Southern Nili Fossae Trough

Examination of in situ carbonate-bearing layers and habitability in an ancient hydrothermal environment

C. Viviano-Beck, A. Brown, E. Amador, J. Mustard, and K. Cannon

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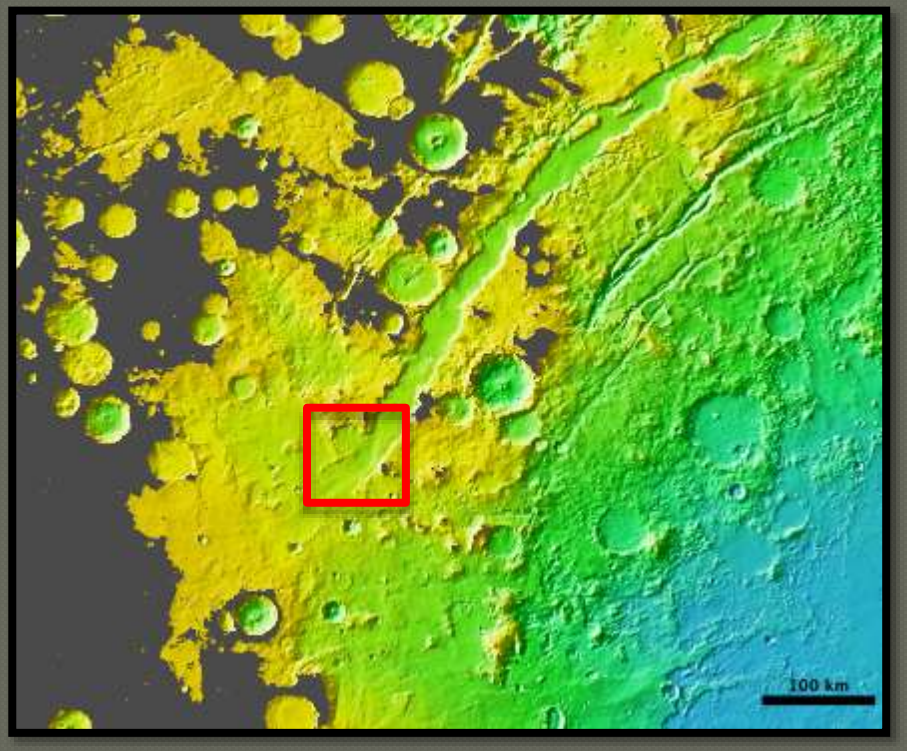
Proposed landing site: Southern Nili Fossae Trough



- South of the "Nili Fossae Trough" site
- Within Mars 2020 elevation constraints
- Stratigraphy similar to that exposed in the north; includes strong carbonate signature
- Cache significantly *diverse* material that is in-place (known context)

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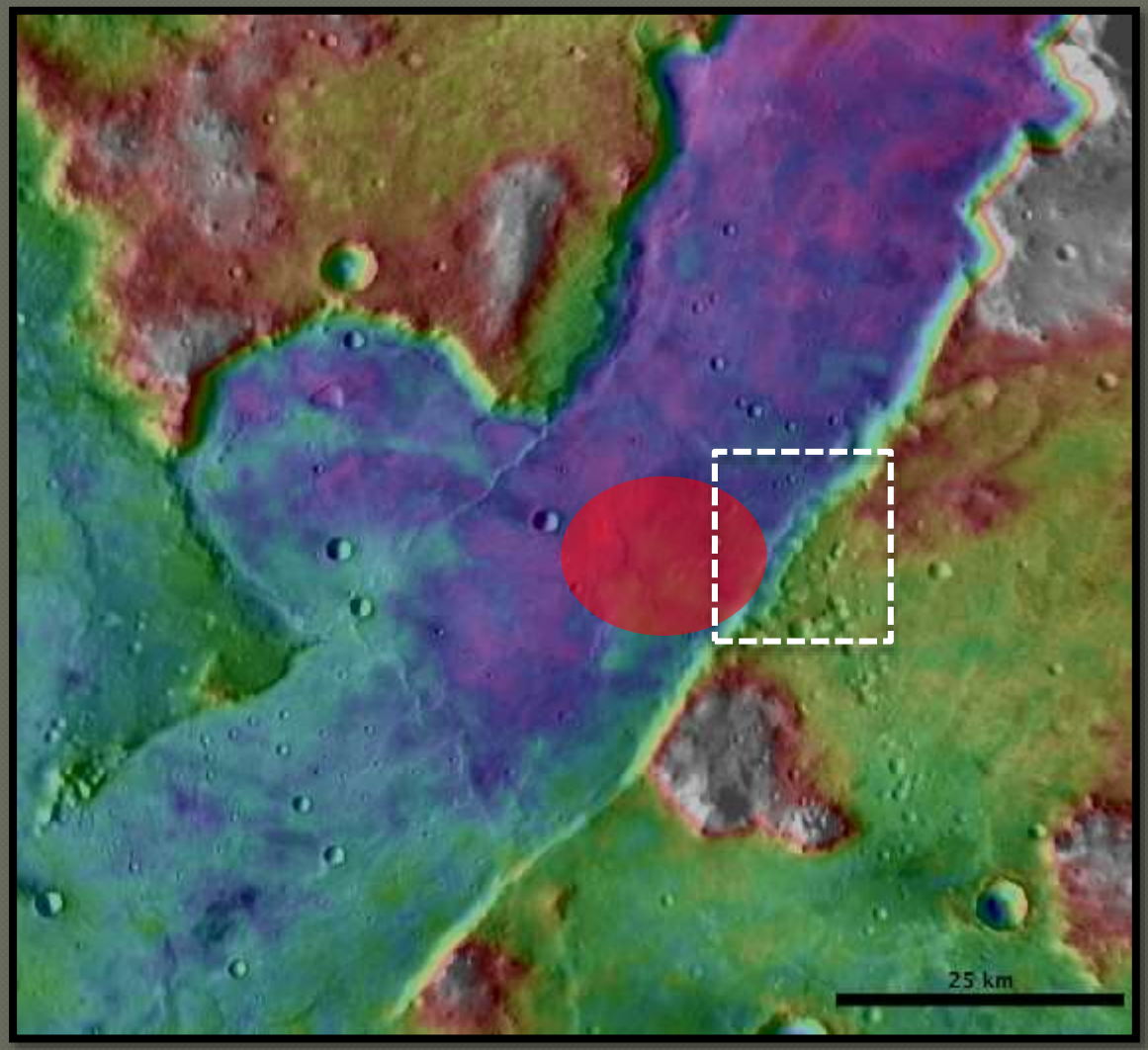
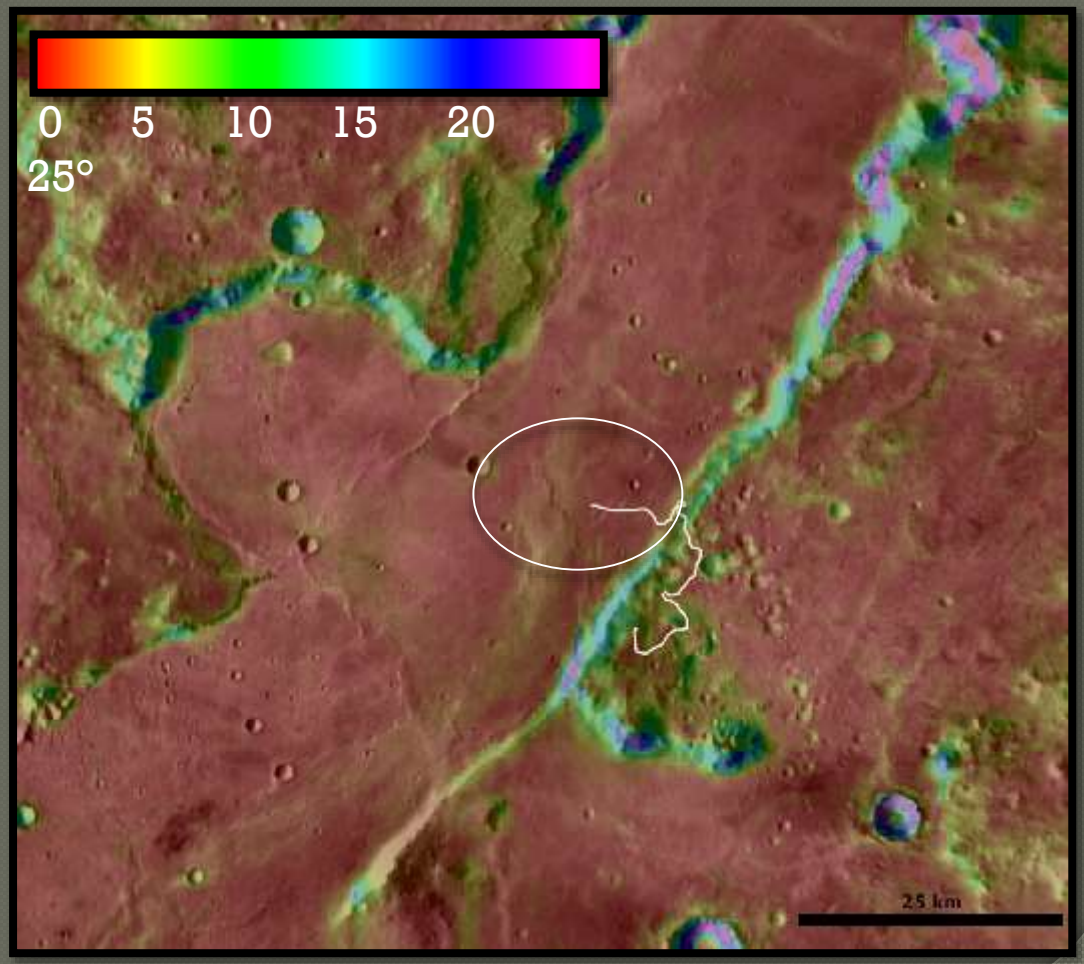


- Elevation: Relatively low slope to drive out of trough and access phyllosilicates and plateau

Landing Ellipse stats

LON	LAT	Dust Index			Thermal Inertia			Slope			Albedo		
286.193359	19.7285156	0.965	0.985	0.972	219	235	230	0.03	8.48	1.22	0.121	0.131	0.126
		MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG

- MOLA slope:



