Mineralogic diversity at Holden crater

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HiRISE ESP_019045_1530

Holden mineralogy intro

Background

• Light-toned layered deposits and overlying flood deposits have Fe/Mg-phyllosilicates (Milliken et al., Mars Conf. 2007)

• These may be smectite/chlorite mixed-layer clays (Milliken & Bish, 2010)

• Crater wall near Uzboi breach contains similar clays, pyroxene, olivine (Milliken & Bish, 2010)

Questions

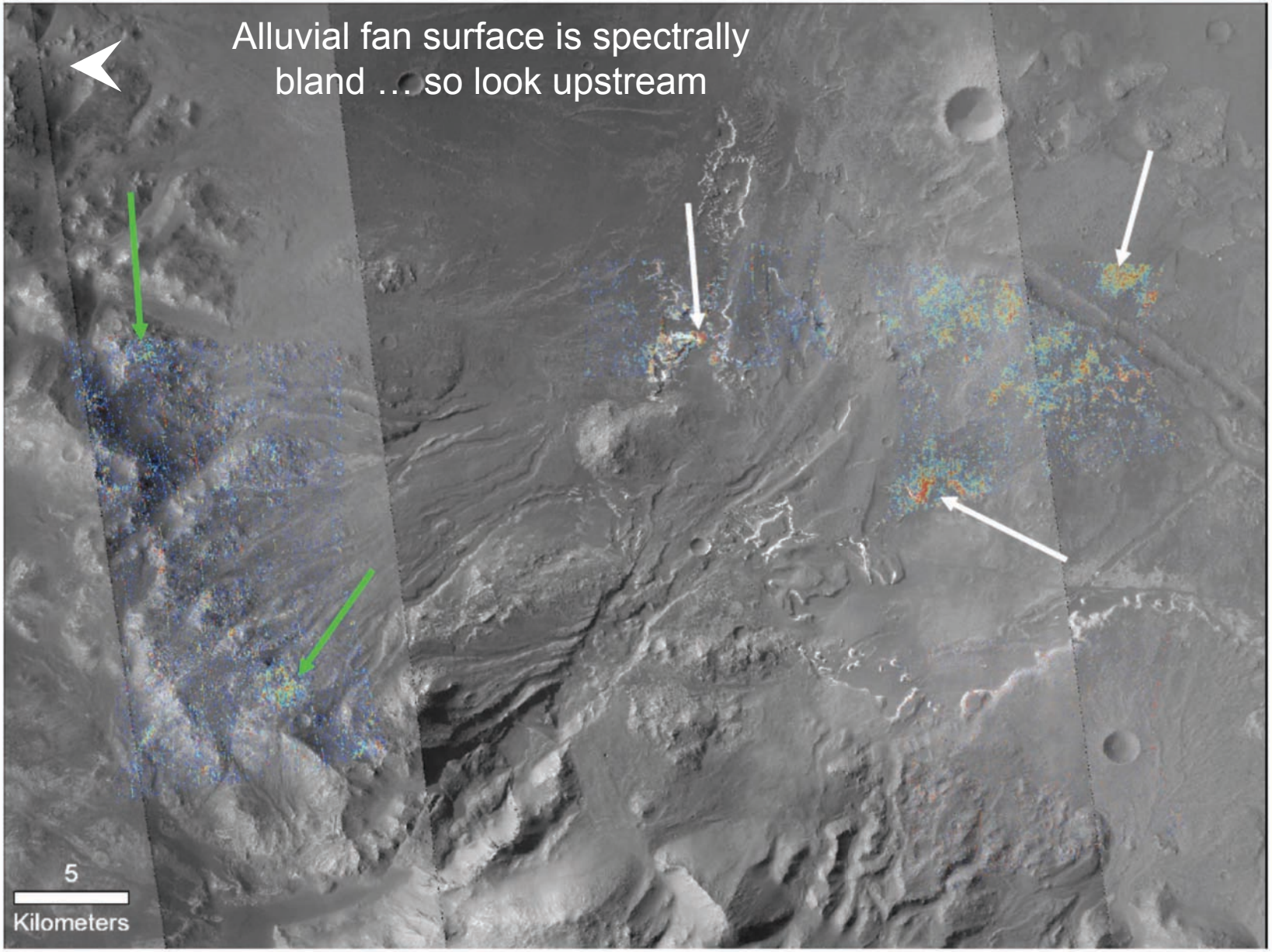
• Composition of alluvial materials in landing ellipse?

• Additional phases in light-toned layered deposits?
  - Evaporites??

• “Missing salts” in the crater wall? (Milliken et al., 2009)

• Mineralogy of bedrock mound?

