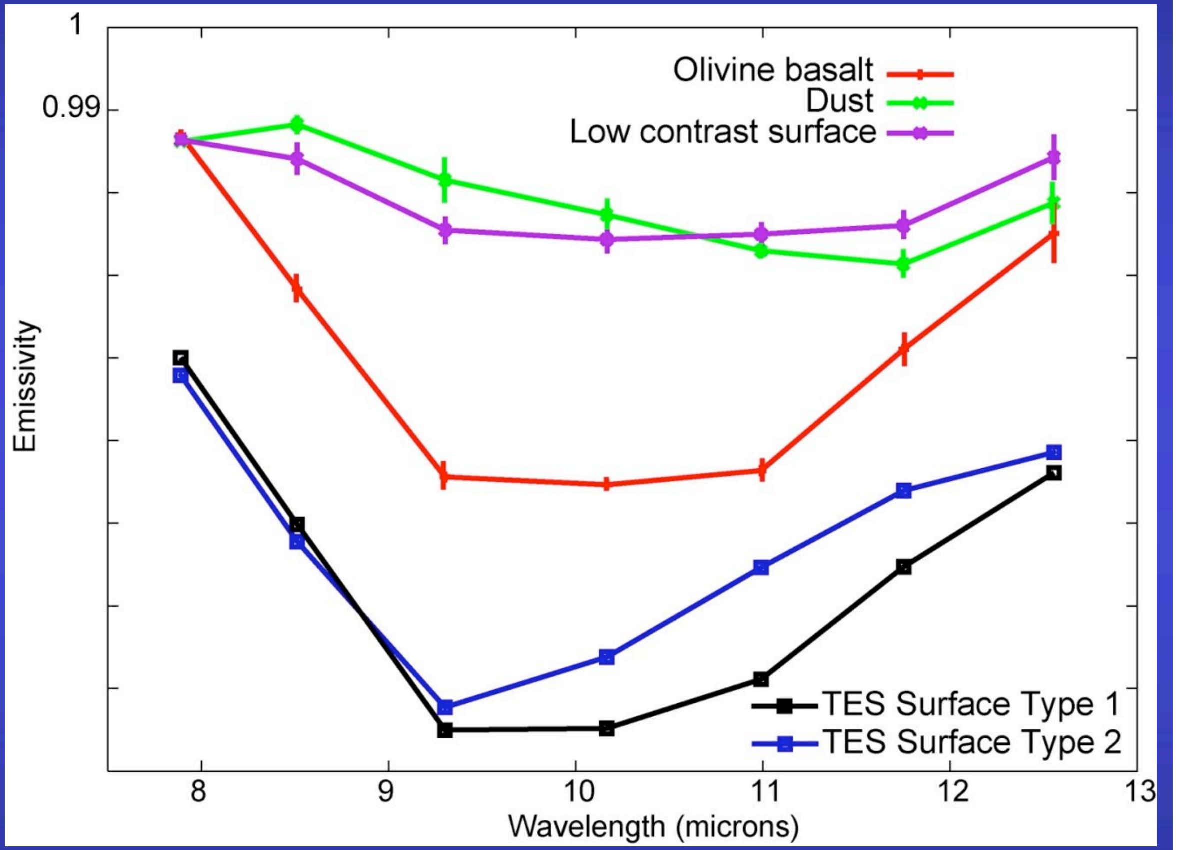
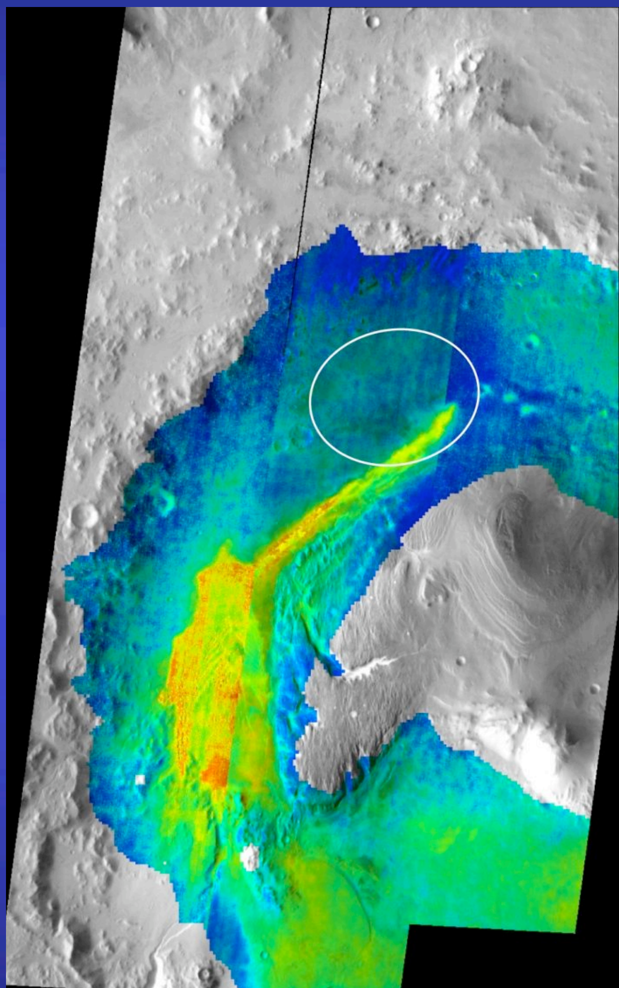
Gale Crater THEMIS spectral endmembers