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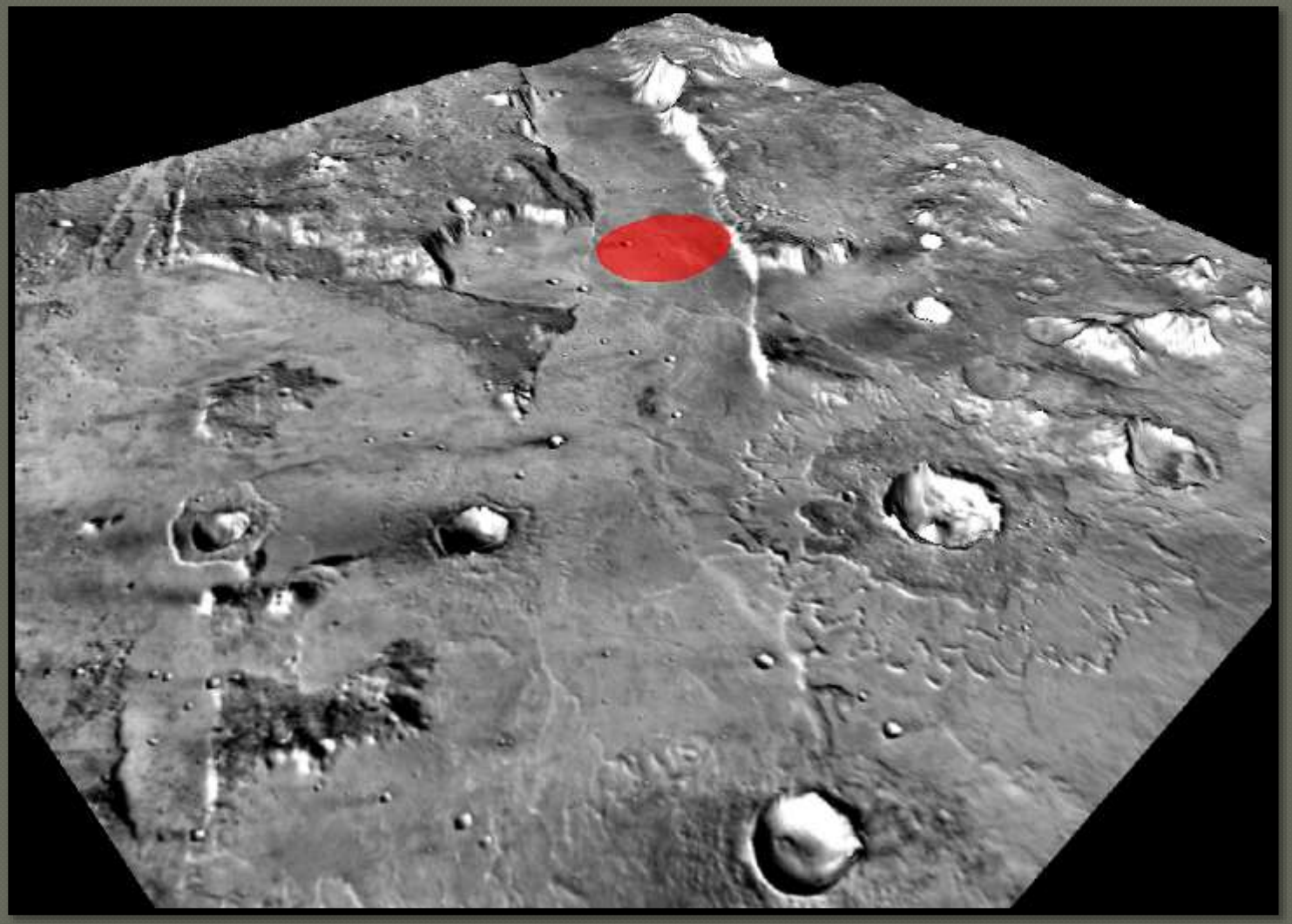
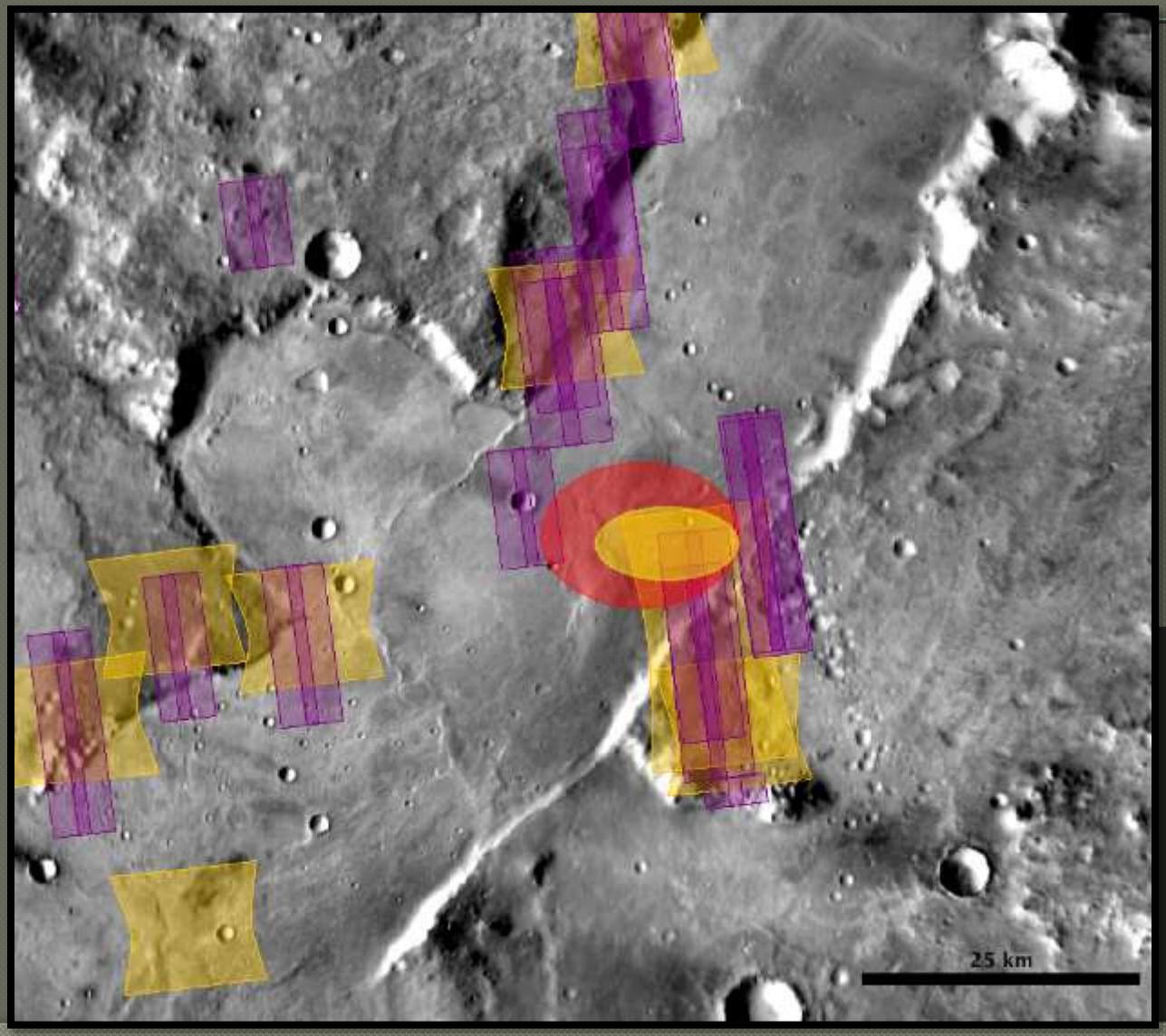
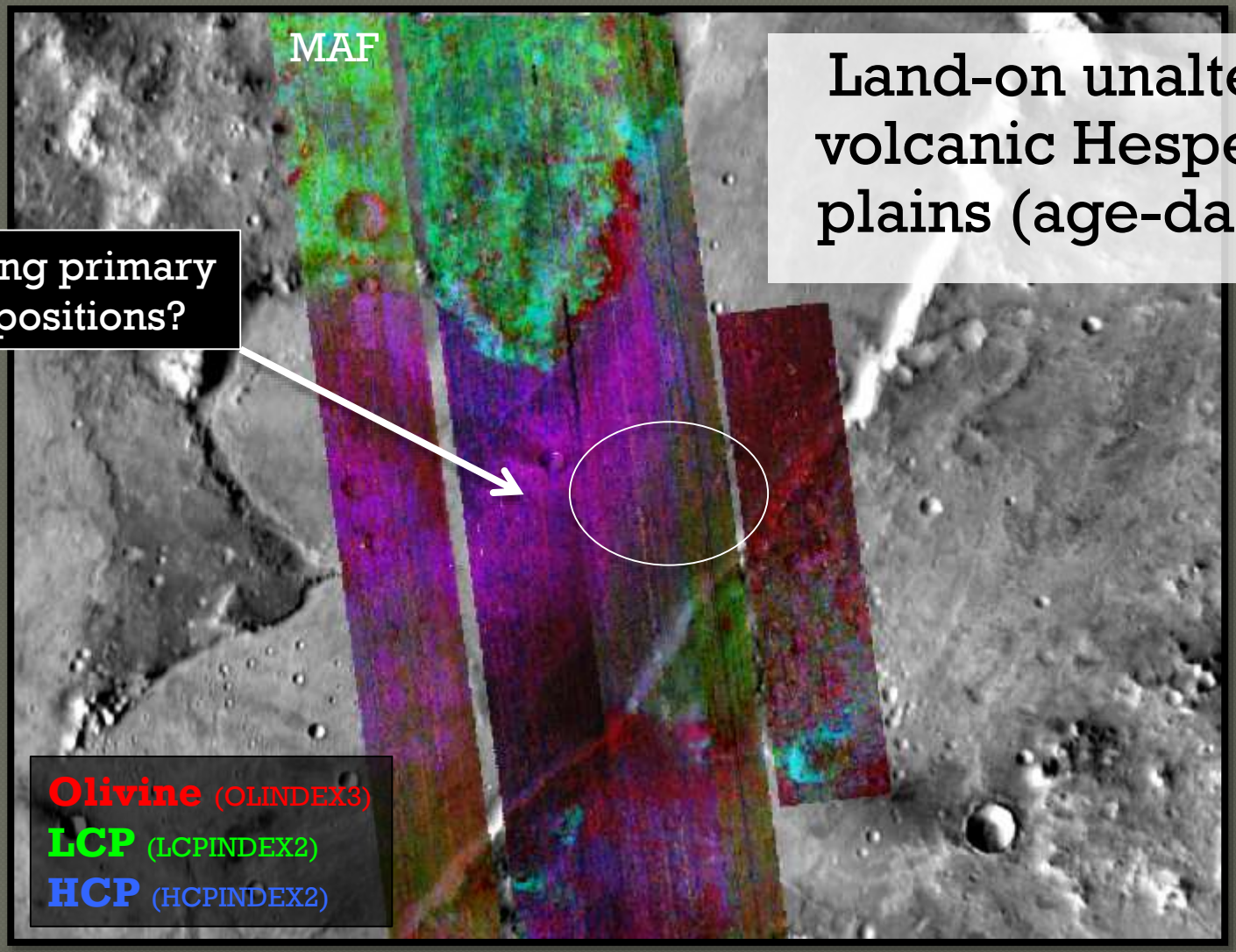


High resolution coverage in and around the landing ellipse



- CRISM
  (FRT & HRL)
- HiRISE

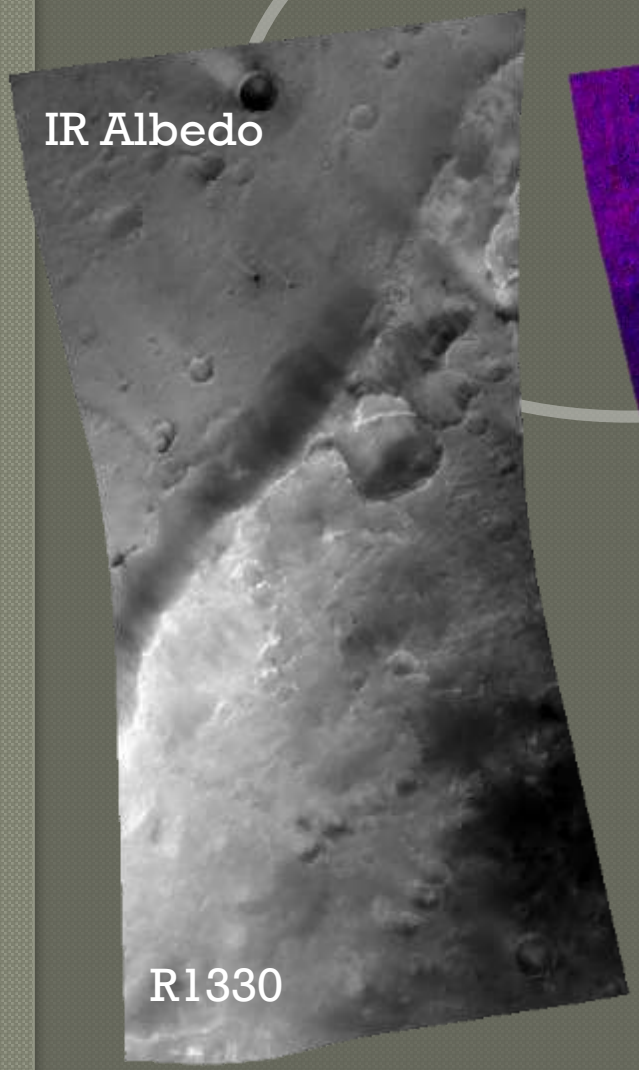
Diversity within landing ellipse: Primary (igneous) mineralogy

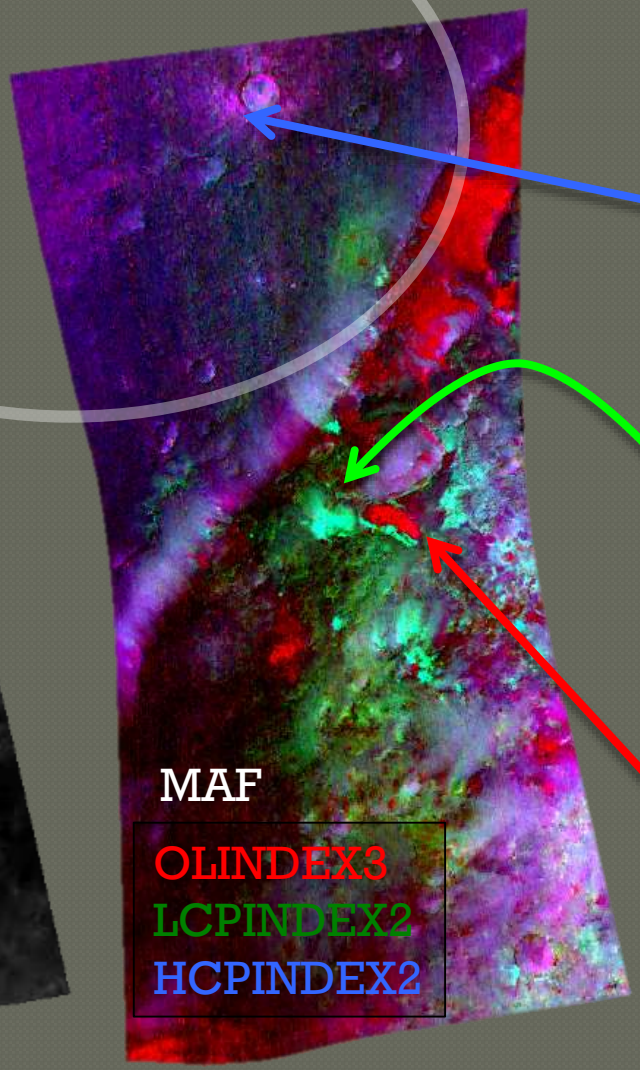


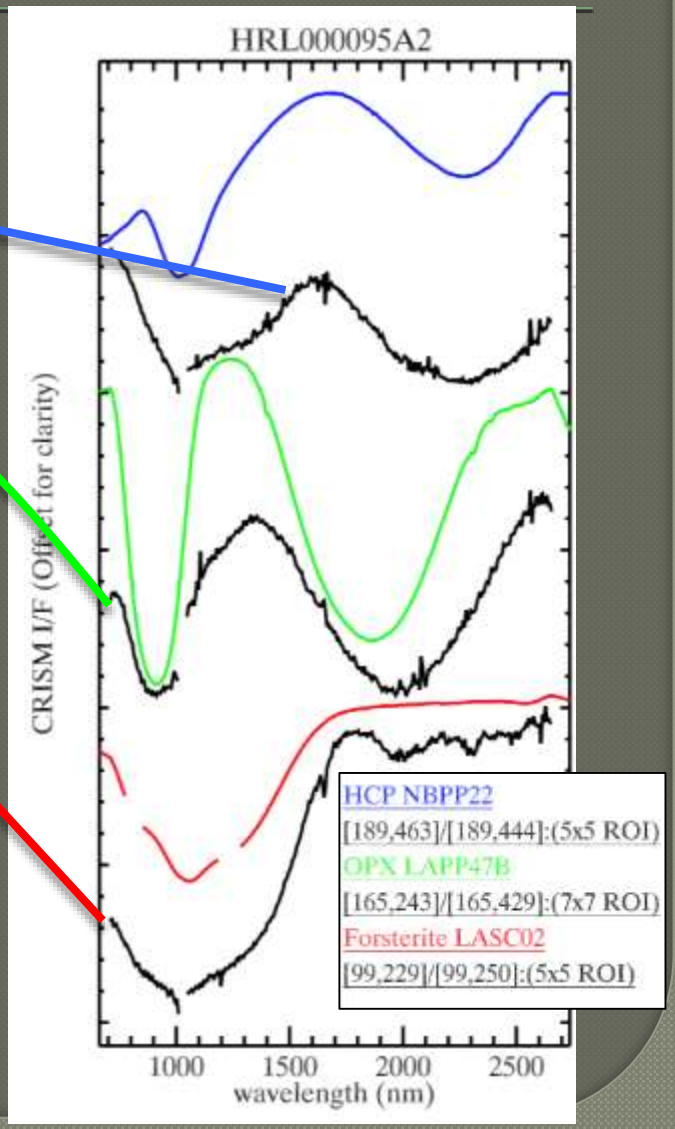
Land-on unaltered volcanic Hesperian plains (age-dating)

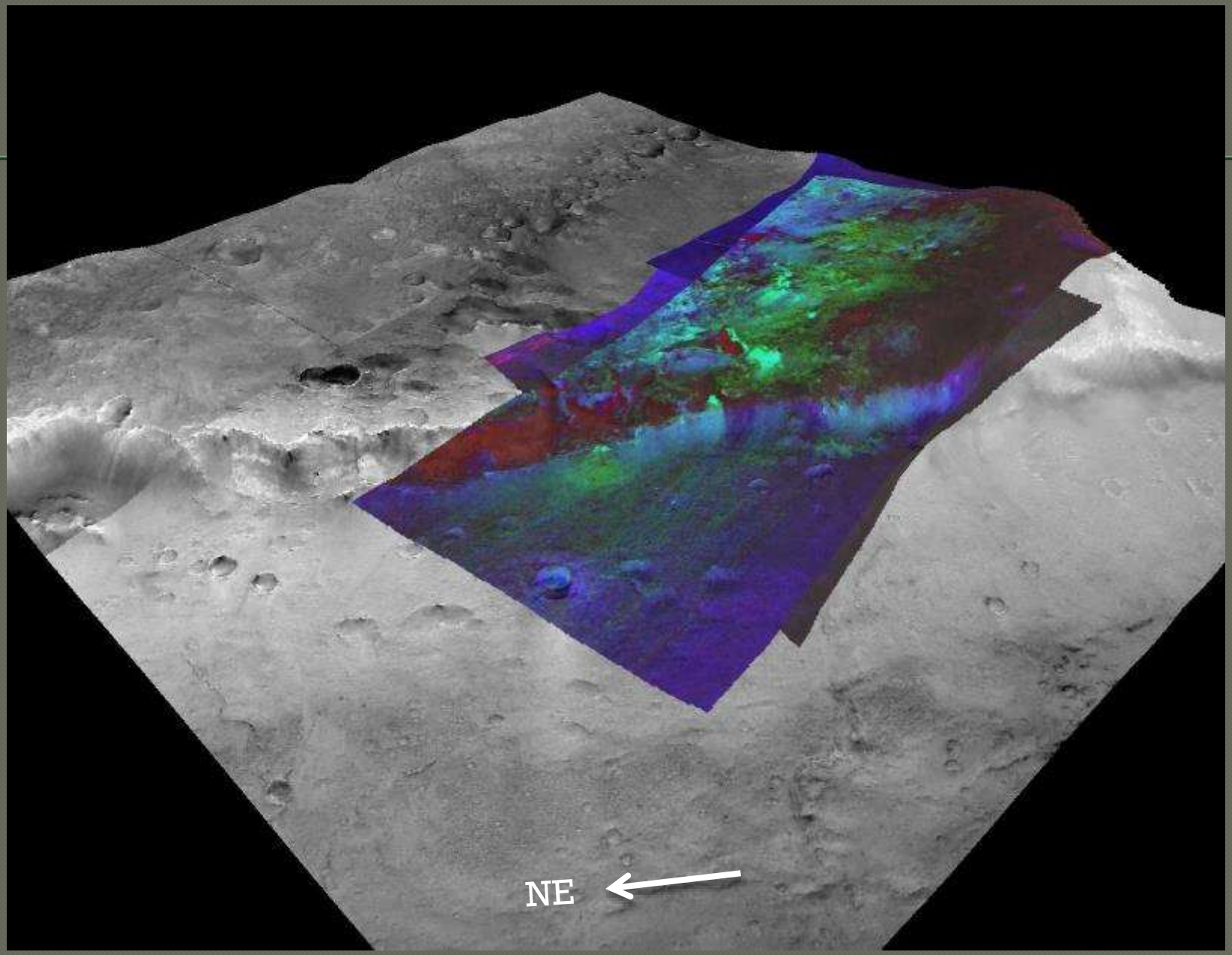
Evolving primary compositions?