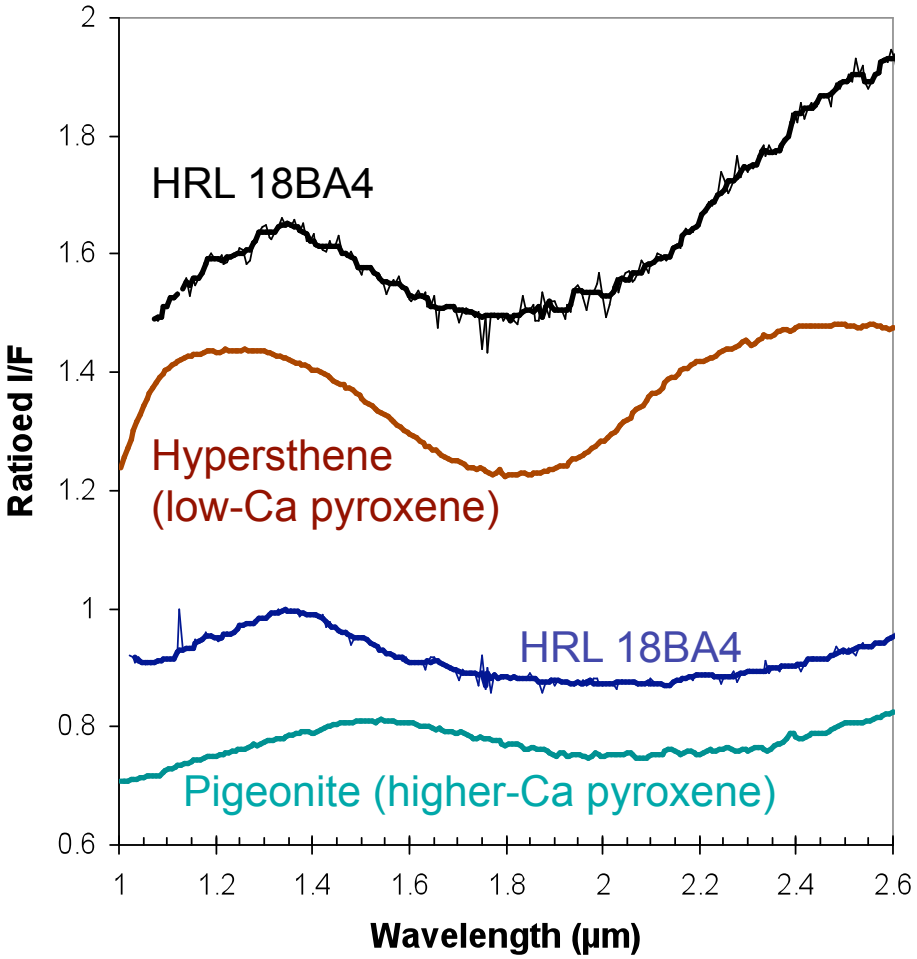
Mapping hydration in Holden



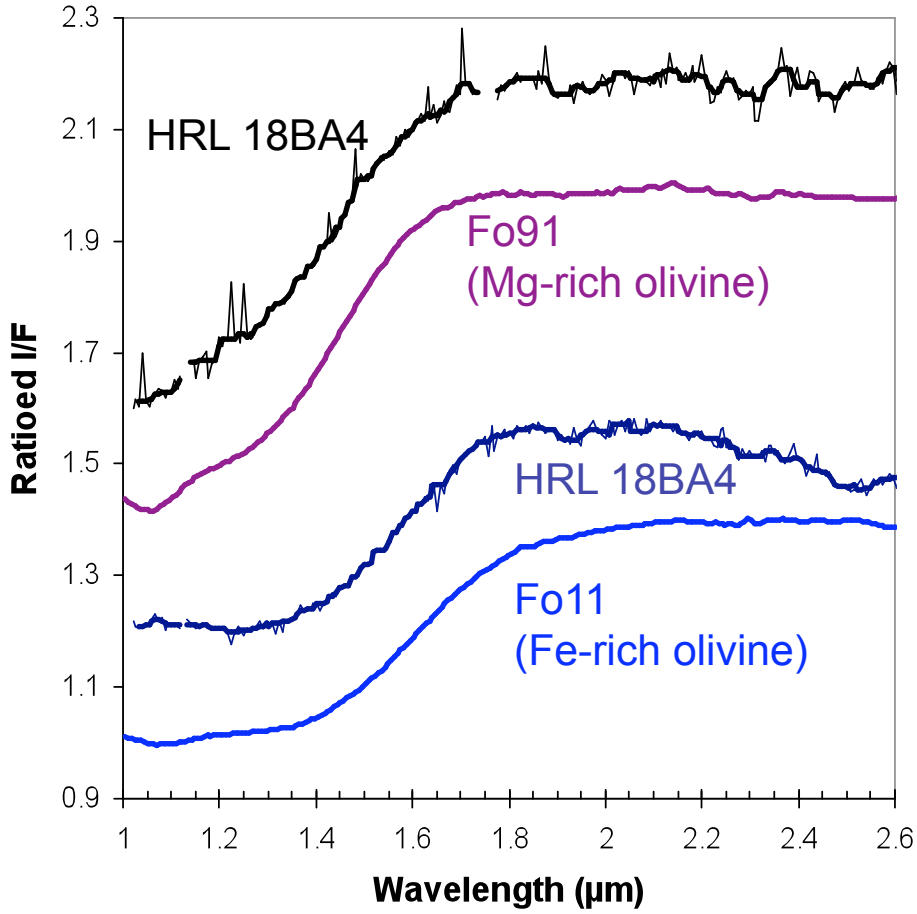
Credit: R. Milliken

Mafic minerals in fan source rocks

Two pyroxenes



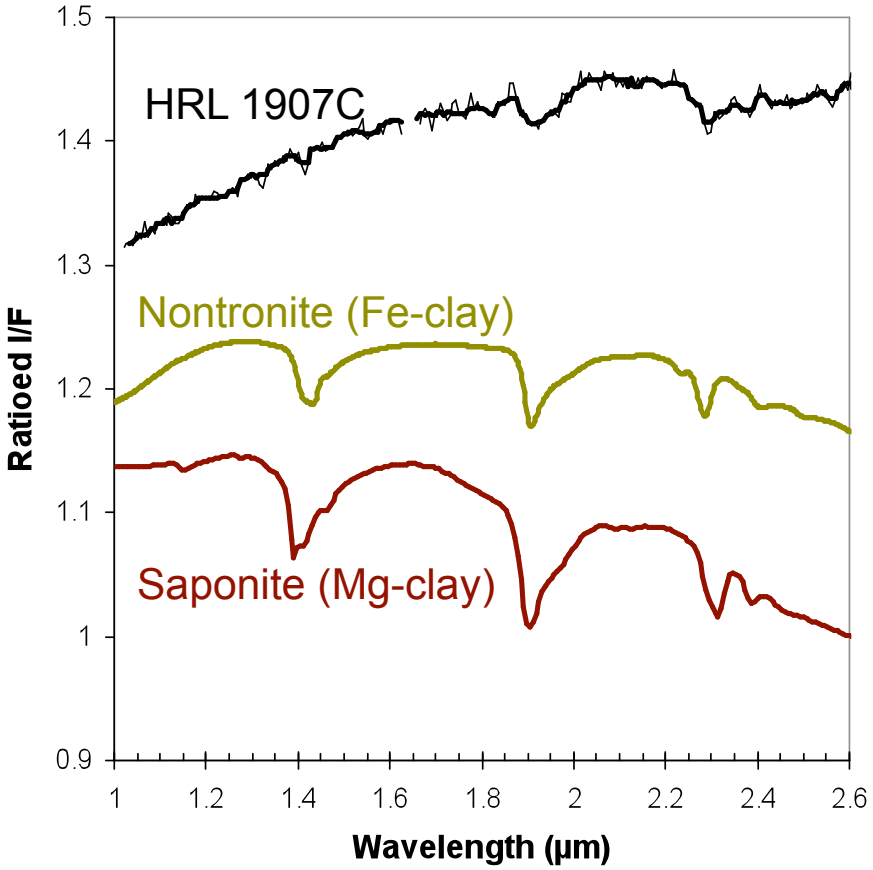
Two olivines



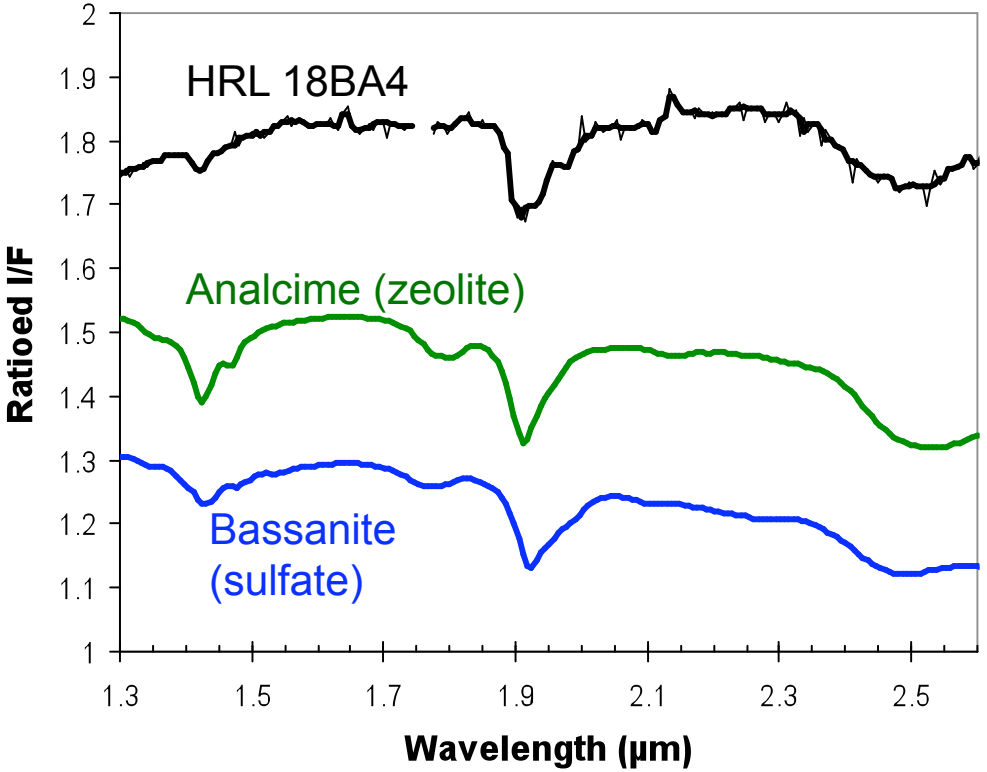
(lab spectra scaled for comparison)

Hydrated minerals in fan source rocks

Fe/Mg-phyllosilicate

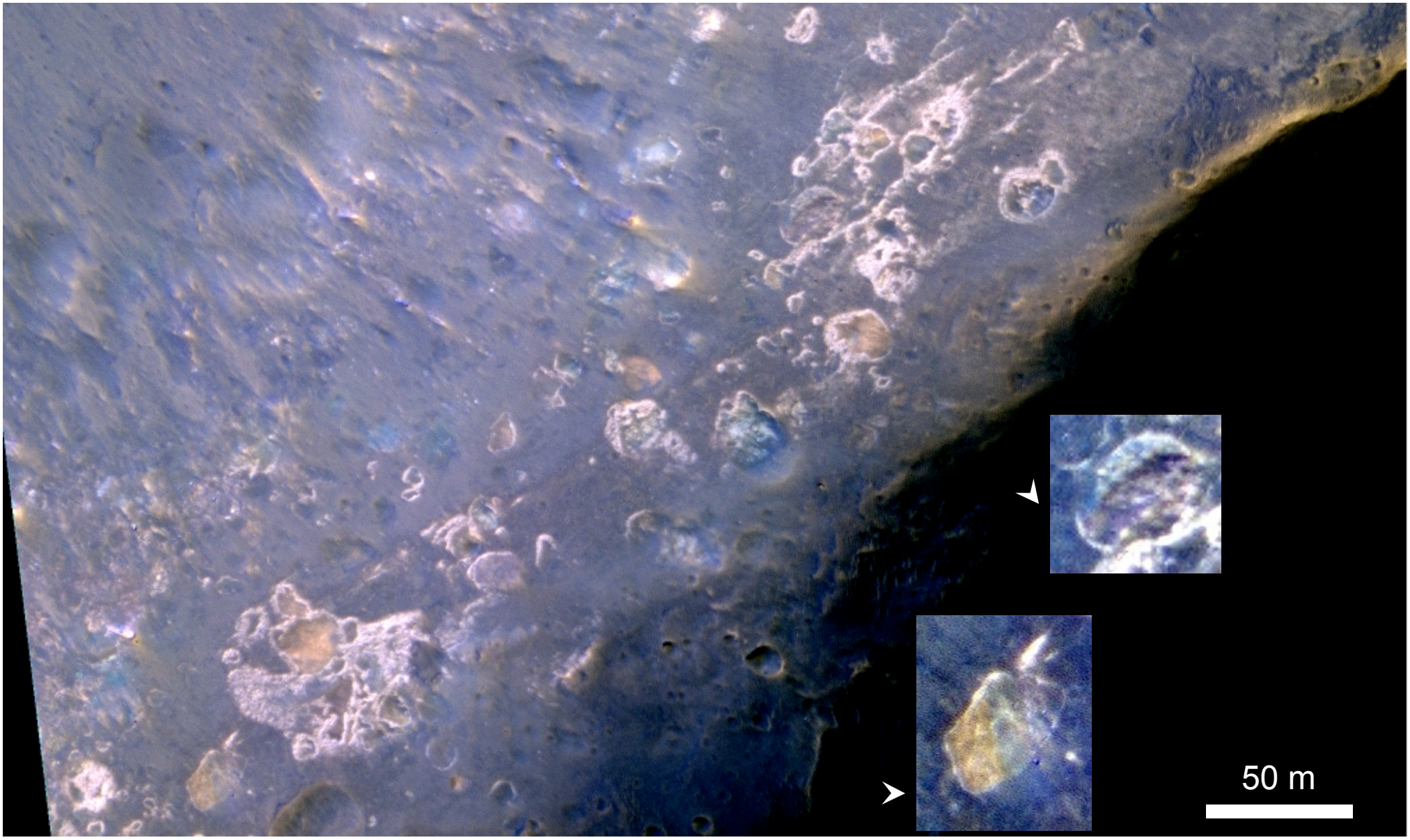


Hydrated salt / zeolite



MSL can look for compositional differences between layers/distributaries across the fan