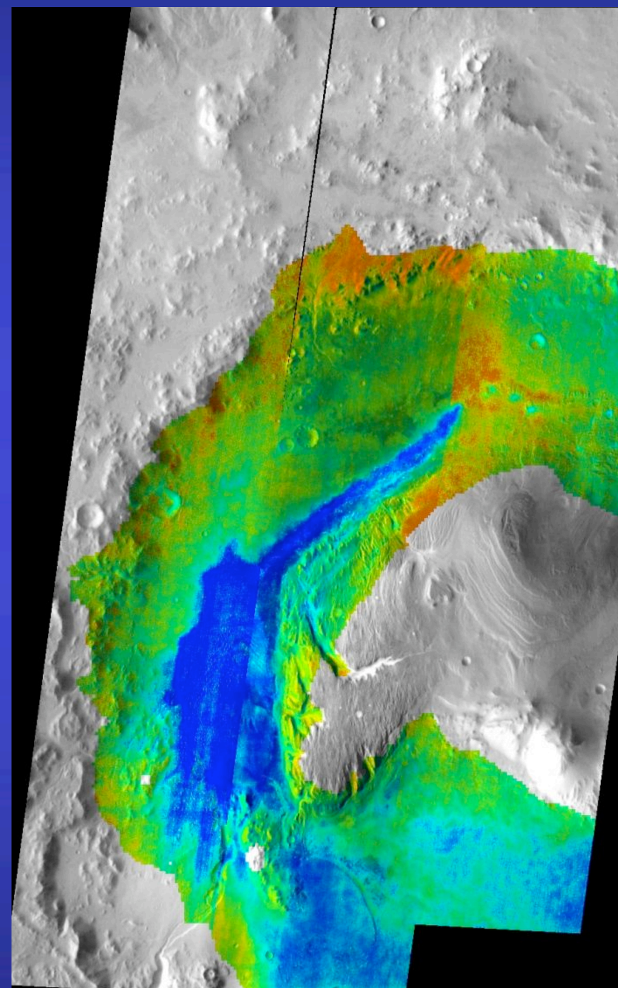
- Olivine basalt surface is similar to TES Surface Type 1 but with stronger absorption at 11 microns
  - Consistent with slightly increased olivine relative to Surface Type 1
- Dust and blackbody distributions represent varying contributions from dust or to varying particle size/surface texture