Diversity within/outside landing ellipse: Primary (igneous) mineralogy

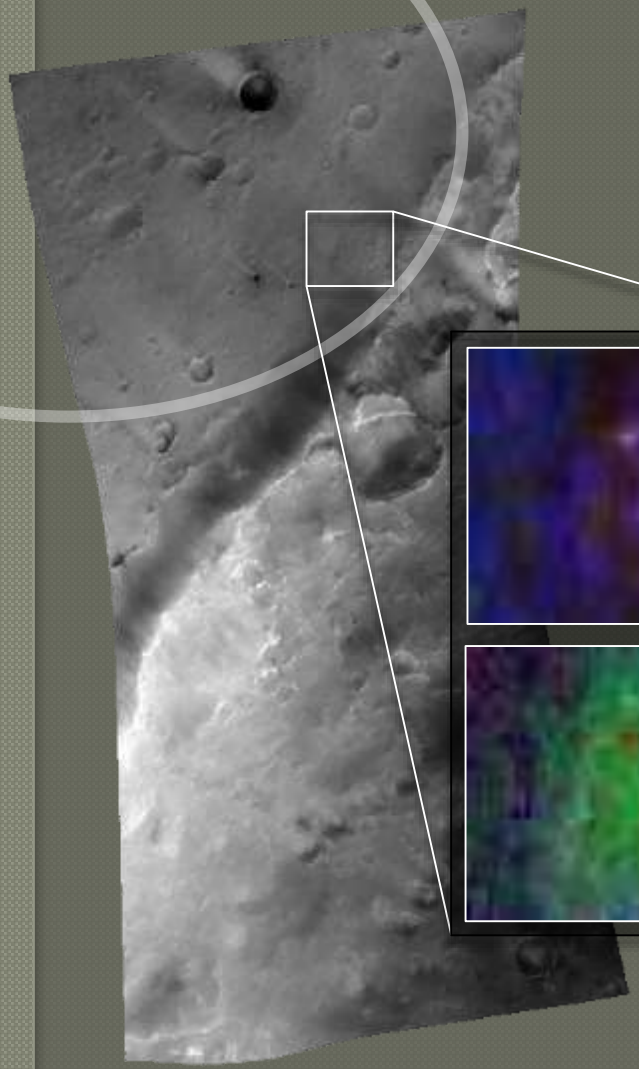


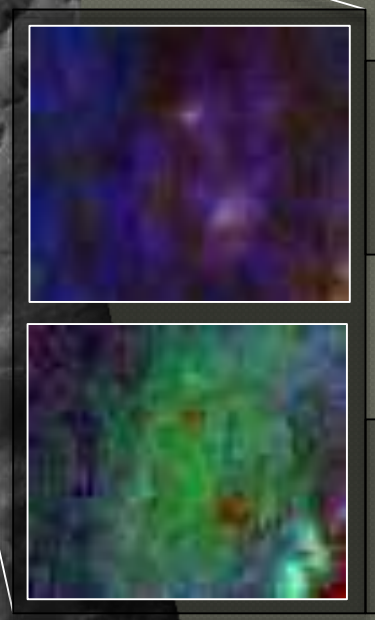





NE

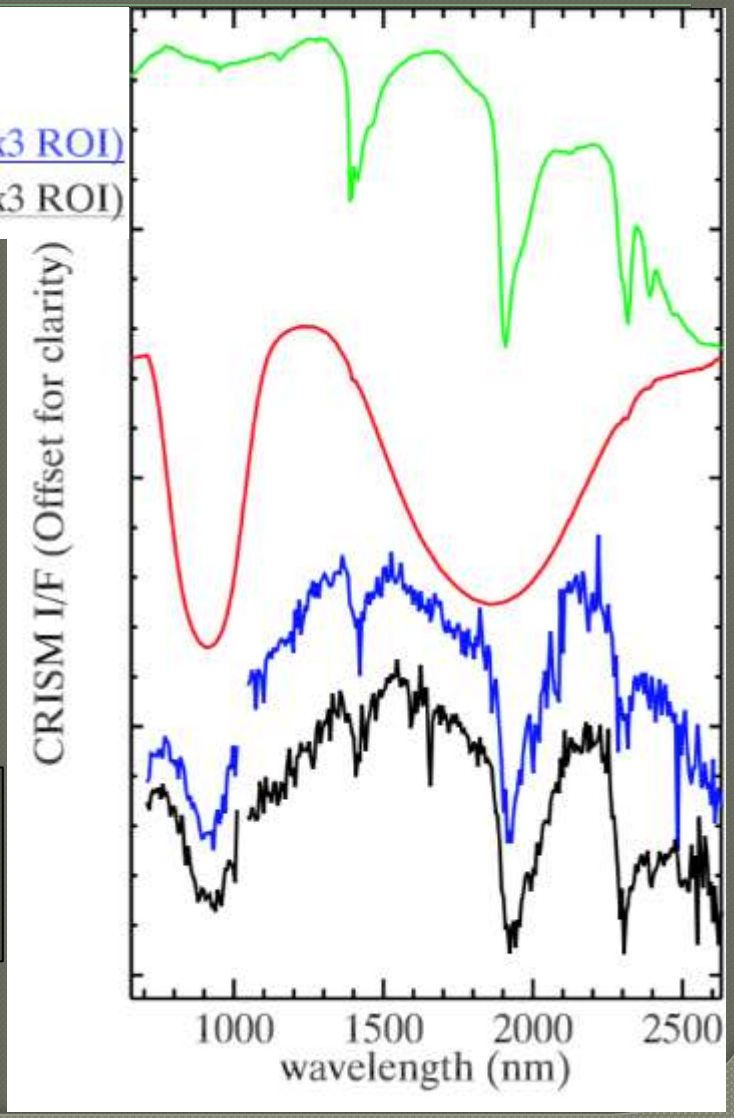
Diversity within landing ellipse: Noachian primary/altered



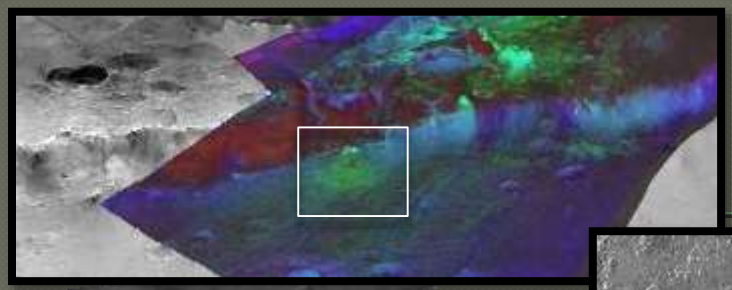


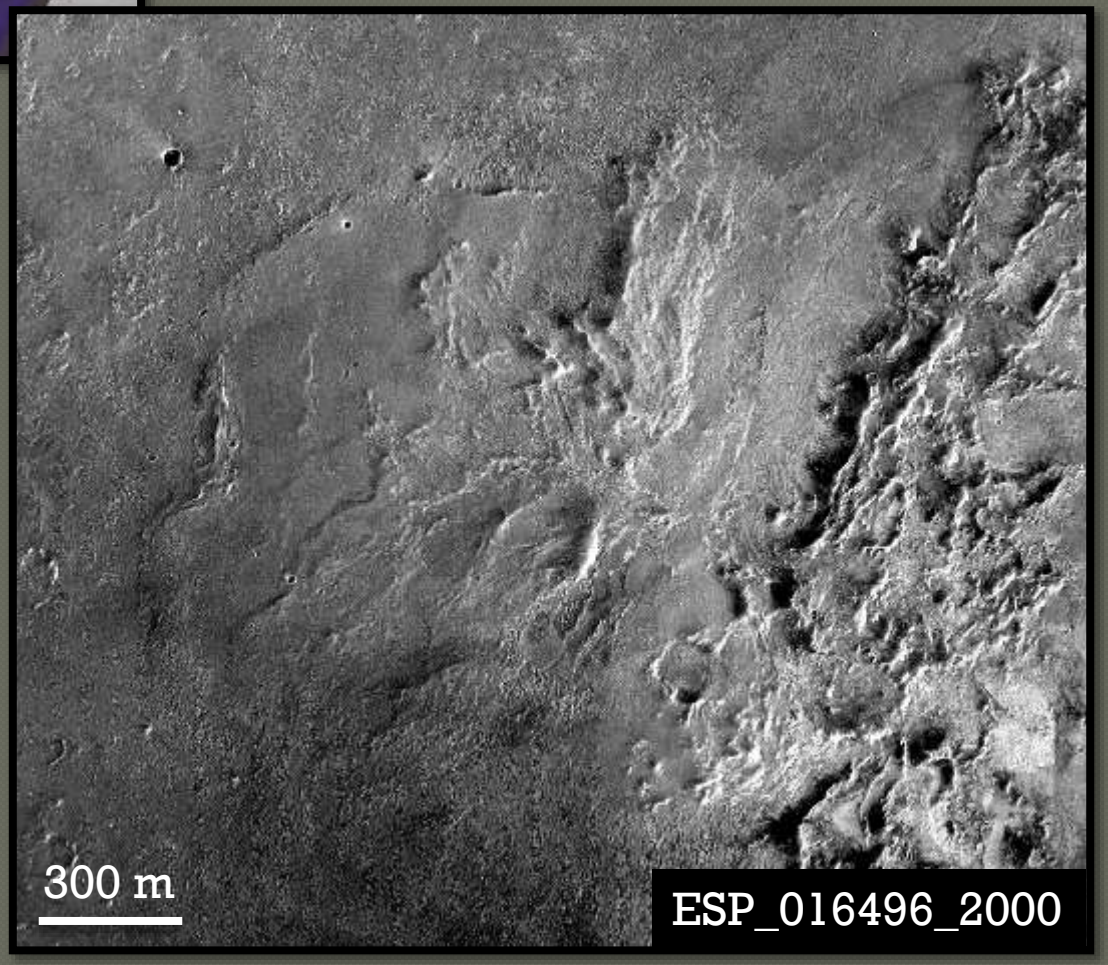
BD1900R2
D2300
BD1400

OLINDEX3
LCPINDEX2
HCPINDEX2



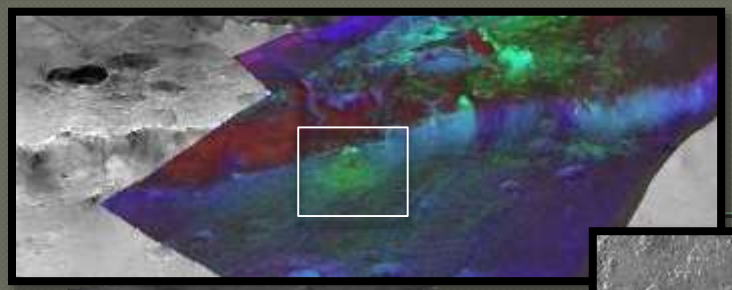
HiRISE analysis:

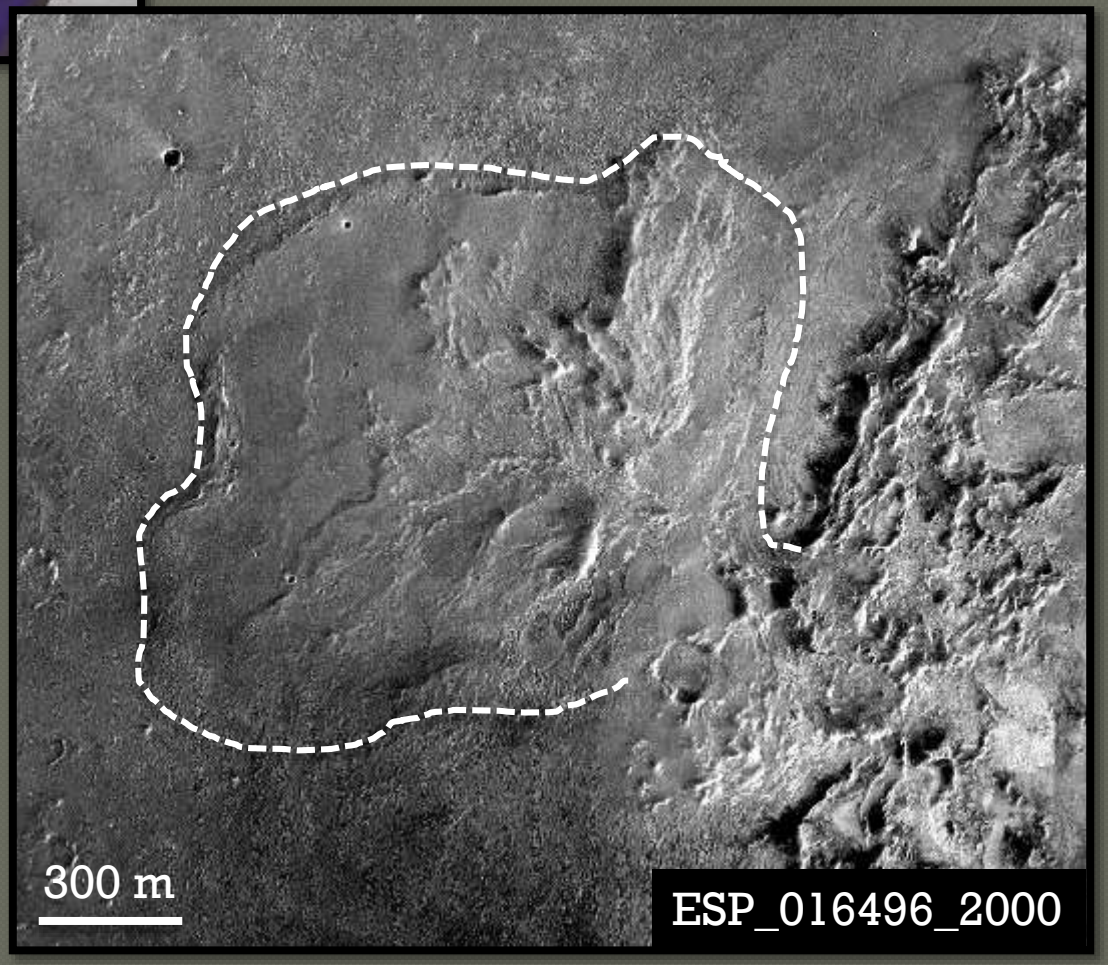




- Fan?/debris flow?