Breccia blocks on fan source valley wall



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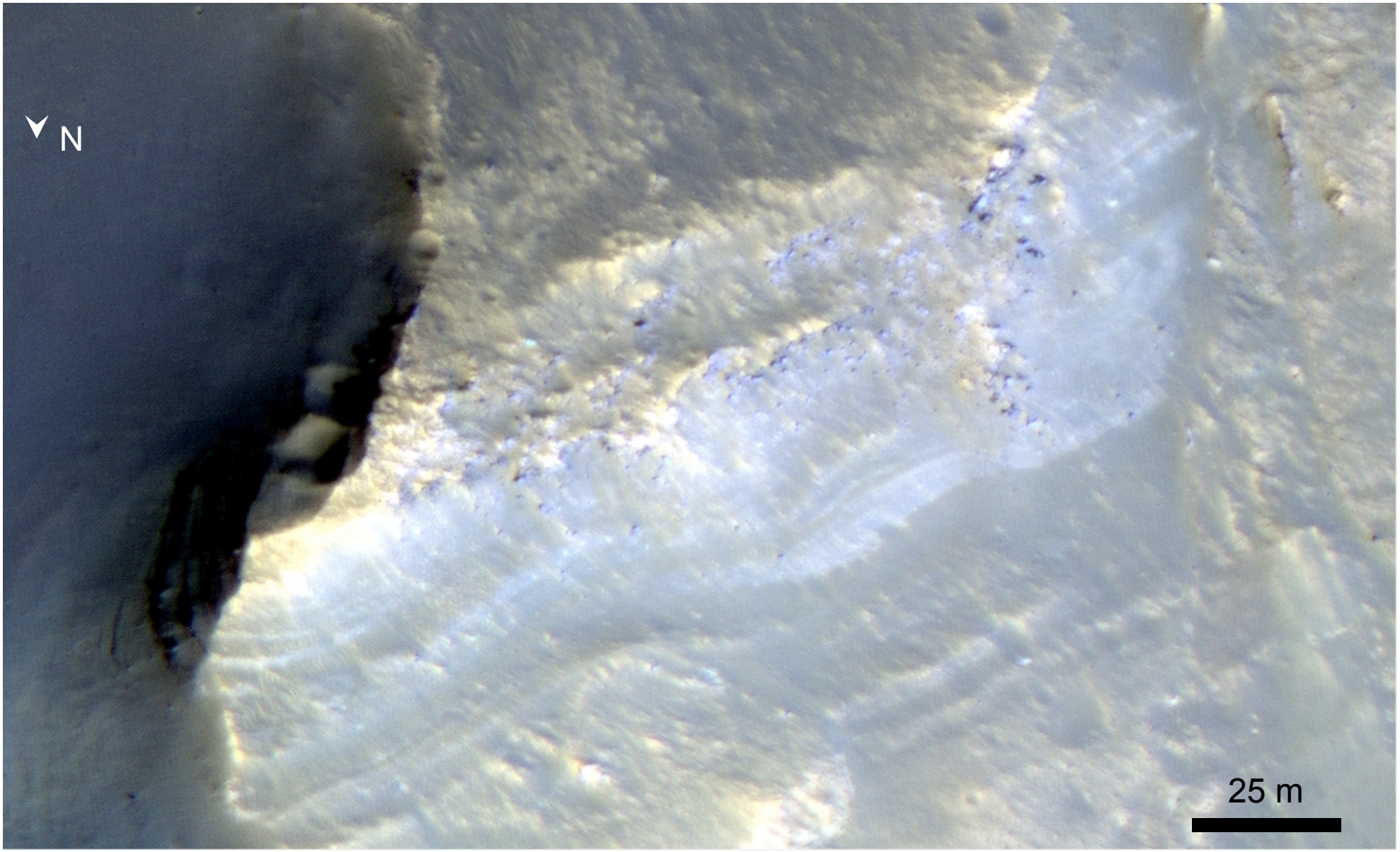
Light-toned layered rock, fan source valley wall



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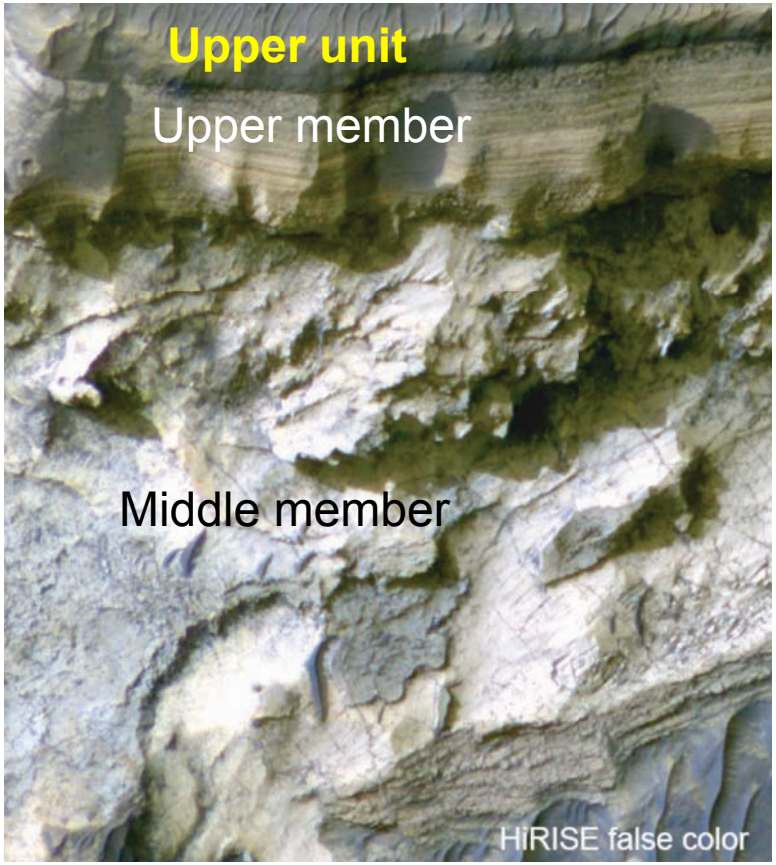
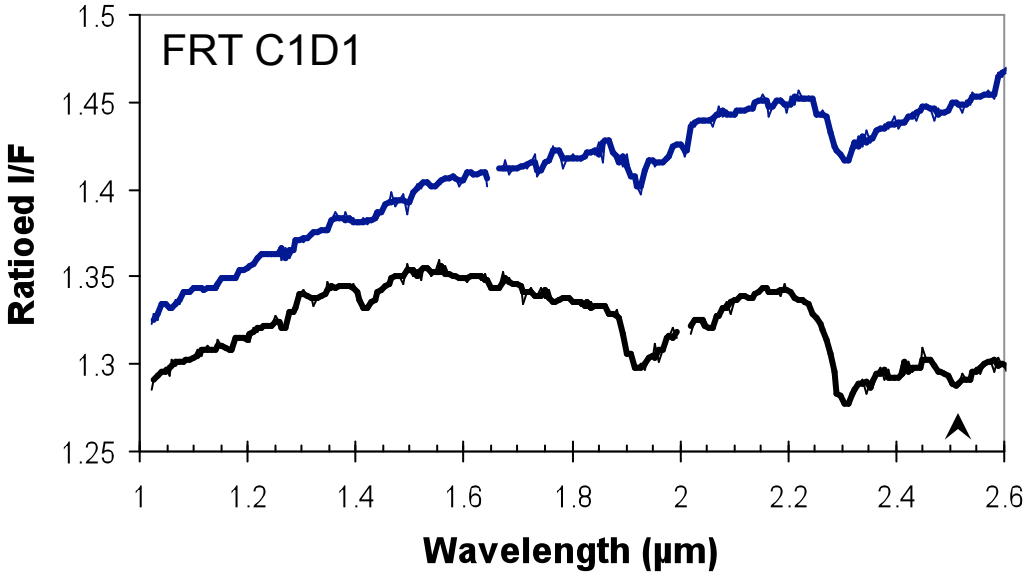
Light-toned layered deposits

