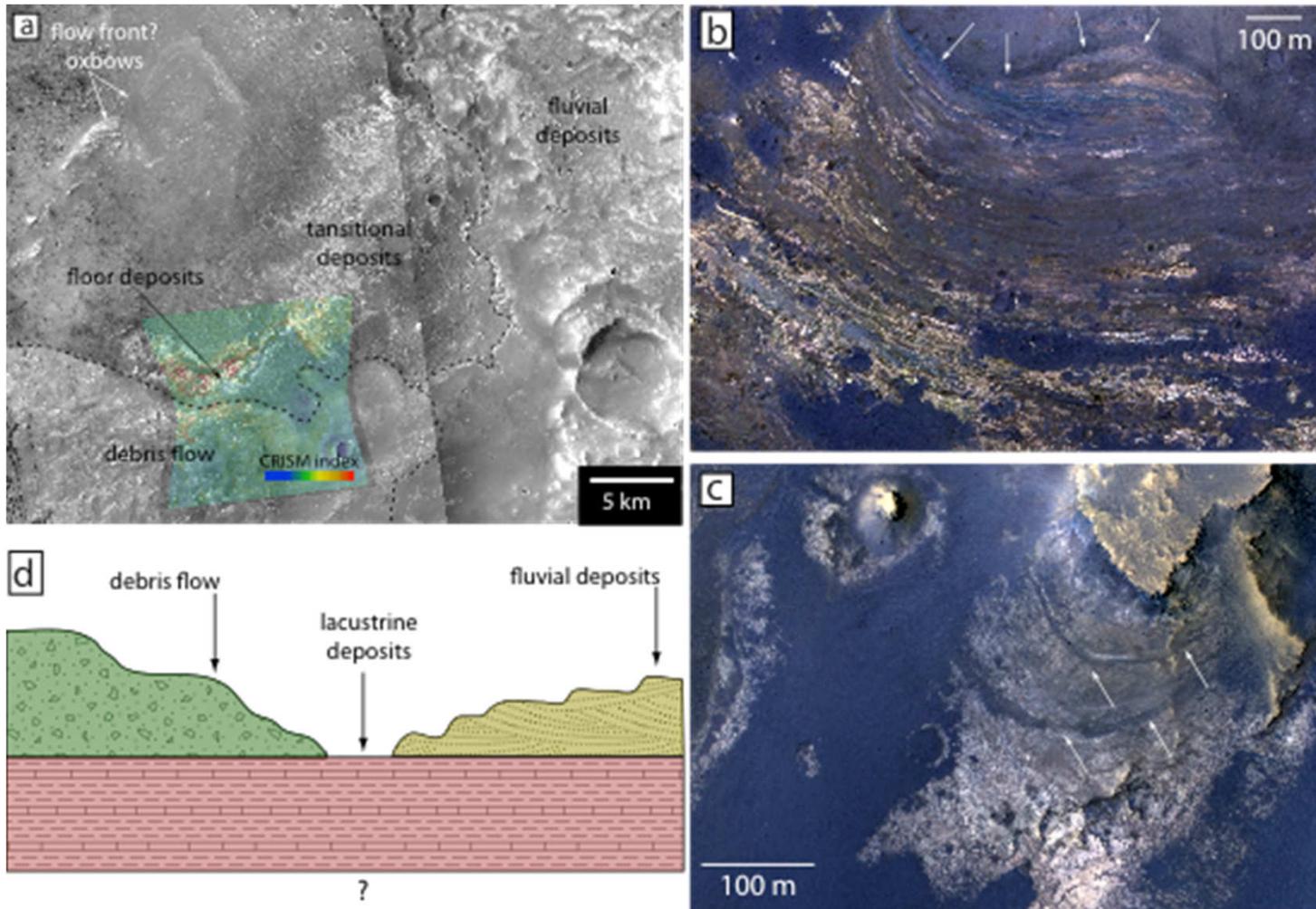


Candidate sites

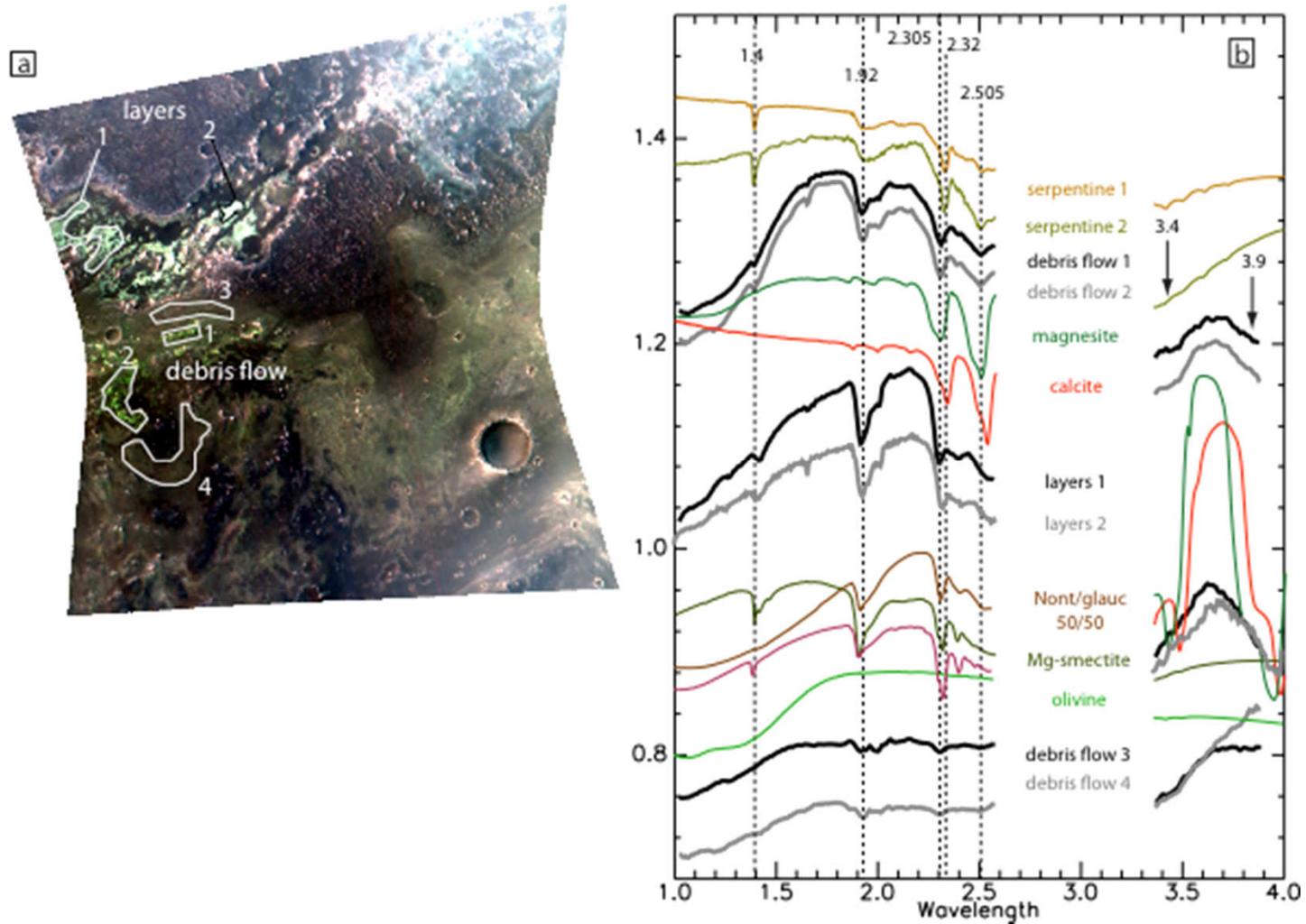


- ✧ Some deep craters contain sapping features in their walls
- ✧ Most are dusty
- ✧ McLaughlin (bottom) displays interesting alteration mineralogy