HiRISE analysis:



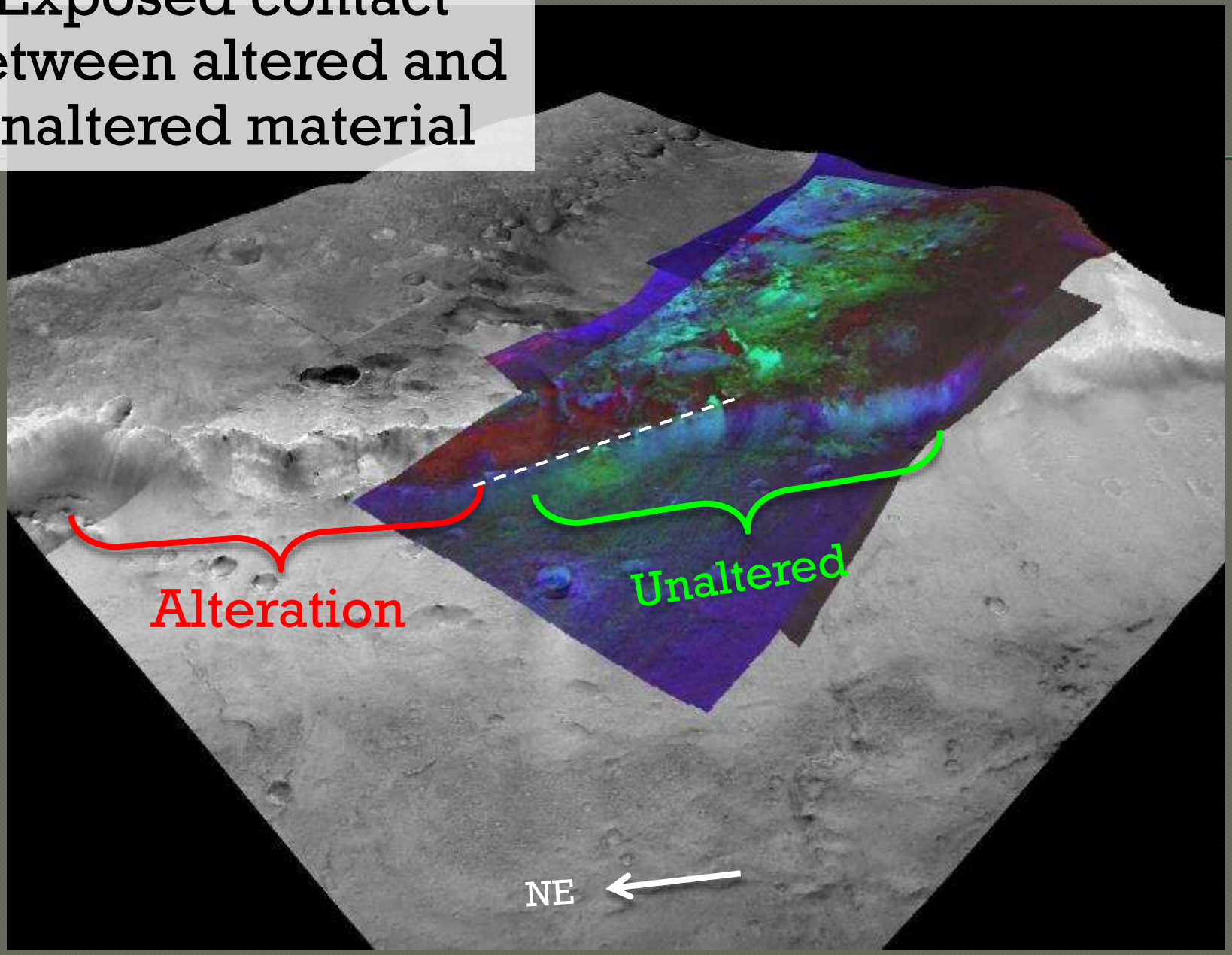


- Fan?/debris flow?

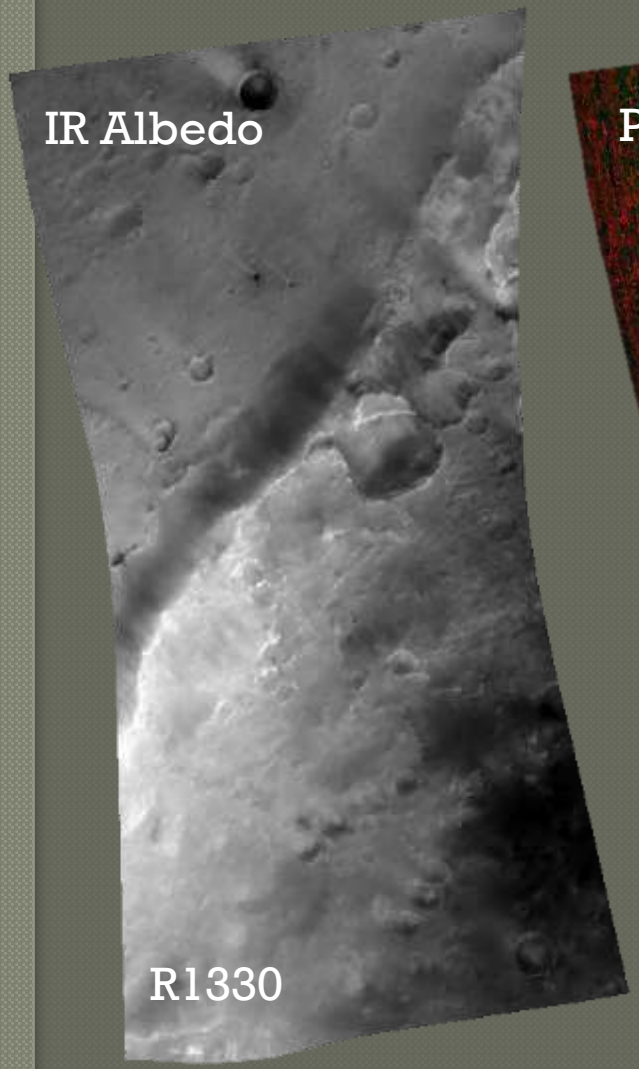
Diversity within landing ellipse: Noachian primary/altered

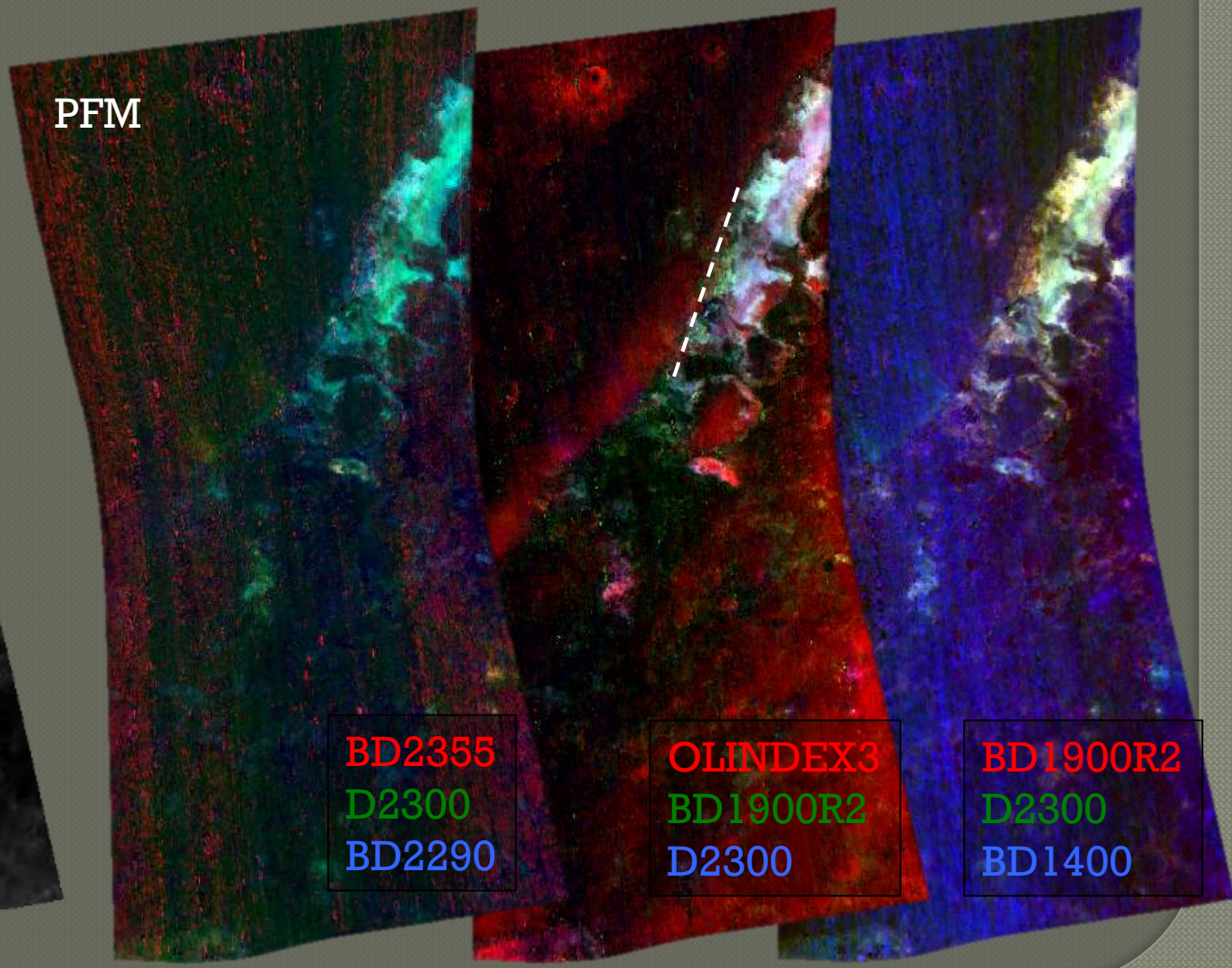
- Land-on in place unaltered volcanic Hesperian plains (age-dating)
- Hesperian flow characteristics (magmatic evolution of Syrtis Major through mineralogic/elemental analysis, flow layers/thickness with GPR)
- Ancient Noachian LCP-bearing material (ancient crust composition, mineralogic/elemental analysis)
- Determine composition of Noachian alteration material (constrain alteration temperature, fluid composition, pH, etc.)

Exposed contact between altered and unaltered material



Diversity just past ellipse: Compositional stratigraphy





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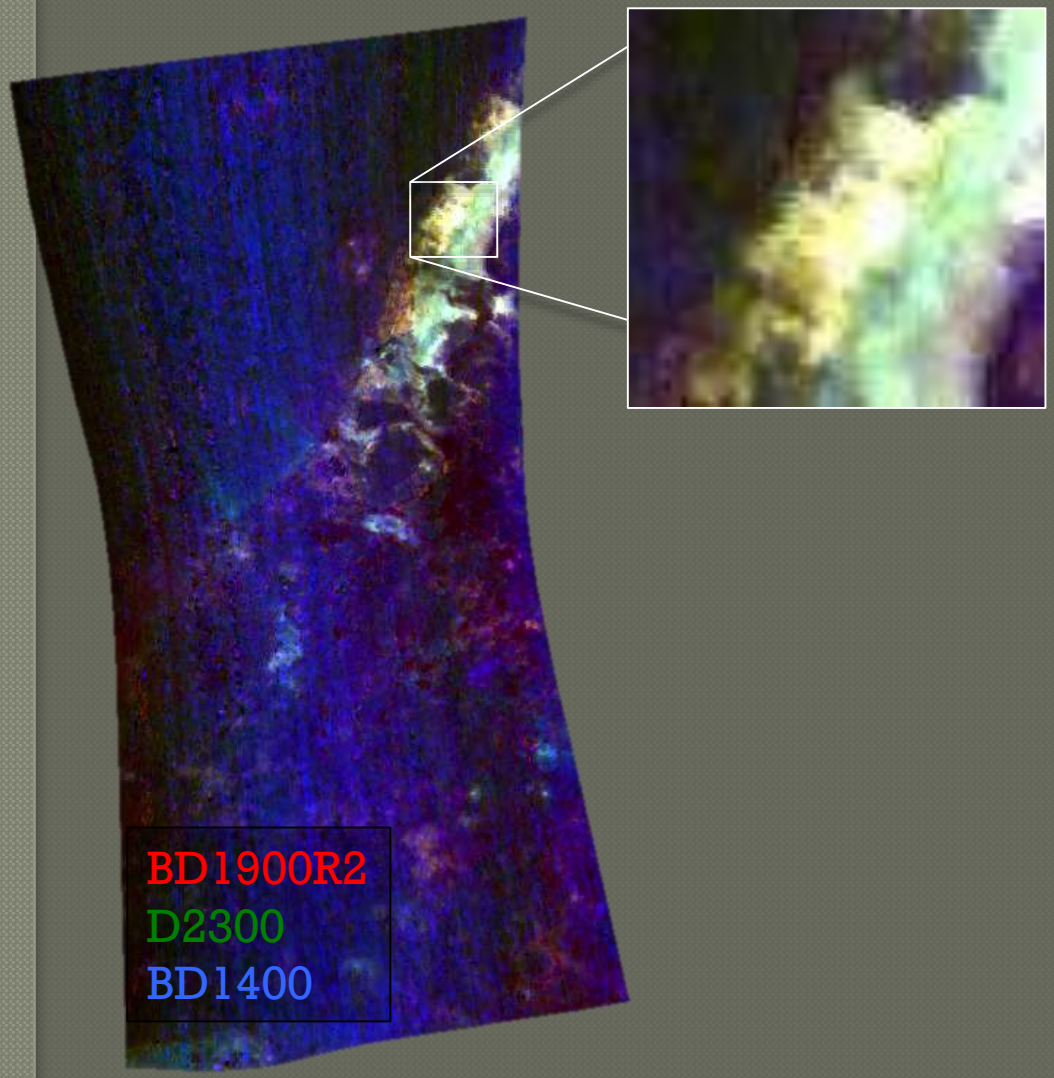