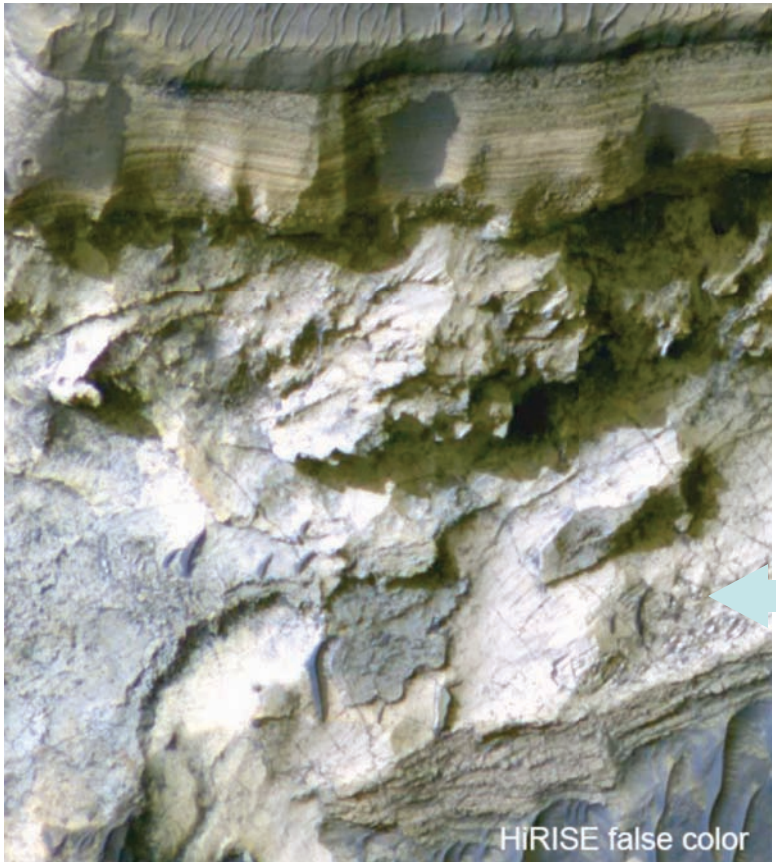


Lower member of lower unit has strongest Fe/Mg-clay signatures (Milliken & Bish, 2010)

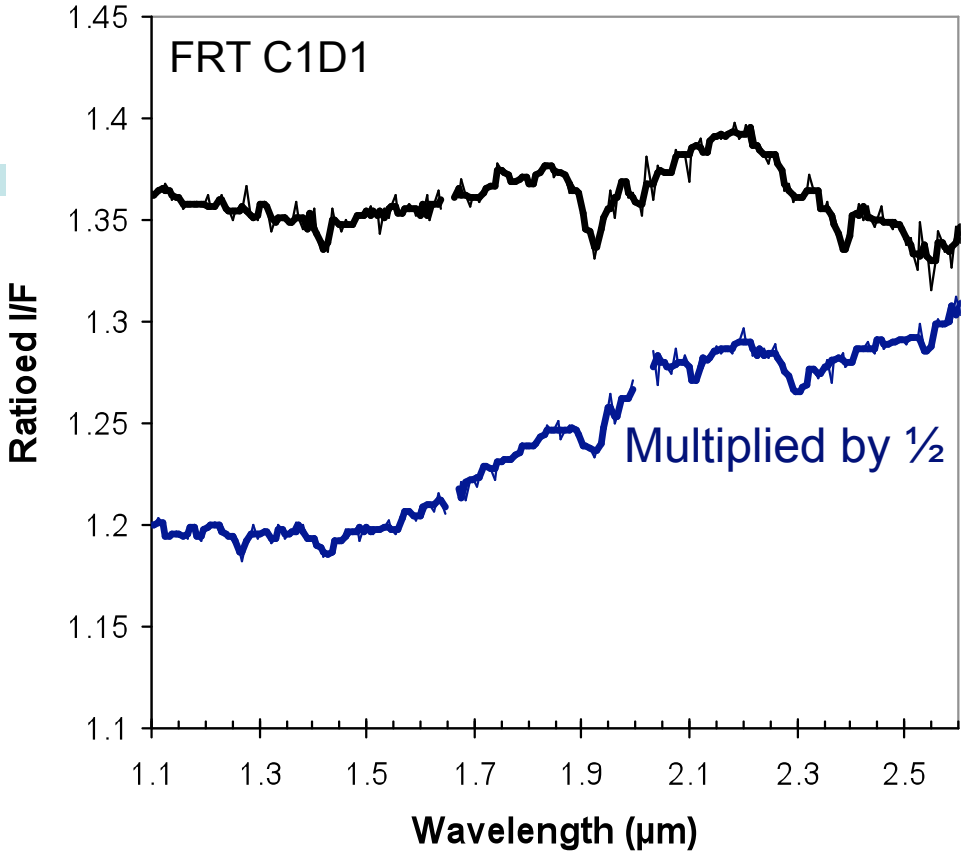


Additional phase, varying in abundance?

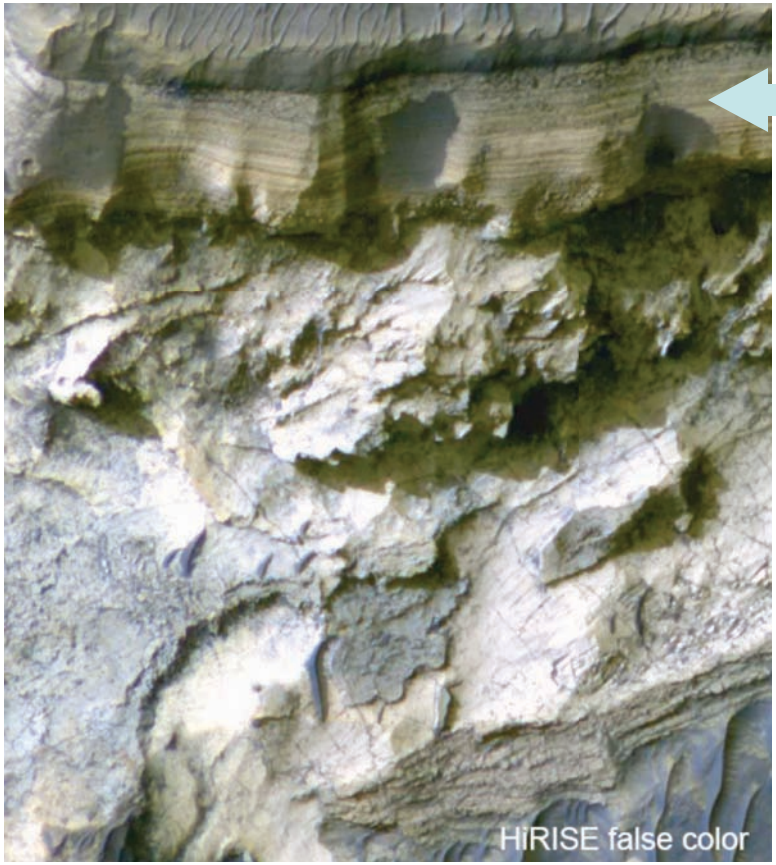
Light-toned layered deposits

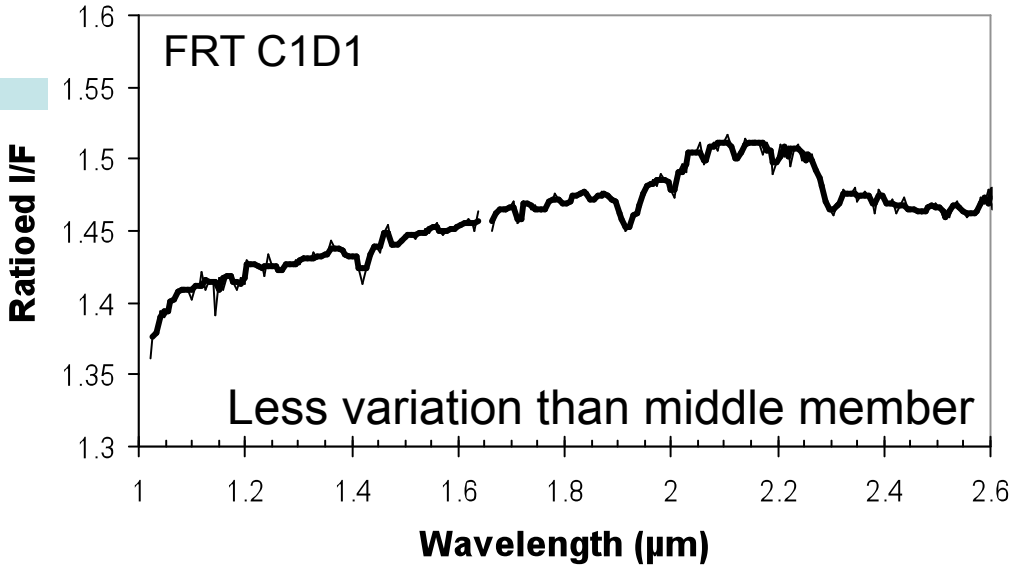


Middle member beds have variable albedos, textures … and spectra:

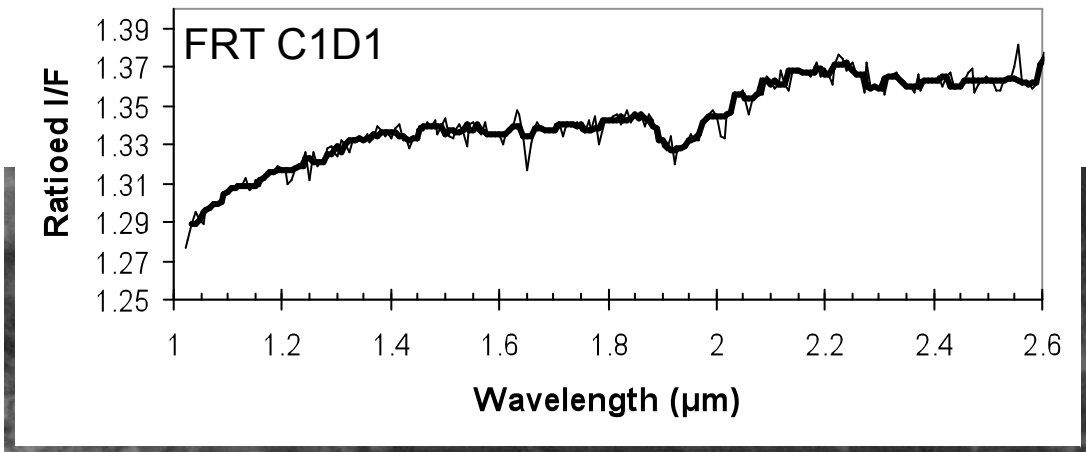


Light-toned layered deposits



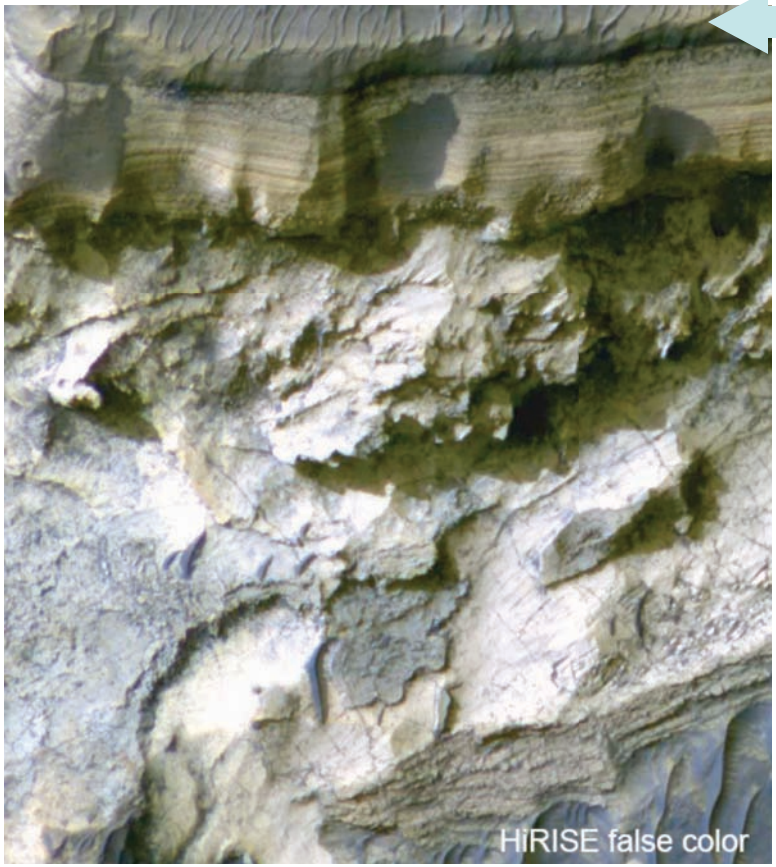


Polygonal surface overlying light-toned layers

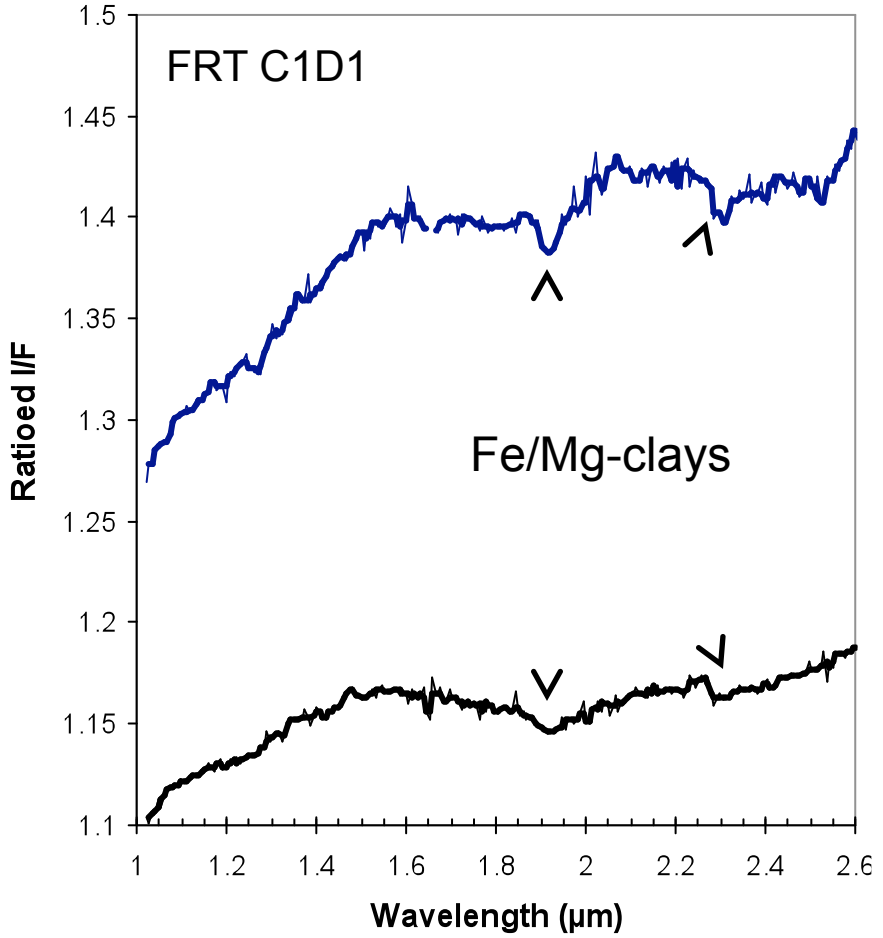


Rare strongly hydrated material seen on polygonal (evaporite??) surface

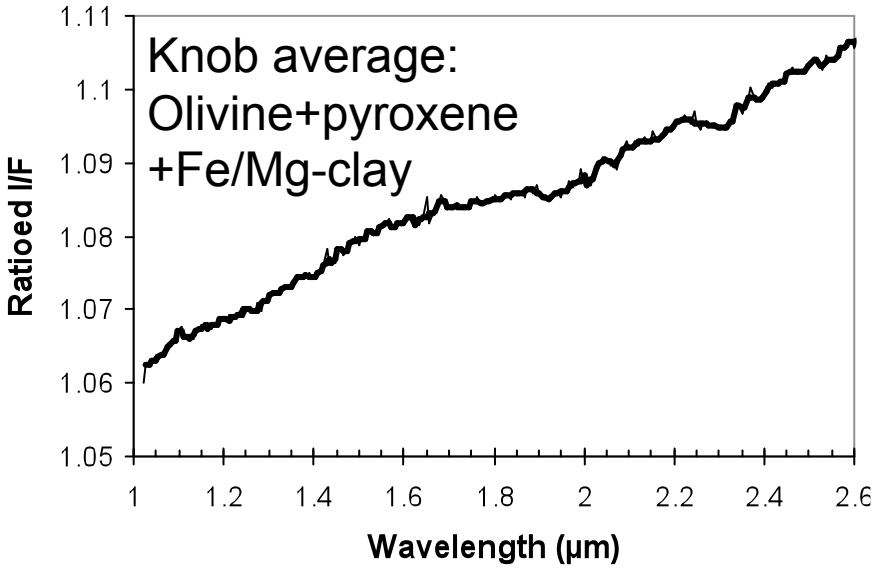
Spectra of upper unit



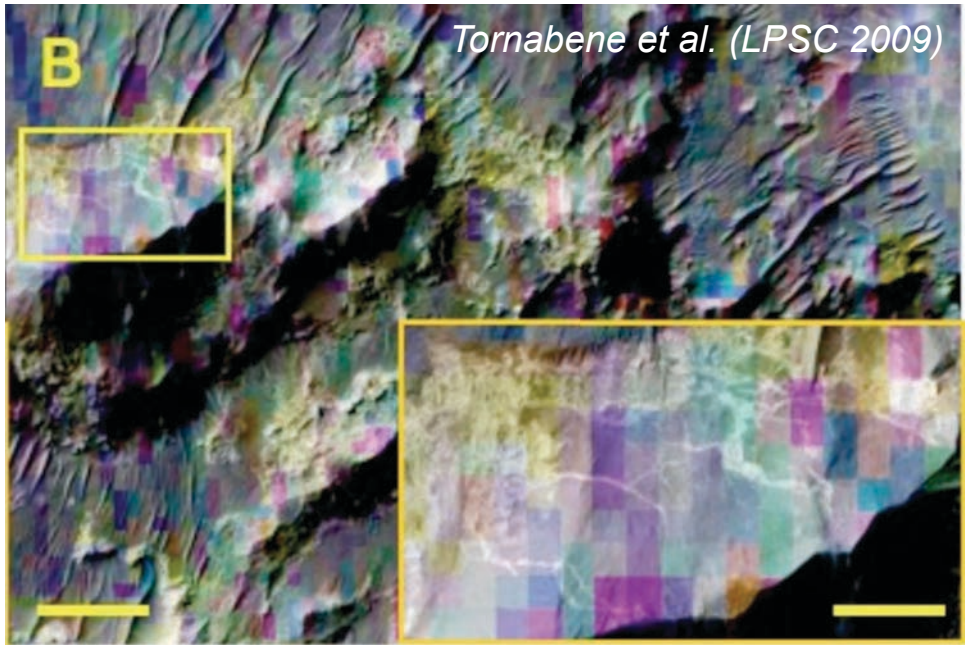