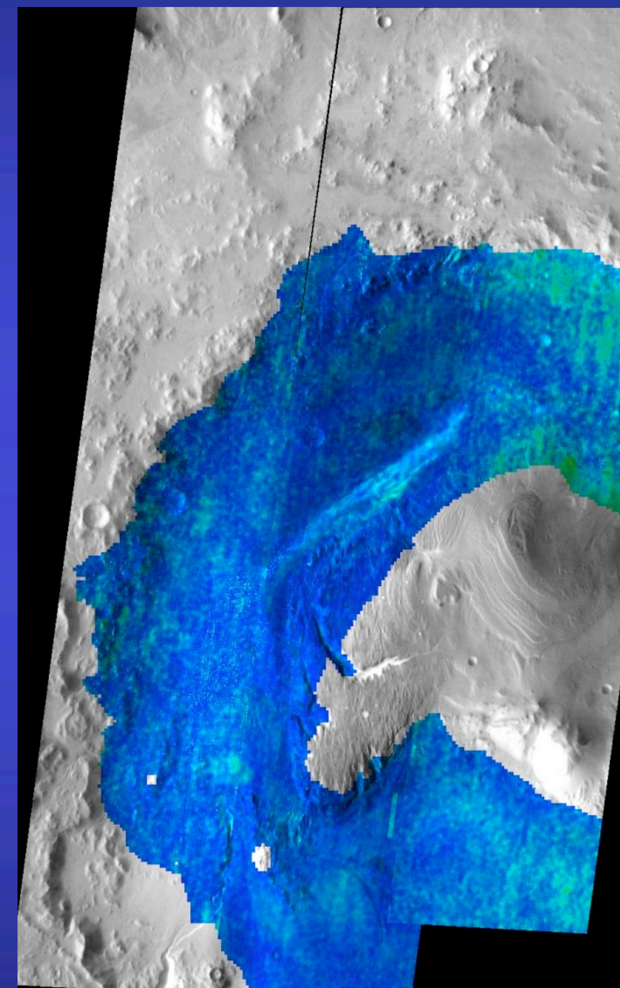
THEMIS spectral unit mosaics



Olivine basalt (0-1.5)



Dust/blackbody (0-1.2)



RMS Error (0-0.01)

Data above -2800 m excluded

Gale crater

TES analysis of THEMIS spectral units

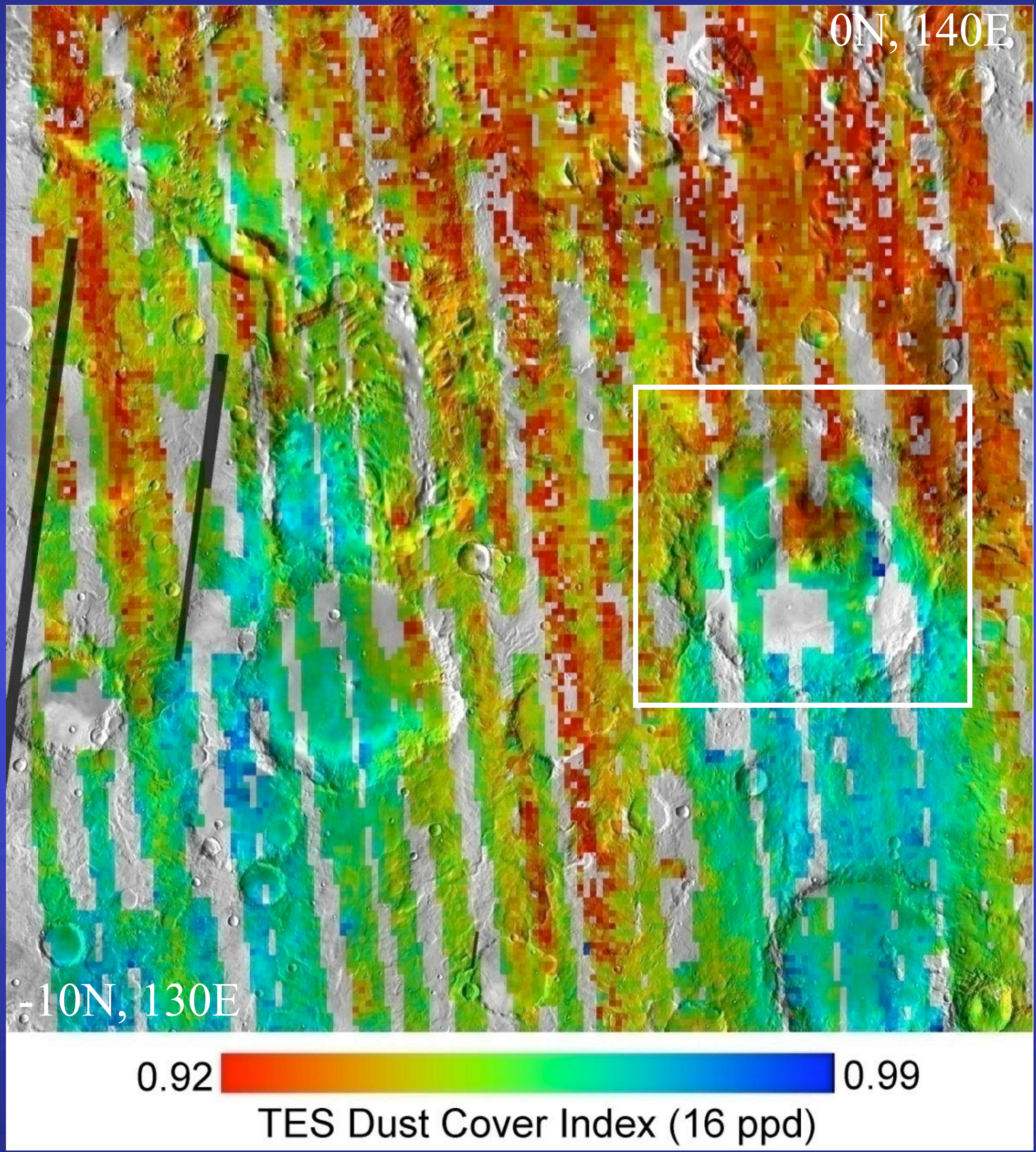
- Surfaces have significant plagioclase, pyroxene, high-silica phases, and olivine(~15-30%)