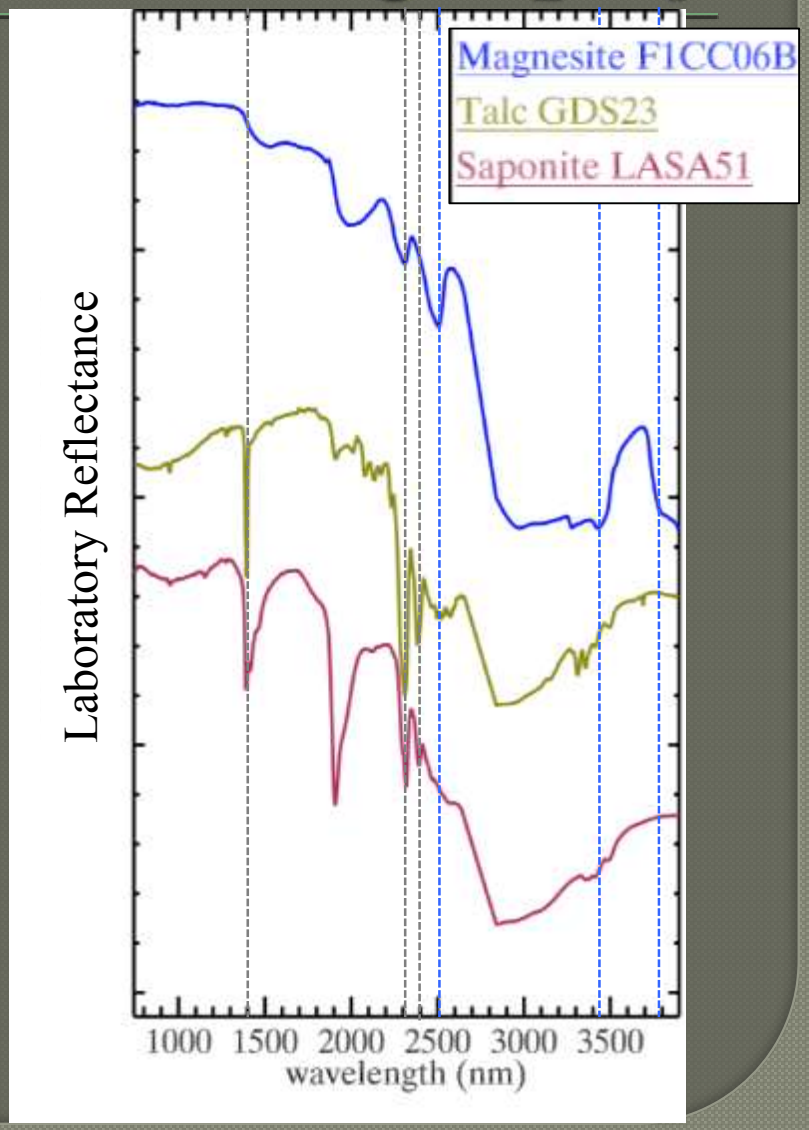

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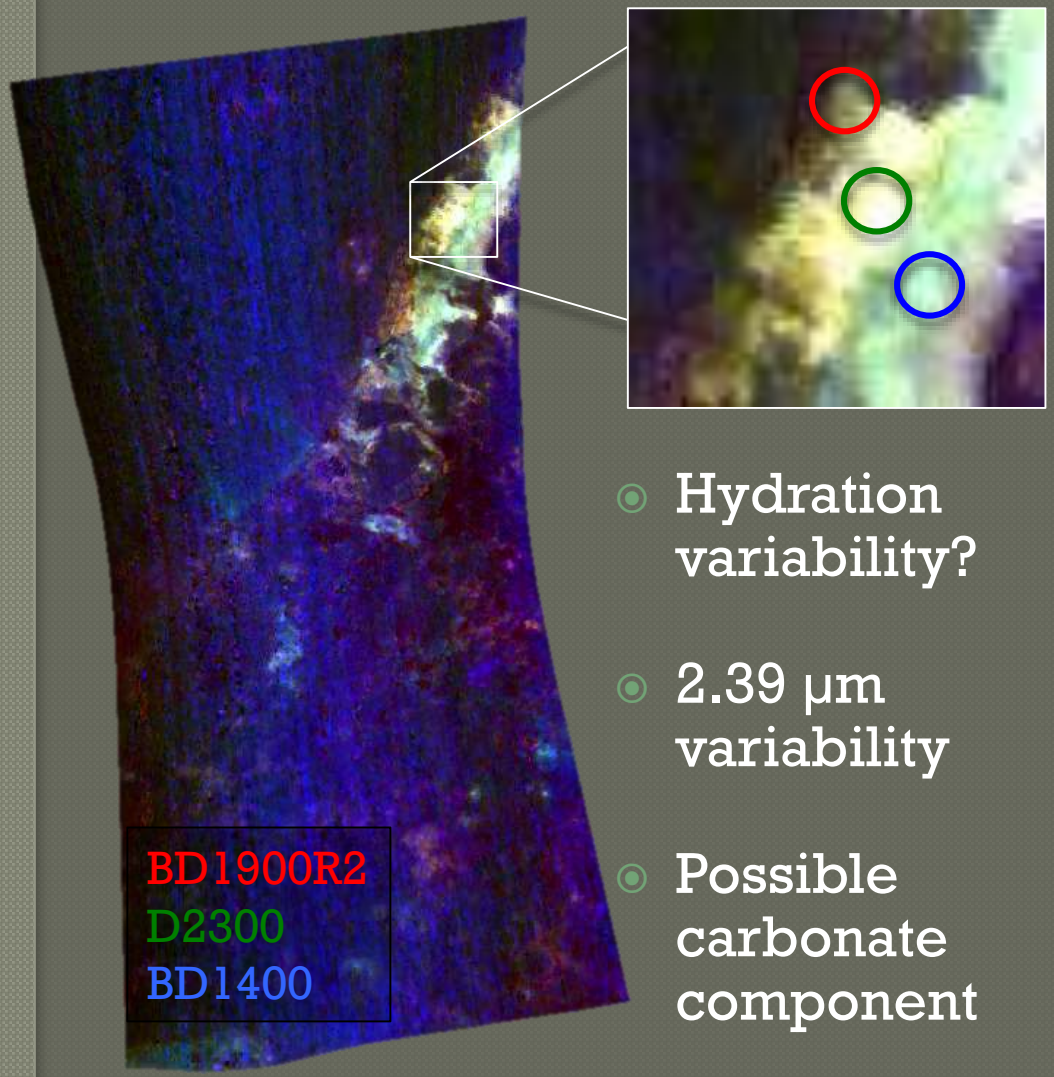
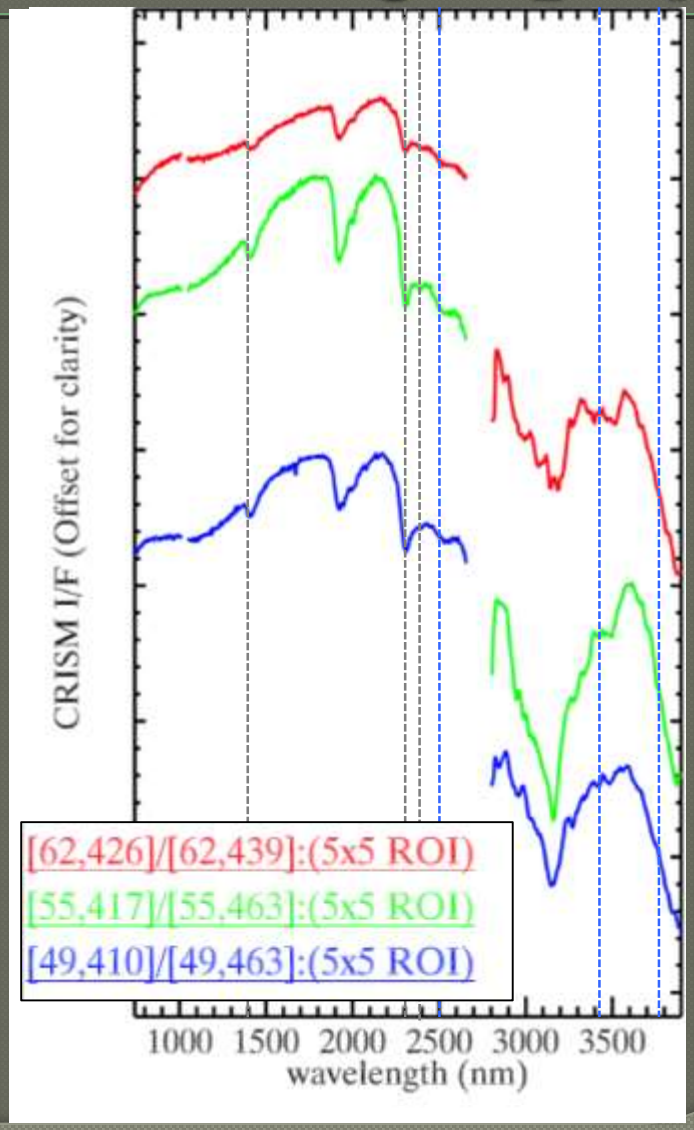
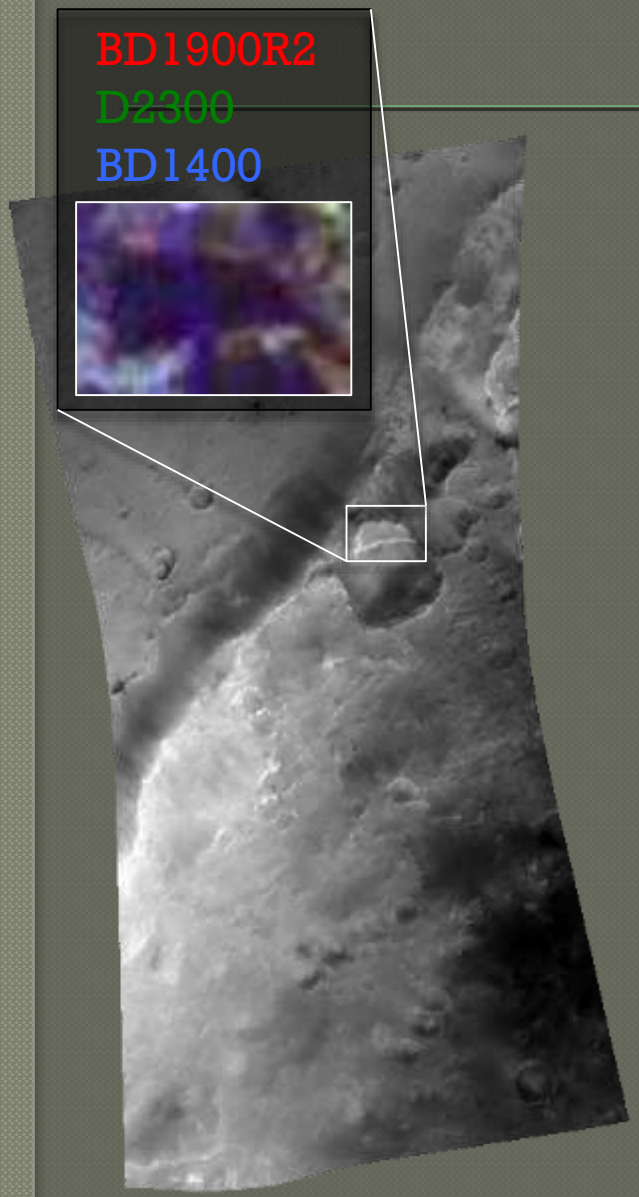
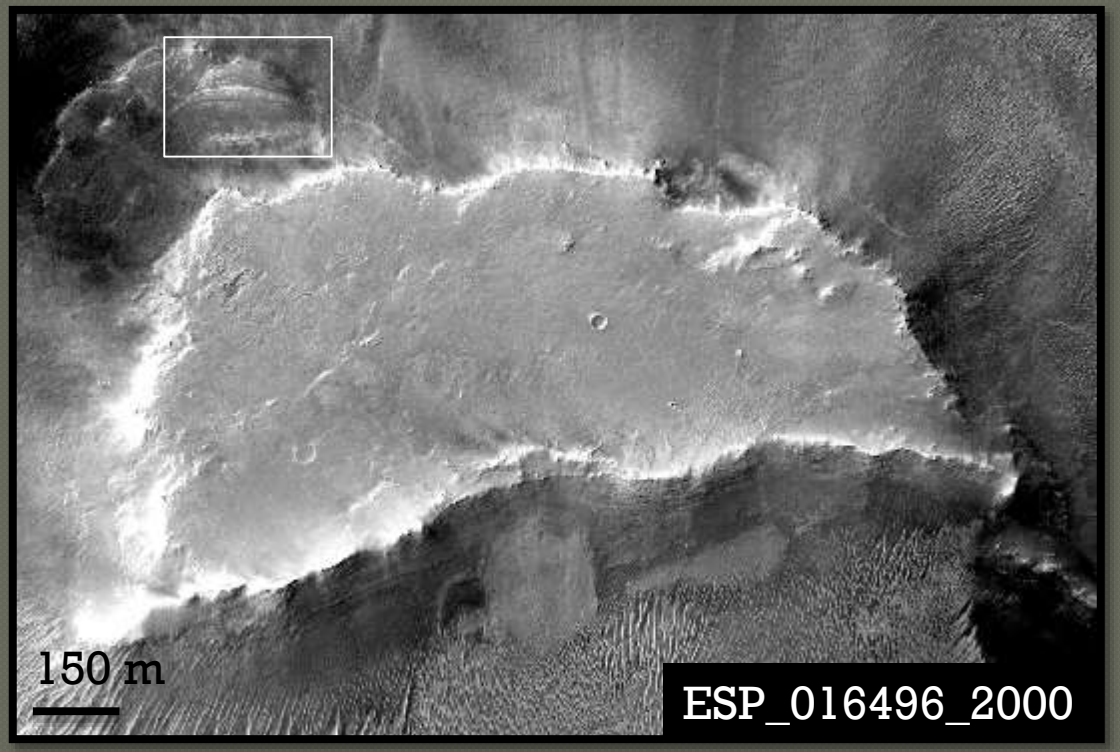