Upper unit (flood deposits) have pyroxene/olivine spectral shape *and* Fe/Mg-clay signature



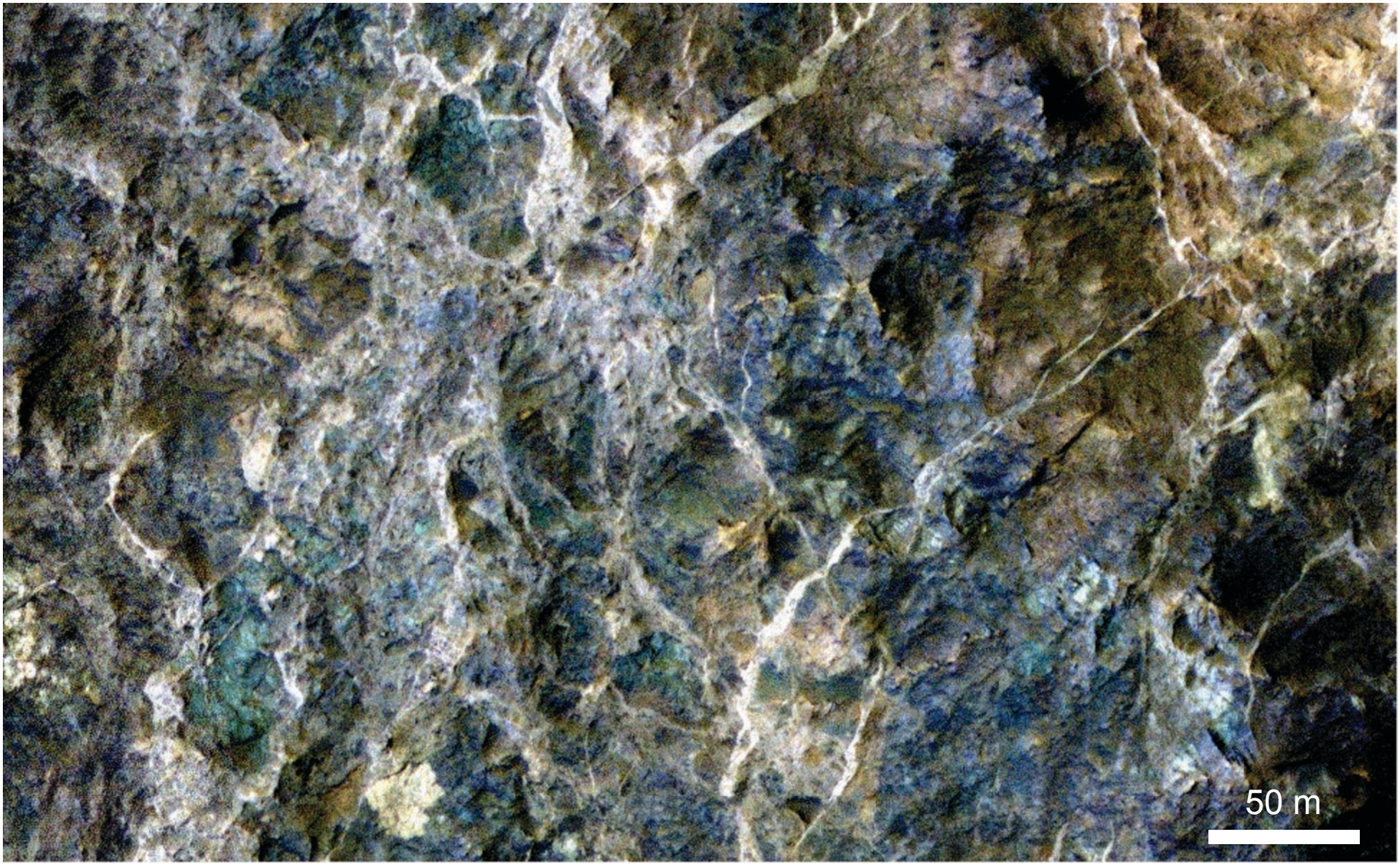
Megabreccia knob



Clays localized within matrix/dikes(?):



Megabreccia knob (extended mission target)



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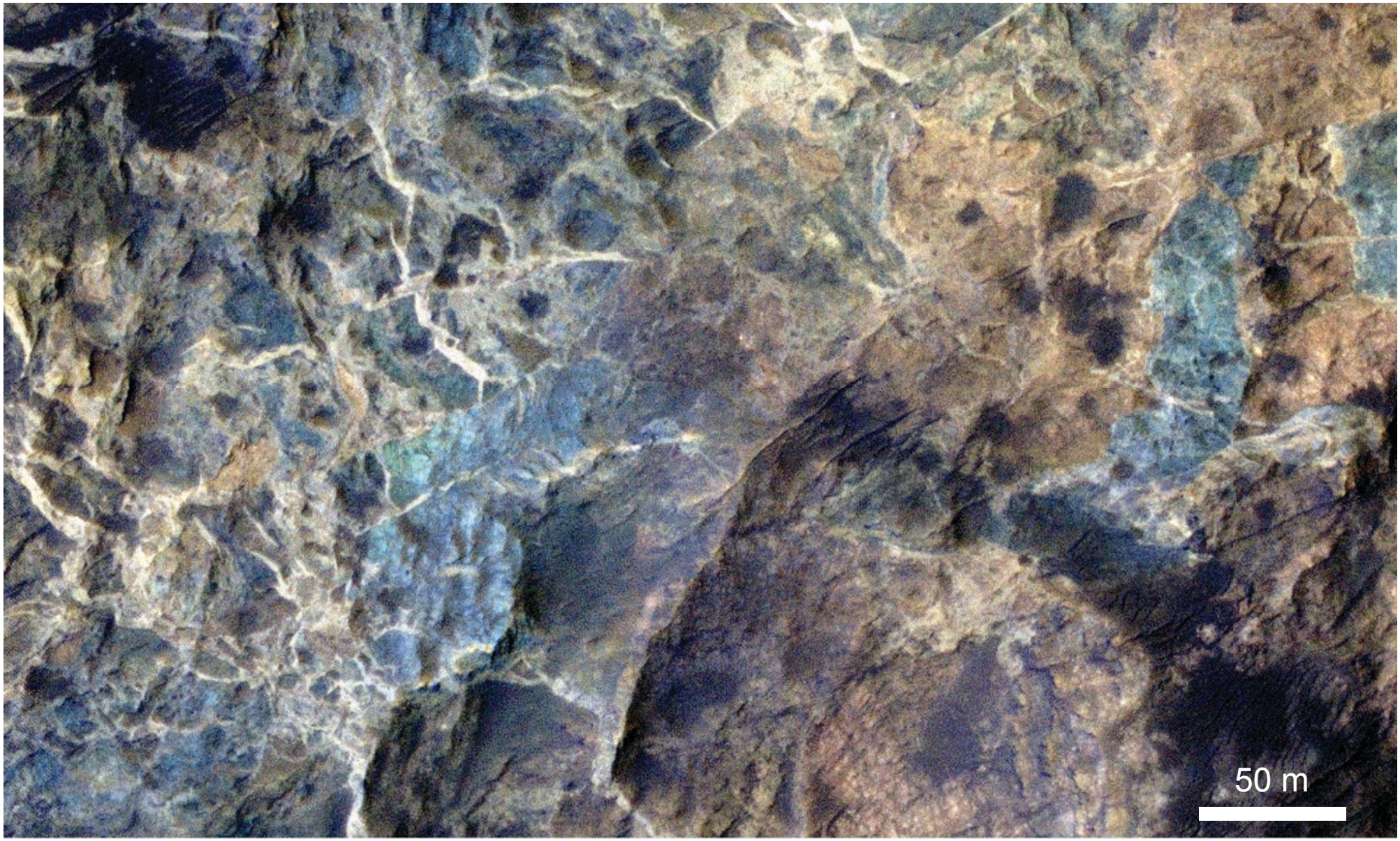
Megabreccia knob (extended mission target)