McLaughlin Crater

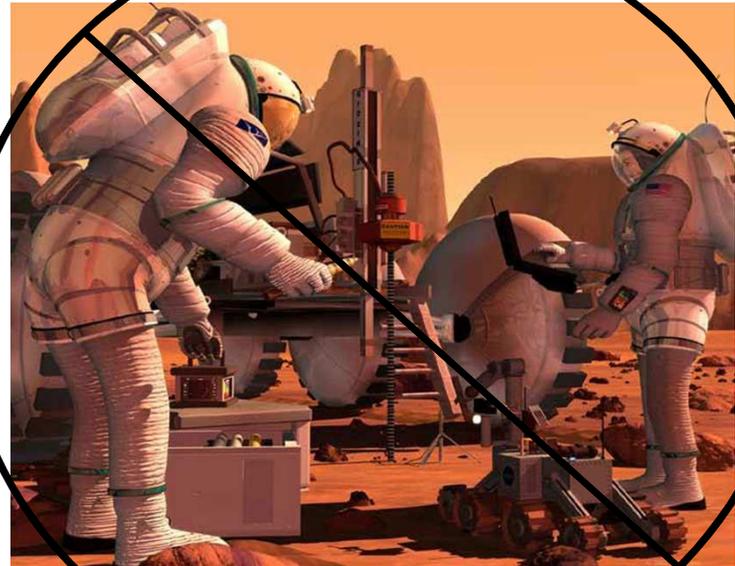


McLaughlin Crater



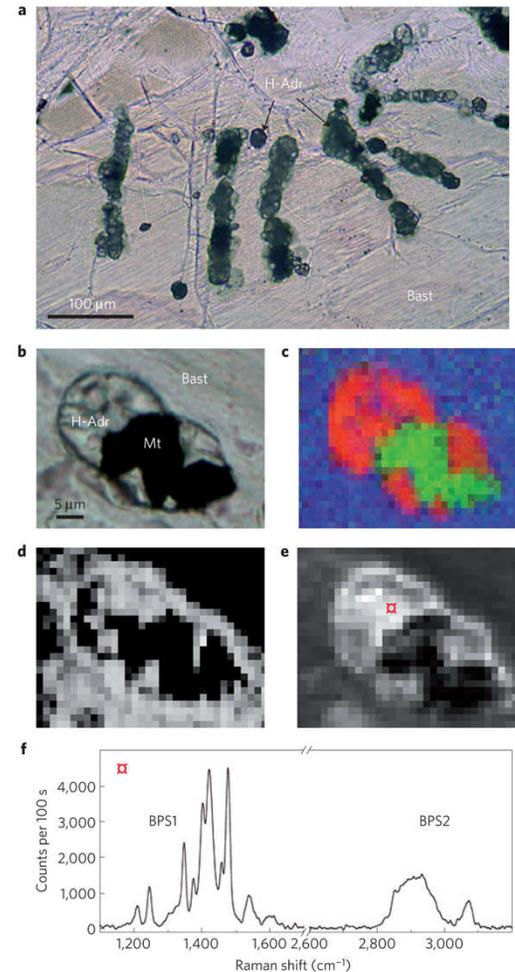
Summary

- Deep biosphere is the best target on Mars
- Does not require drilling
- Focus our exploration on clay-carbonate sites that record subsurface processes



Access to a deep biosphere

- Need to identify accessible materials:
 - Exposed from deep in the crust
 - Formed by hydrothermal fluids from deep in the crust
- Concentration mechanisms don't help if you if there is nothing to concentrate (Hesperian-Amazonian deltas are not interesting)
- The tools required will be:
 - Raman coupled with
 - Micro-imaging
 - precise clay mineralogy (IR and XRD)
 - isotopic analyses (TLS?)







TWO MODELS