- Hydration variability?
- 2.39 μm variability
- Possible carbonate component



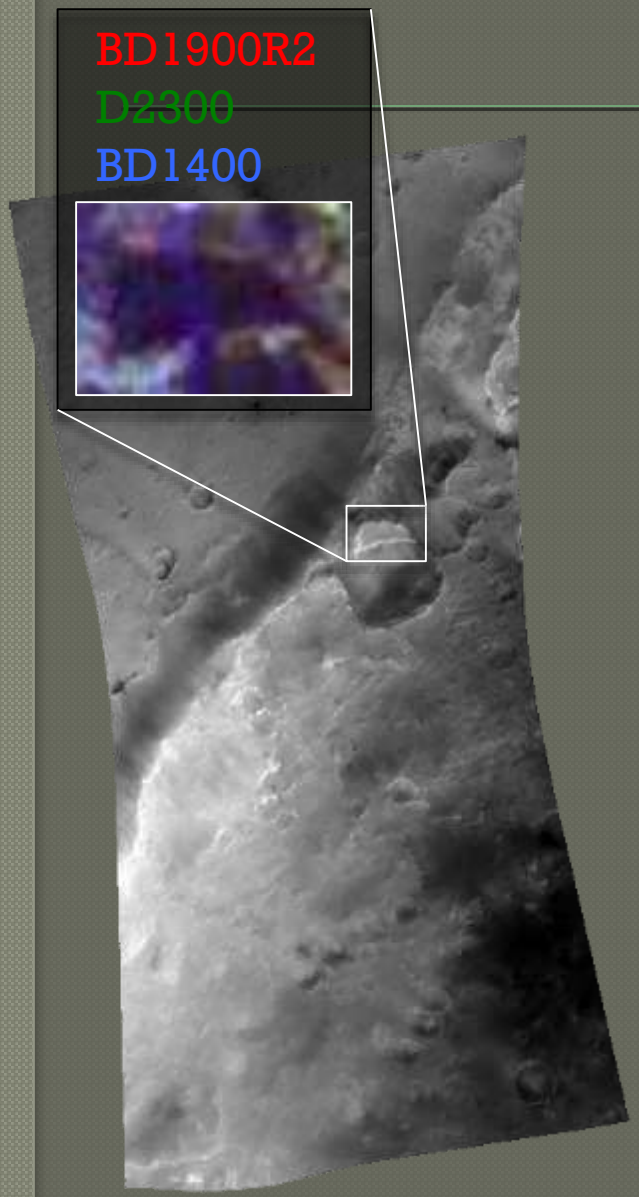
Diversity just past ellipse: Layering

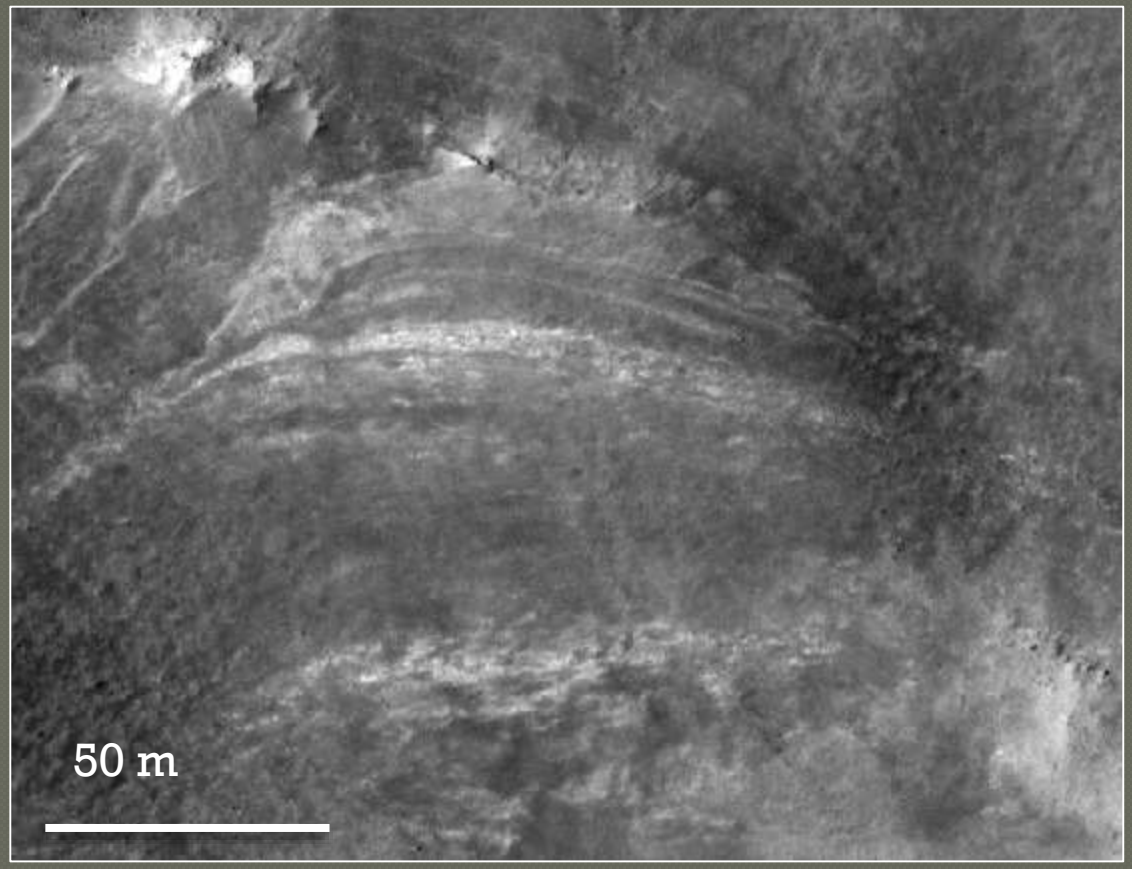




- Mg-OH bearing layered material below plateau

Diversity just past ellipse: Layering





- Mg-OH bearing layered material below plateau

Diversity just past ellipse: Mega-breccia

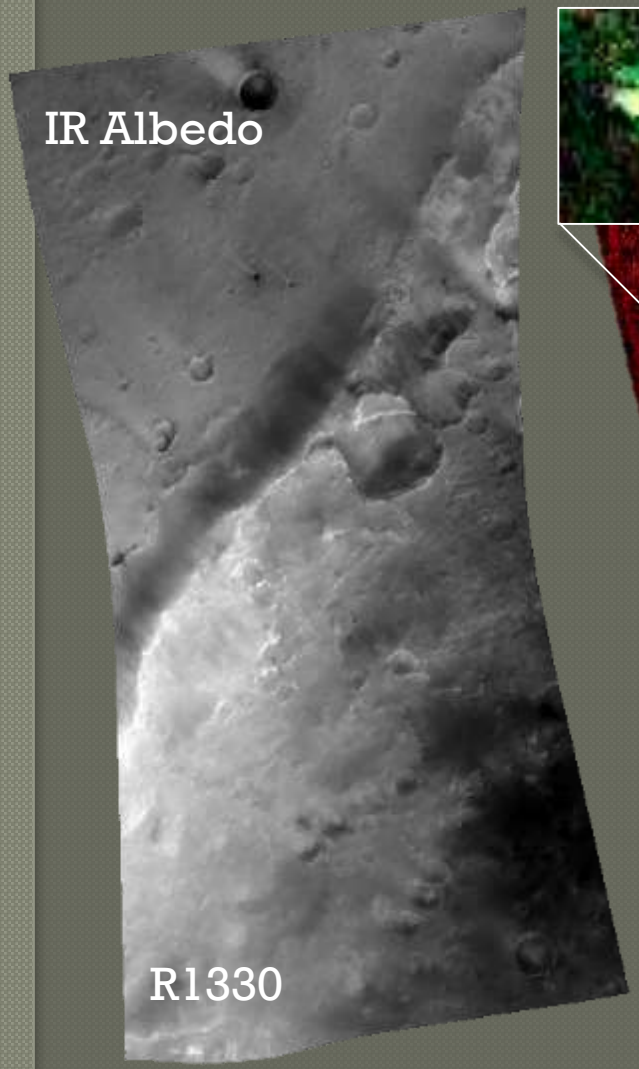
- Mg-OH bearing mega-breccia

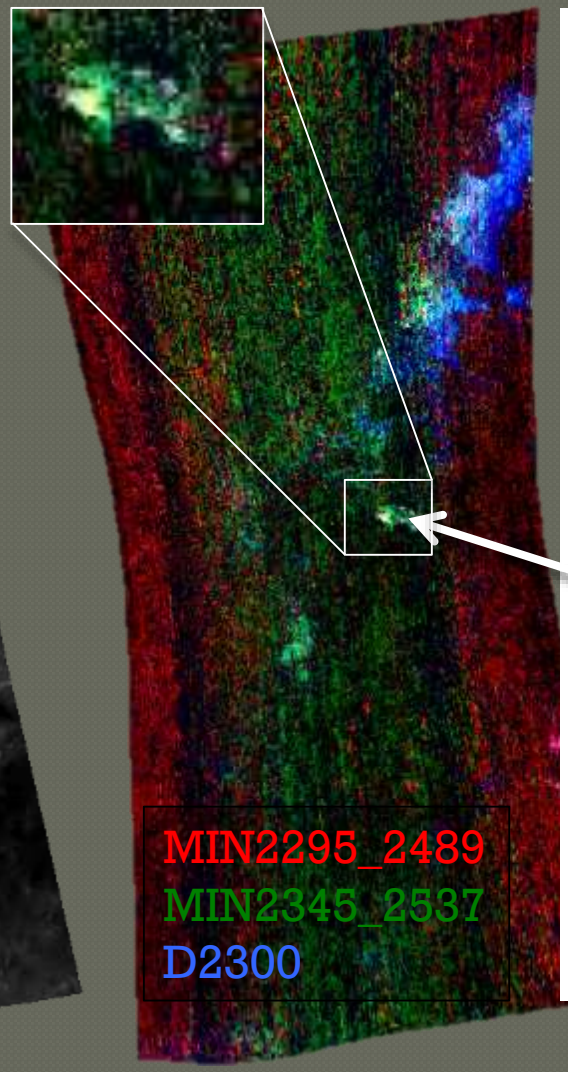
Diversity just past ellipse: Noachian primary/altered

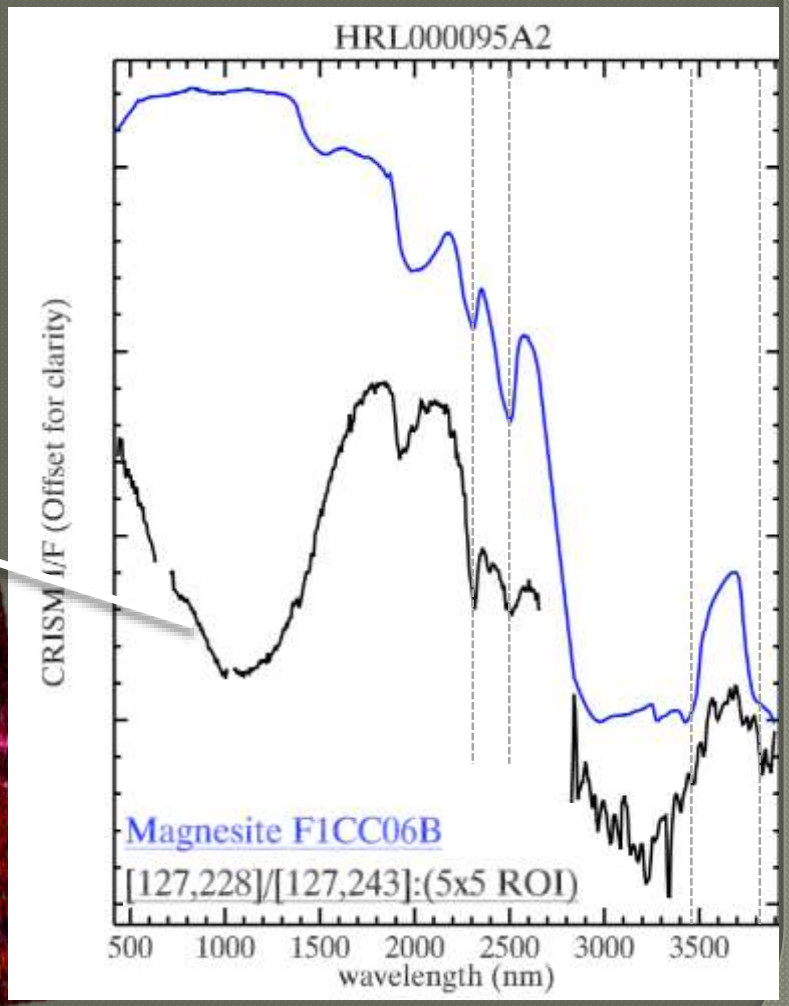
- Discernable contact between unaltered and altered Noachian material (test formation hypotheses)
- Compositional stratigraphy of altered material, carbonate component? (diverse alteration conditions, temperature/pH/fluid gradients > energy gradient)
- Hydration state of phyllosilicates (human resource)
- Layered alteration material at the top of the stack (sedimentary? changing formation mechanism?)
- Possibility of mega-breccia provides even more potential diversity
- Contact between Syrtis flows and plateau material - nature of Fossae faulting (GPR)

Carbonate abundance (CO_2 sequestration/cycling)

Diversity on plateau: Carbonates

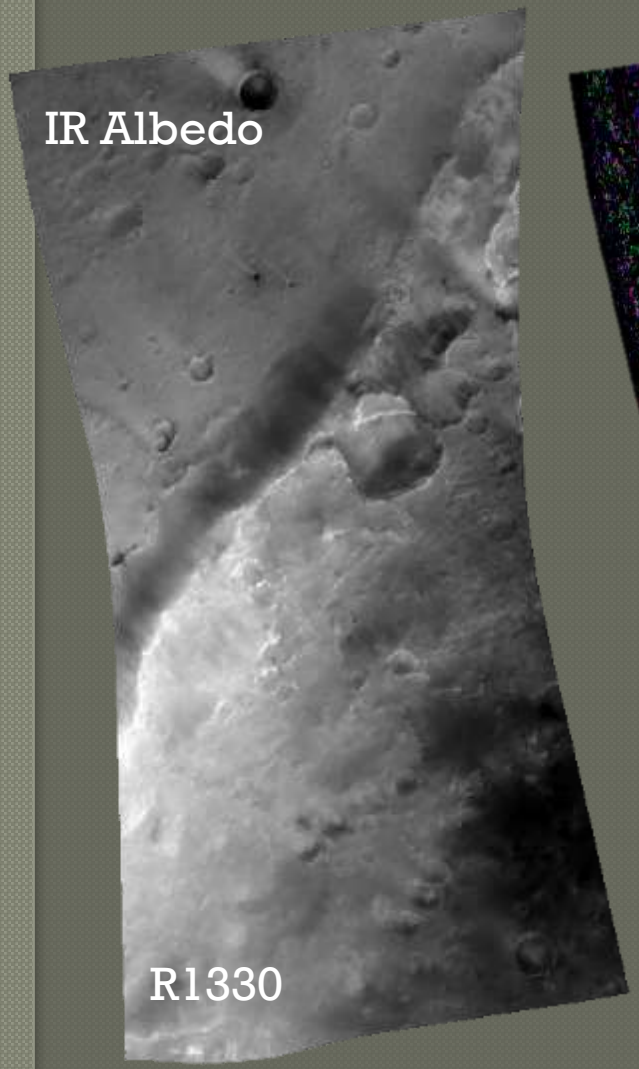


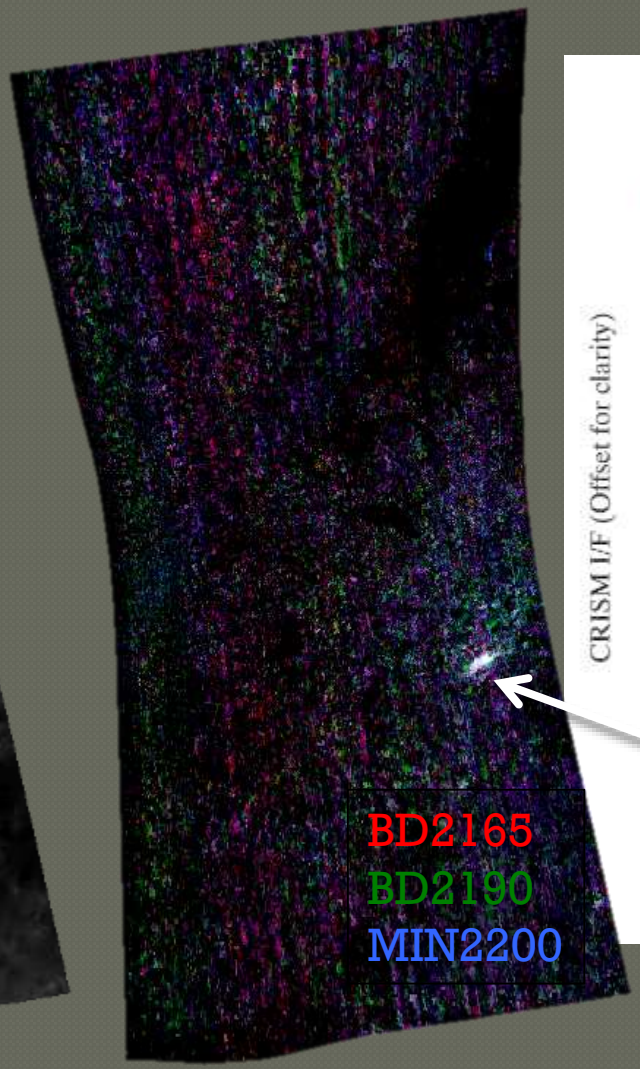


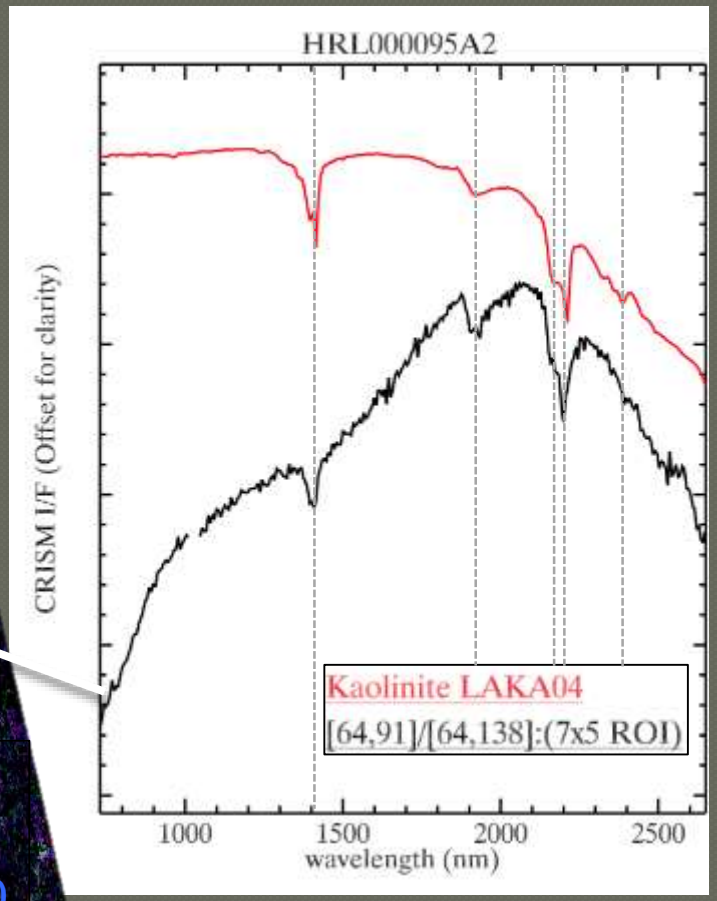


Pedogenesis?