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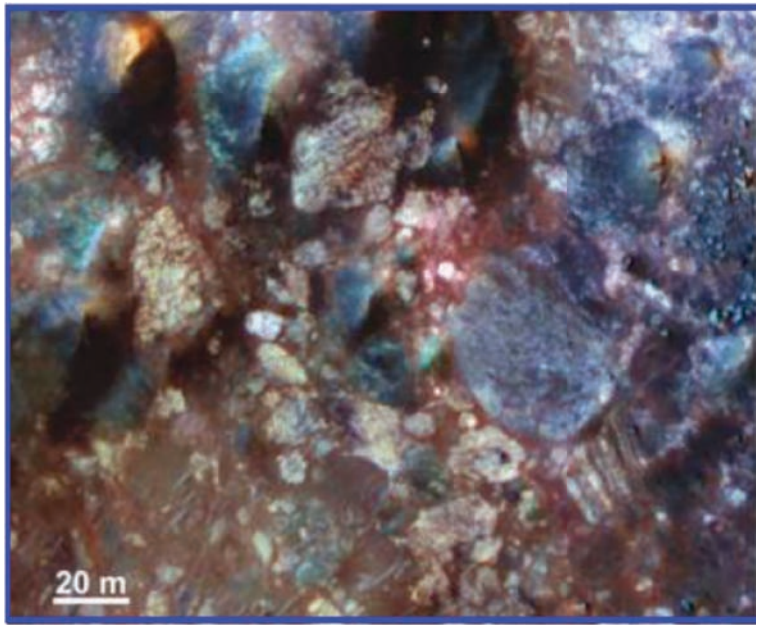
Accessing the Early Noachian crust

TABLE 5.1. SCIENTIFIC PRIORITIZATION OF THE EIGHT MISSION CONCEPTS

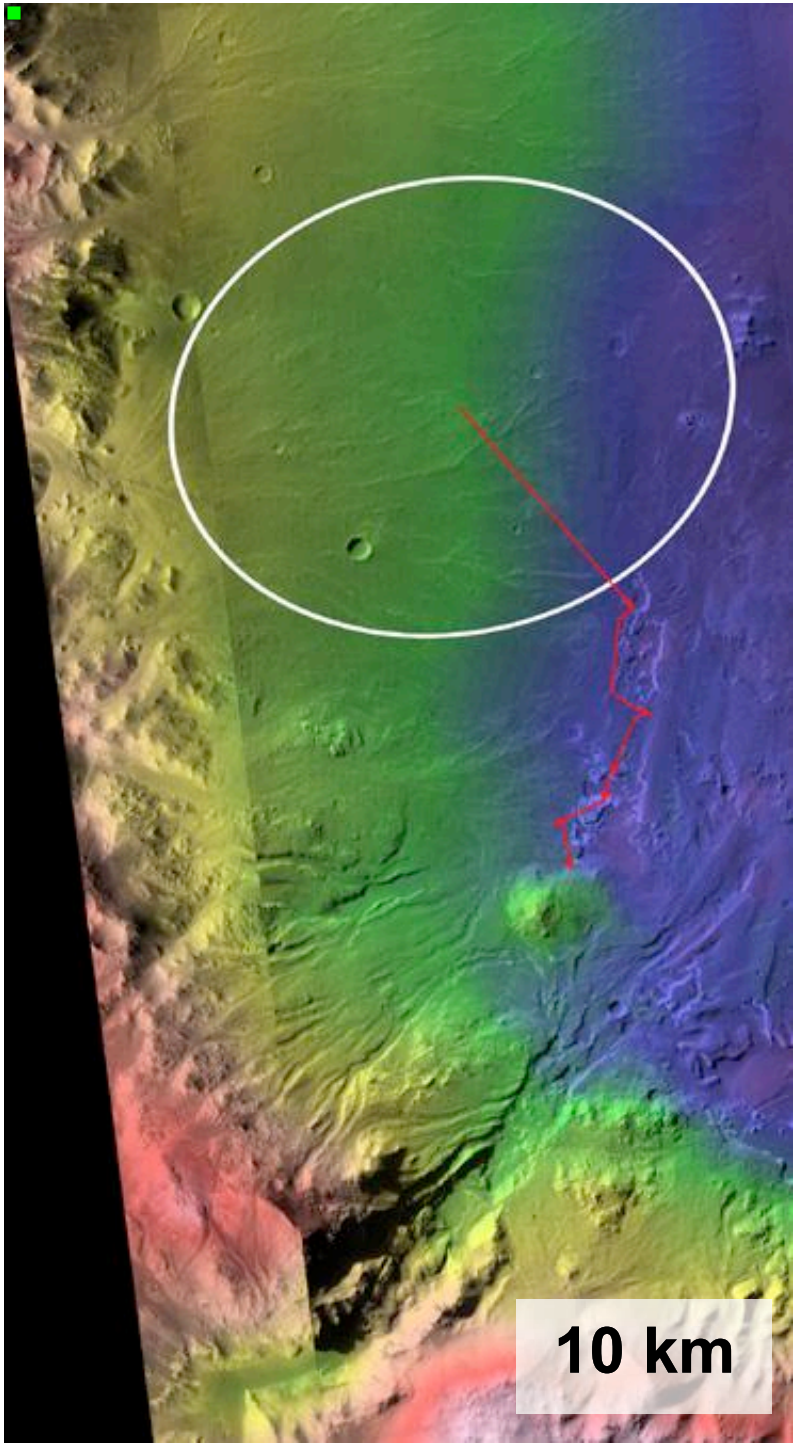
Concept #	Mission Concept	PRIORITY			
		Science value	*Science risk*	*Breakthrough potential*	*OVERALL*
4	Astrobiology Mission to Early Noachian Mars	2.7	2.3	2.6	2.5
2	Stratigraphic Sequence near Noachian-Hesperian Boundary	2.6	2.2	2.5	2.4
5	Astrobiology: New Terrain	2.5	2.1	2.4	2.3
7	Detection of Methane Emission from the Martian Subsurface	2.3	1.2	2.5	2.1
3	Radiometric Dating	2.3	1.5	2.1	1.9
6	"Deep" Drilling	1.9	1.6	1.9	1.8
8	Polar Layered Deposits Traverse	1.8	1.7	1.7	1.7
1	Mid-Latitude Shallow Ice	1.7	1.9	1.7	1.5

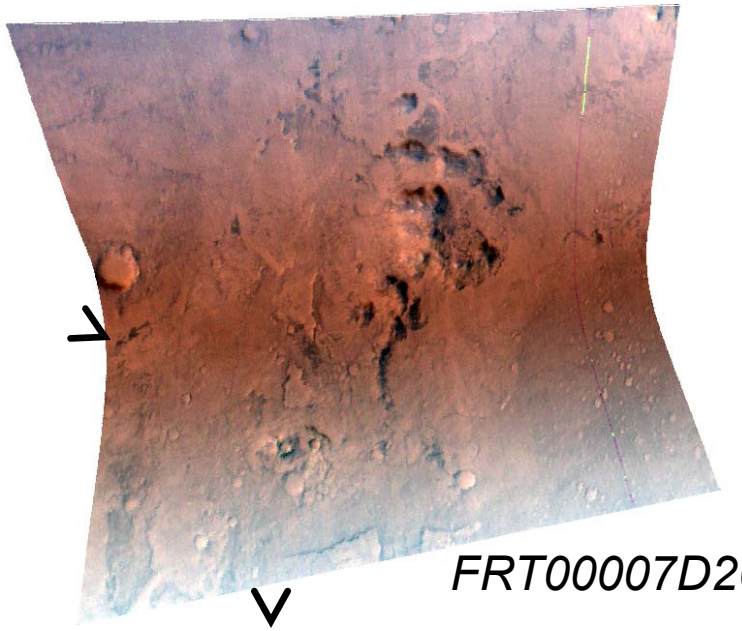
"Ideal landing sites would include layered Noachian sediments, as well as volcanic rocks."