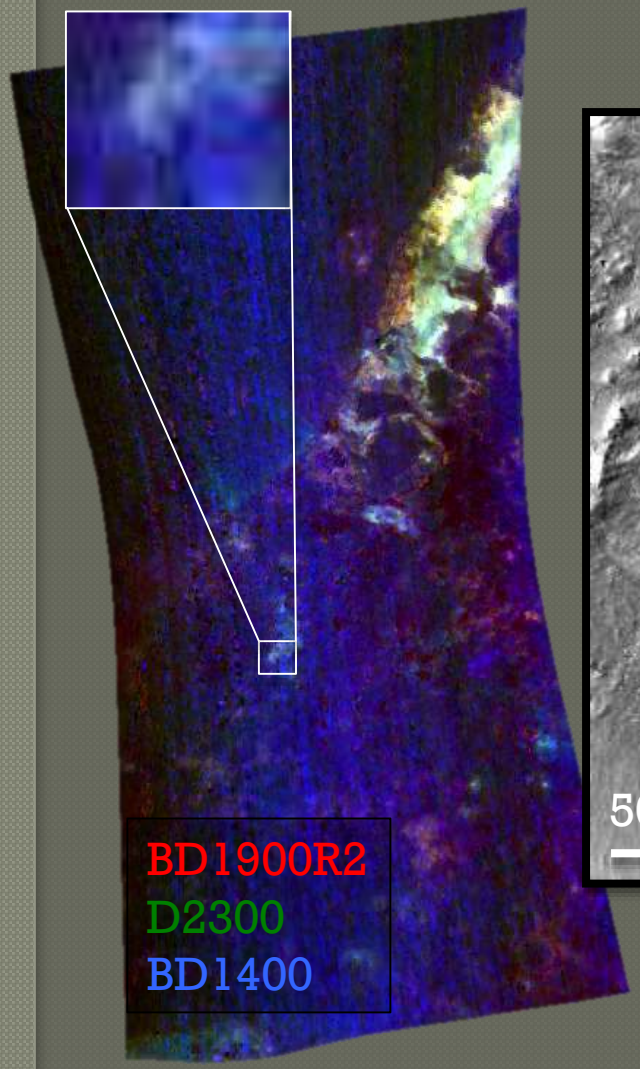
Diversity on plateau: Al-OH phases

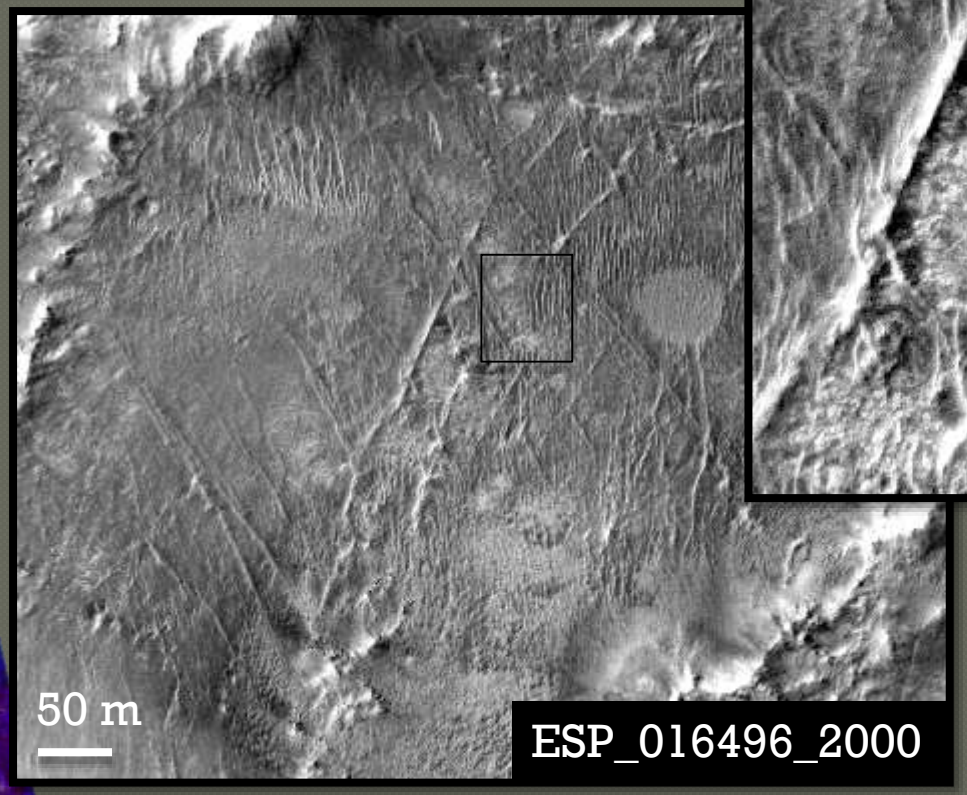


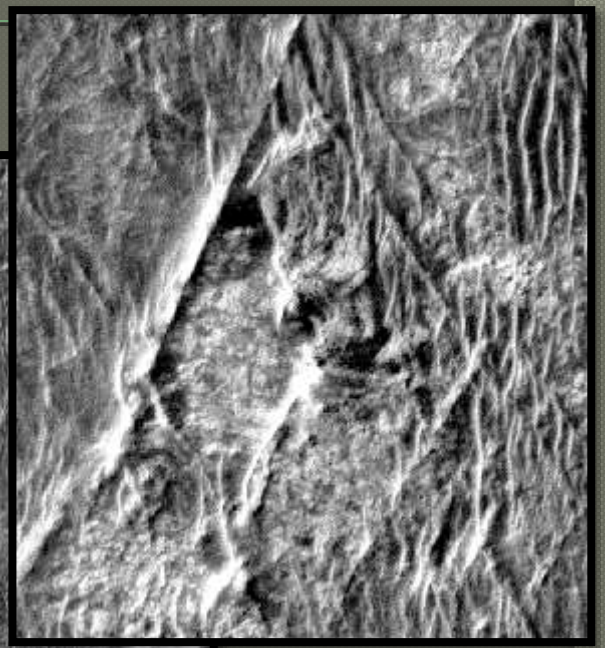




Diversity on plateau: Fractures





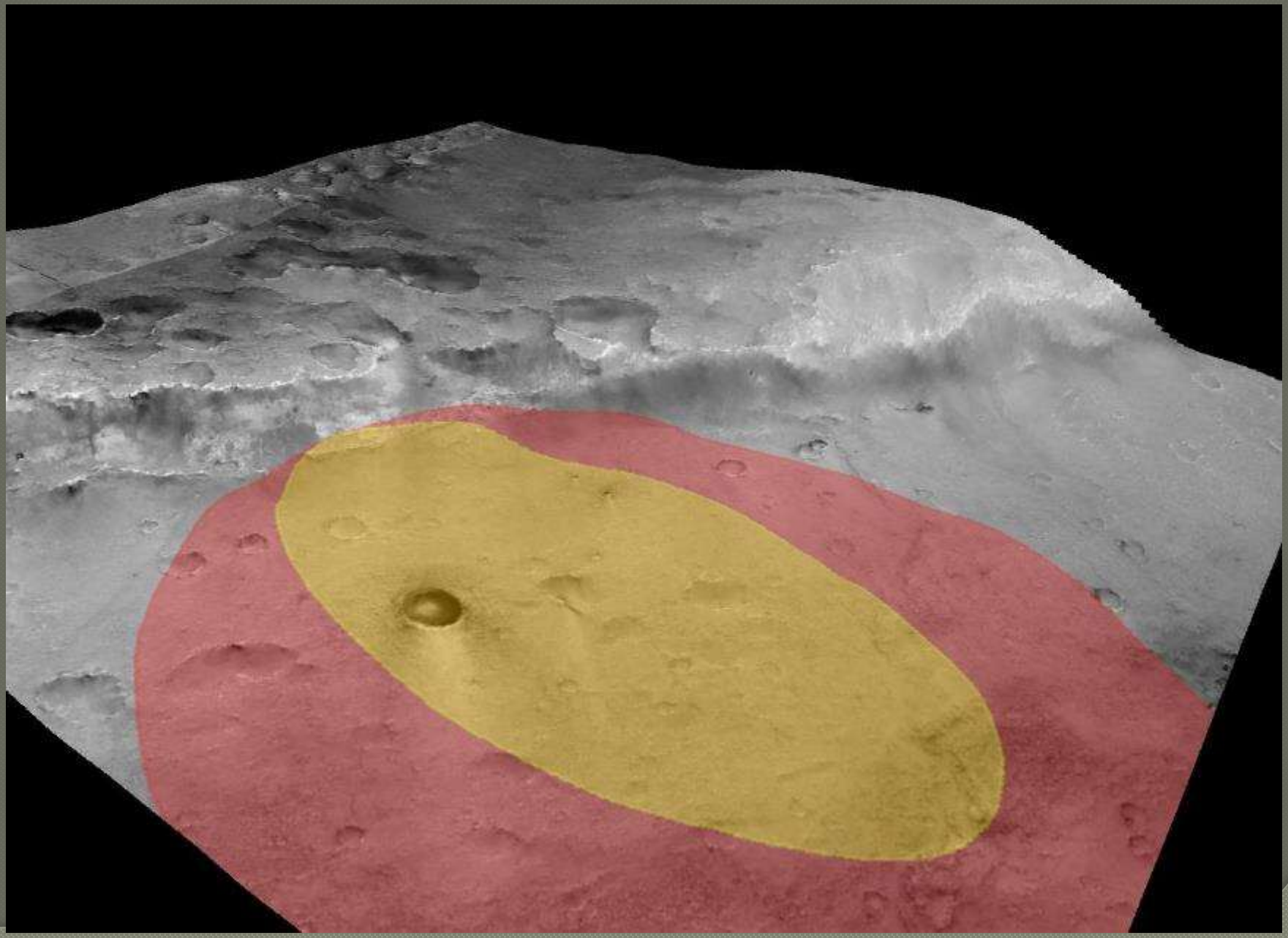


- Erosionally-resistant fracture fill

Diversity on plateau: Noachian primary/altered

- In place Noachian LCP-bearing material (ancient crust composition, mineralogic/elemental analysis)
- Variety of alteration conditions (hydrothermal fluid, mineralization along fractures)
- Olivine-carbonate(-talc?) assemblage (test talc hypothesis: increased Si activity may help preserve biosignature-silicification, exothermic long-lived rxn)
- Kaolinite-bearing material may record pedogenic sequence

Potential Traverse



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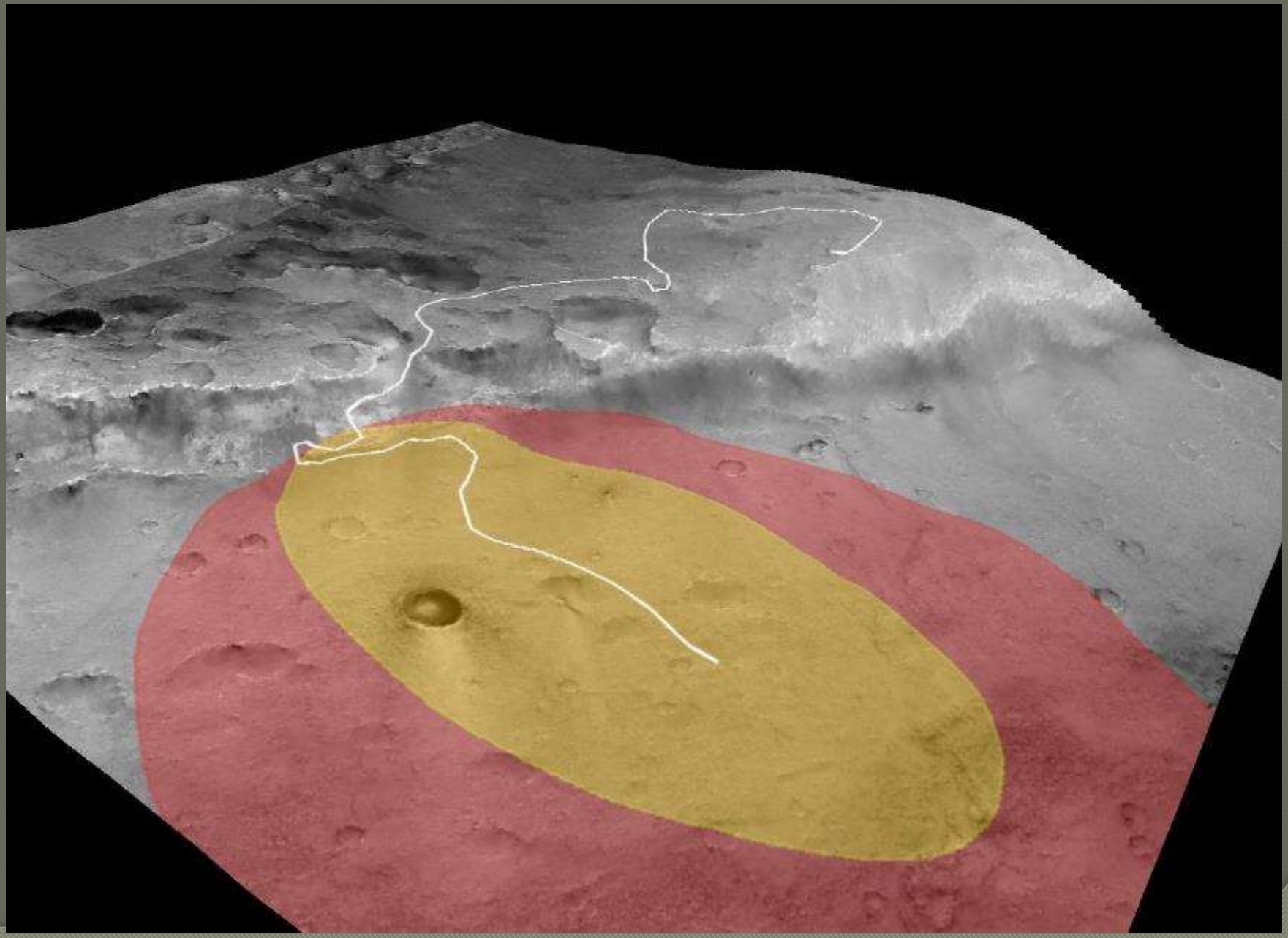

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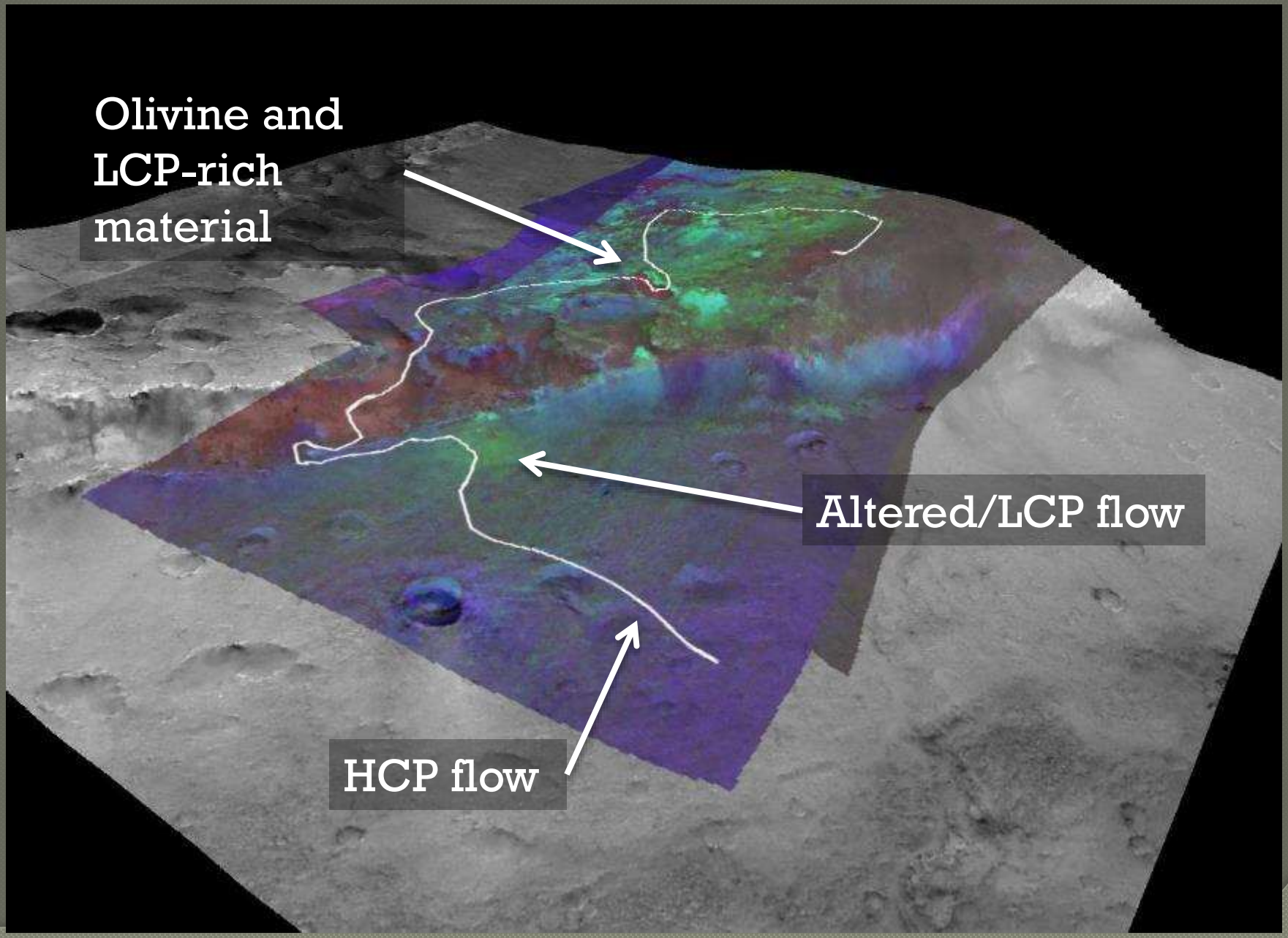
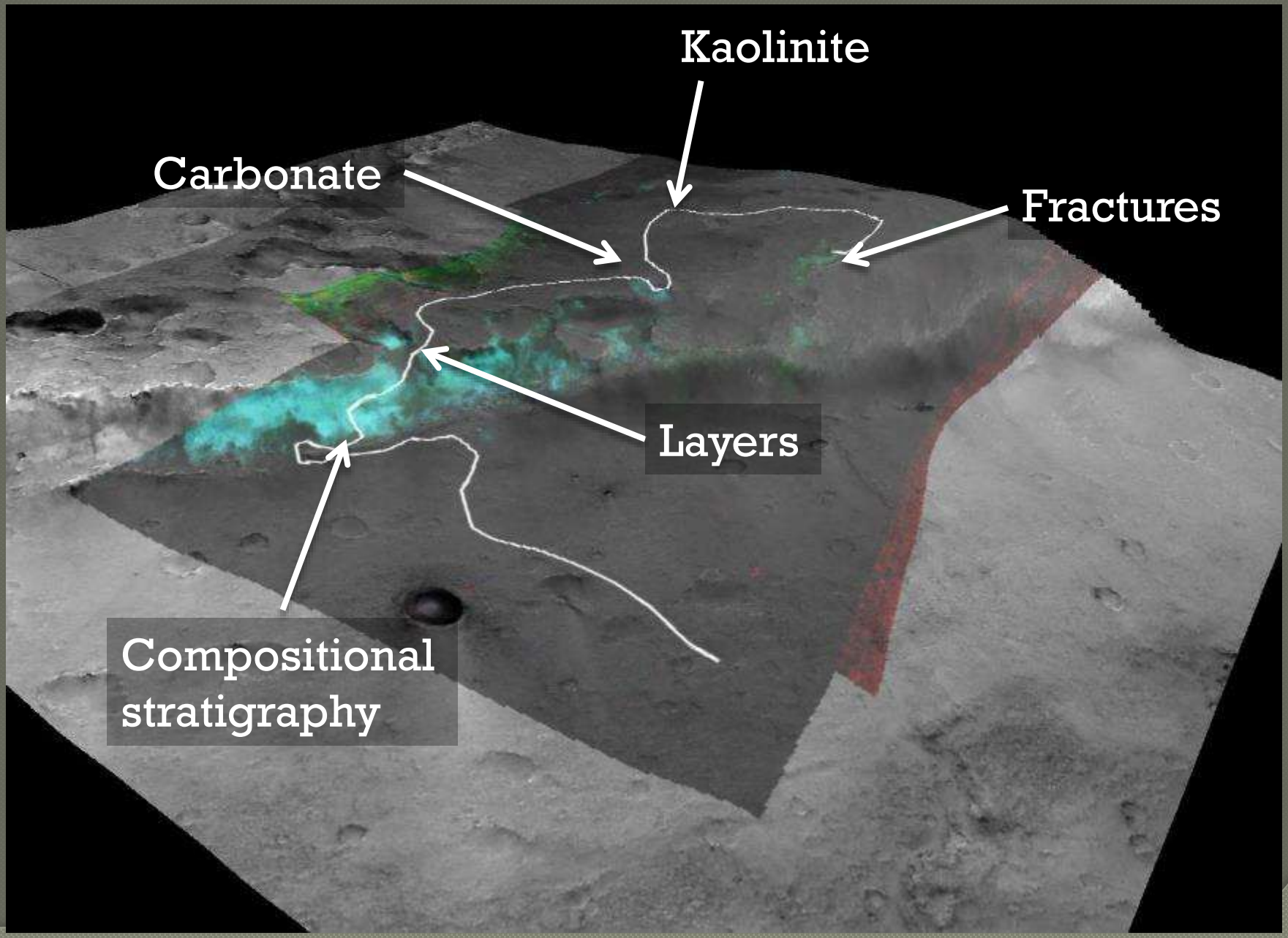
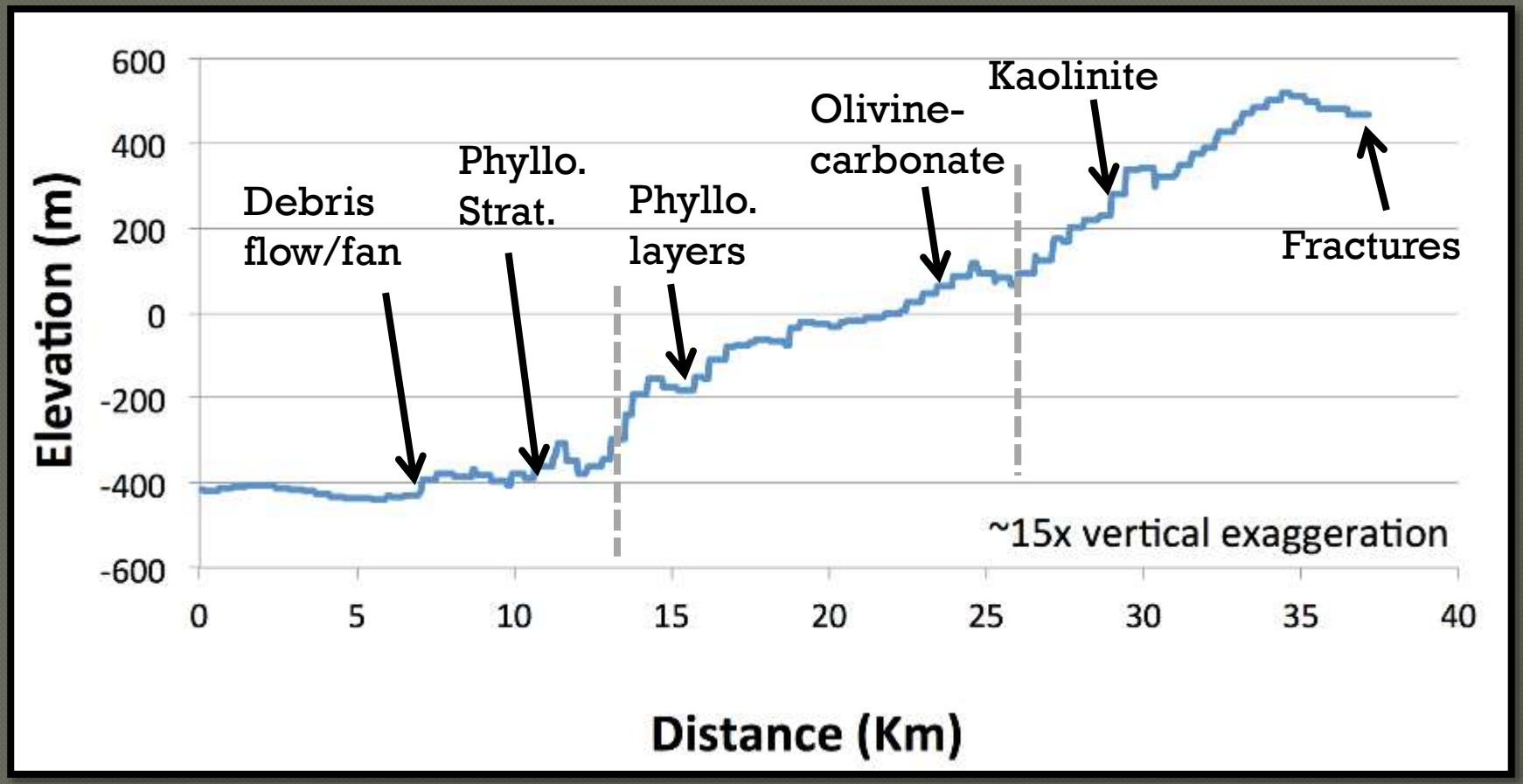


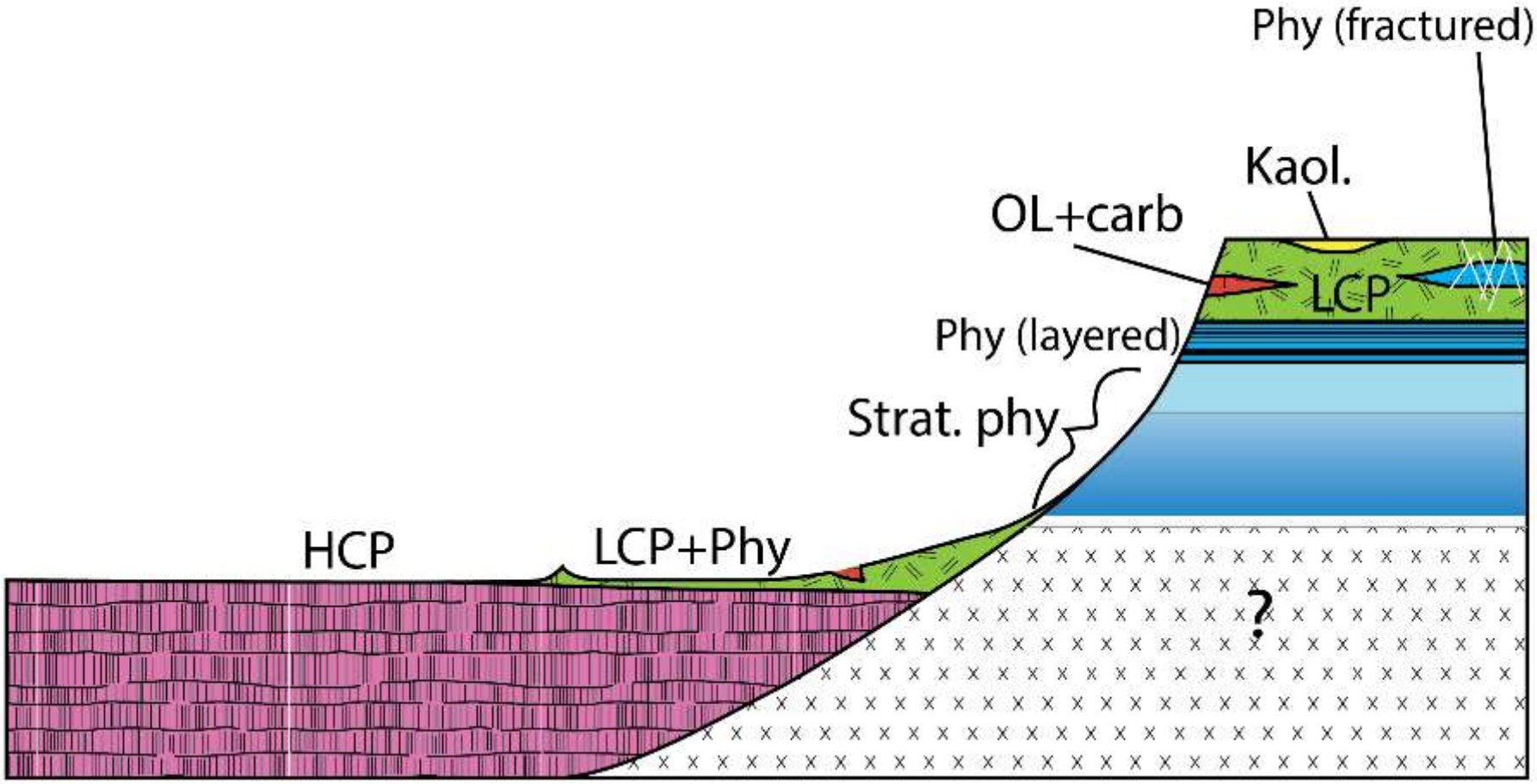
Potential Traverse



Potential Traverse Elevation



Potential Traverse Stratigraphy



Rubric

Environmental Setting for Biosignature Preservation and Taphonomy of Organics								Type 1A & 1B Samples: Aqueous Geochemical Environments indicated by Mineral Assemblages									Type 2 Samples: Igneous		Context: Martian History Sampled, Timing Constraints				
Deltaic or Lacustrine (perennial)	Lacustrine (evaporitic)	Hydrothermal (<100°C) surface	Hydrothermal (<100°C) subsurface	Pedogenic	Fluvial/Alluvial	No diagenetic overprinting	Recent exposure	Crustal phyllosilicates	Sedimentary clays	Al clays in stratigraphy	Carbonate units	Chloride sediments	Sulfate sediments	Acid sulfate units	Silica deposits	Ferric Ox./Ferrous clays	Igneous unit (e.g, lava flow, pyroclastic, intrusive)	2nd Igneous unit	Pre- or Early-Noachian Megabreccia	Oldest stratigraphic constraint	Youngest stratigraphic constraint	Stratigrapy of units well-defined	Dateable surface, volcanic (unmodified crater SFD)
			~	~	~		▯	▯	~	○	○						▯	▯	○	EN	EH	○	▯
			Olivine-carbonate(-talc)	Kaolinite over Fe/Mg- phyllo.	Layered phyllo.		Debris flow/fan	LCP+clay	Layered phyllo.	Kaolinite	With phyllo. and olivine-carbonate in plateau				Resistant fractures may be silica-bearing		Syrtis flows	Olivine and LCP units	Phyllosilicate-bearing	Isidis	Syrtis flows	Stratigraphy mostly outside ellipse	Syrtis flows