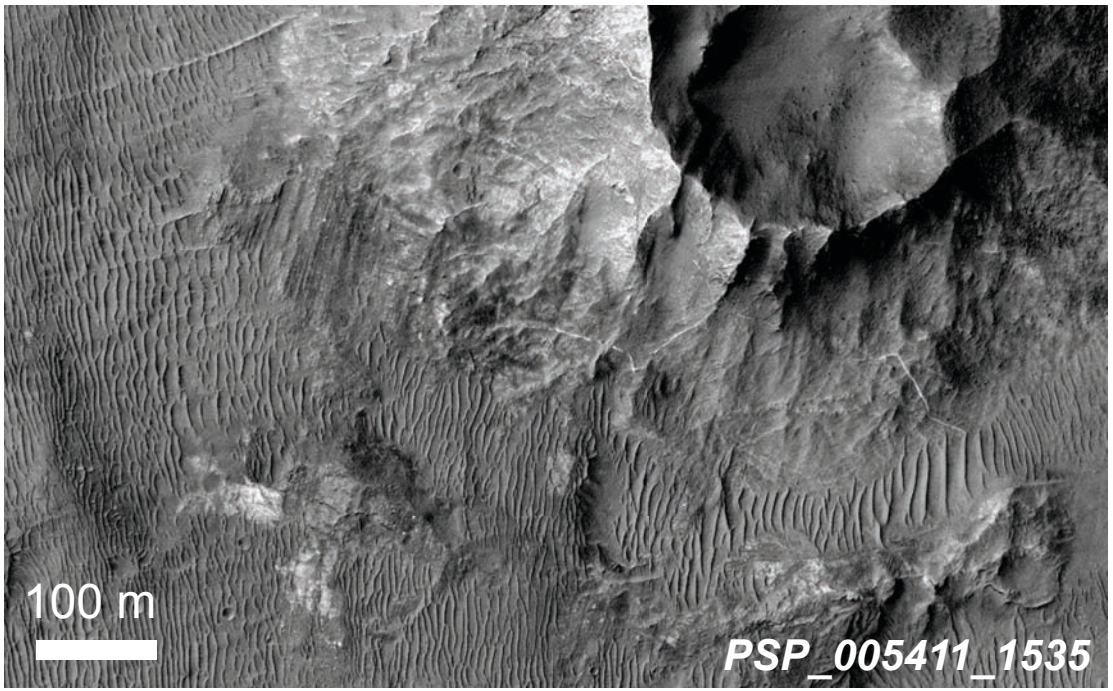
—MRR-SAG Final Report



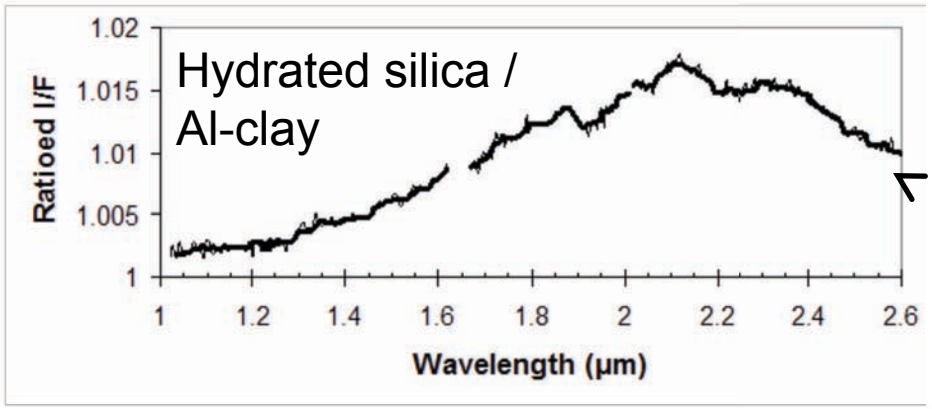
Eastern ellipse outcrops

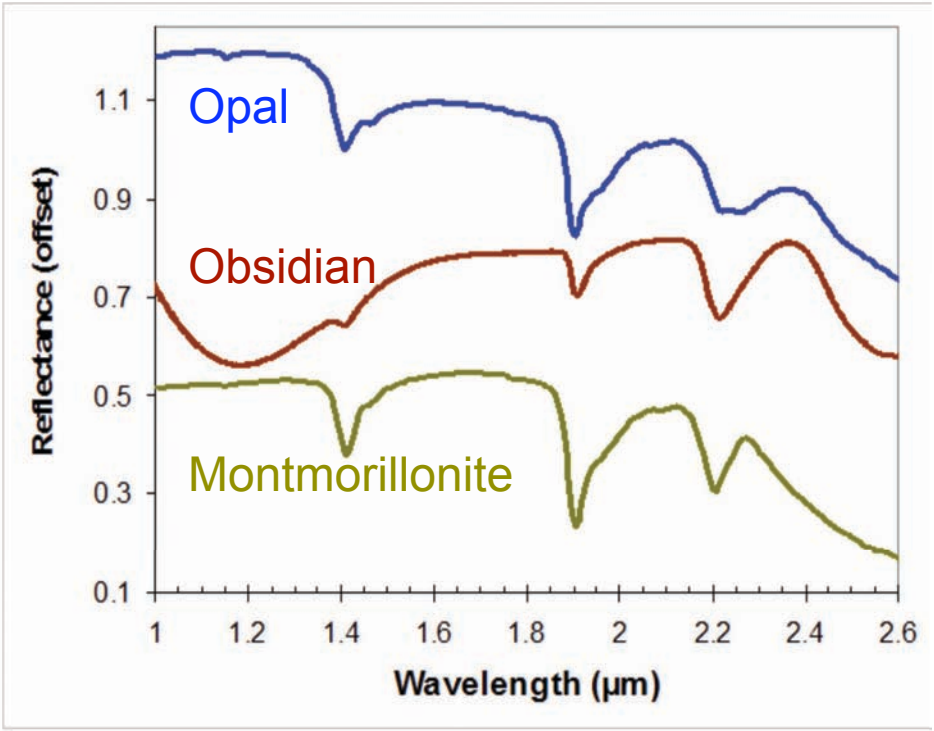


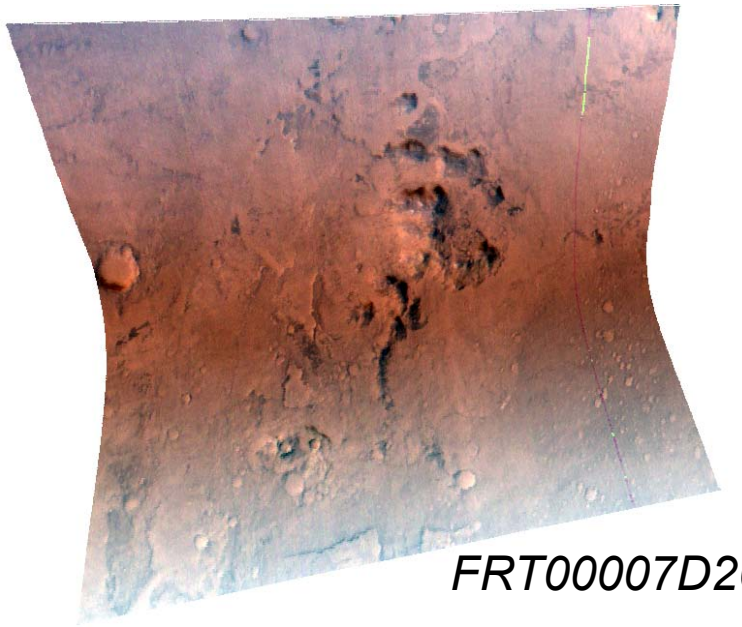




Eastern ellipse outcrop spectra







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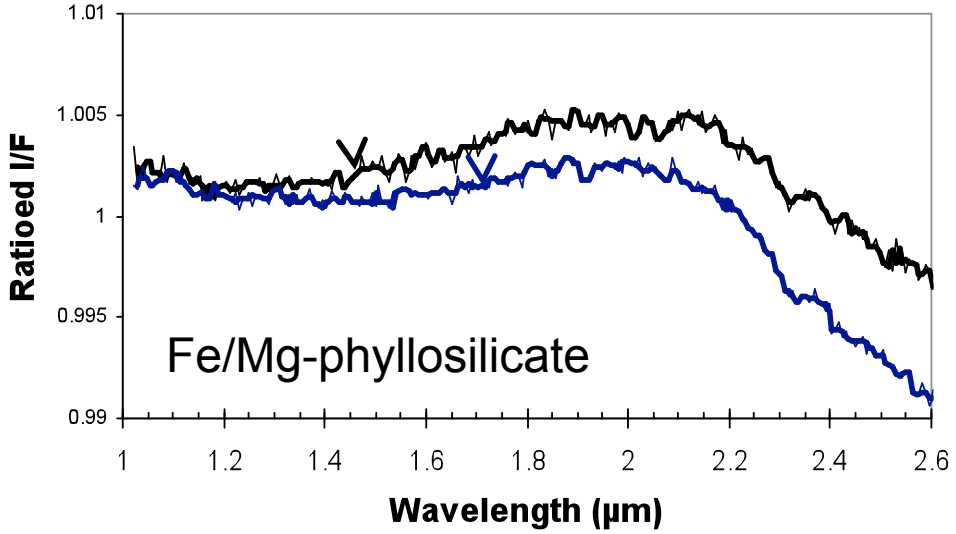

Summary

- **Holden's mineralogy is diverse!**

Fan source area:	Ellipse:	Layered deposits:	Megabreccia:
Low-Ca pyroxene	*Fe/Mg-clay*	*Fe/Mg-clays*	*Fe/Mg-clay*
High-Ca pyroxene	*Hydrated silica*	*Hydrated phase*	*Much more!*
Mg-rich olivine		*2.5 μm phase?*	
Fe-rich olivine			
Fe/Mg-clay			
Hydrated salt/zeolite			

- Alluvial/lacustrine deposits remain the primary science target for MSL
  - →*But* MAX-C cannot go to Holden (26°S)
  - →Mineralogic/astrobiologic characterization of Early Noachian materials (altered and unaltered) by MSL would feed forward to MSR