- Low albedo surfaces may be slightly altered

Gale crater

TES dust cover index

- Values in proposed ellipse range from 0.93 to 0.95, indicating relatively high dust cover compared to classic low-albedo regions (*Ruff and Christensen*, 2002)



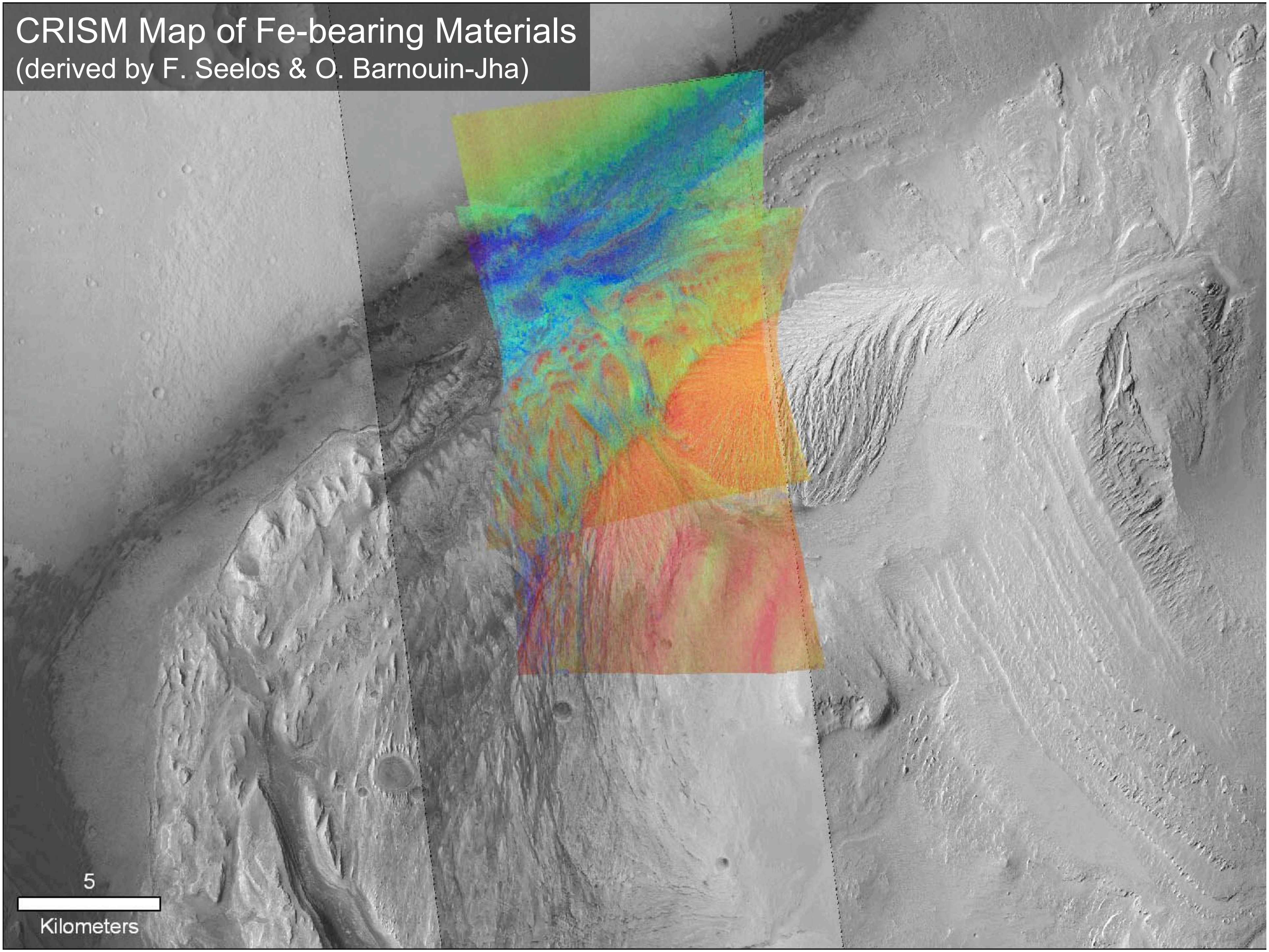
Gale crater

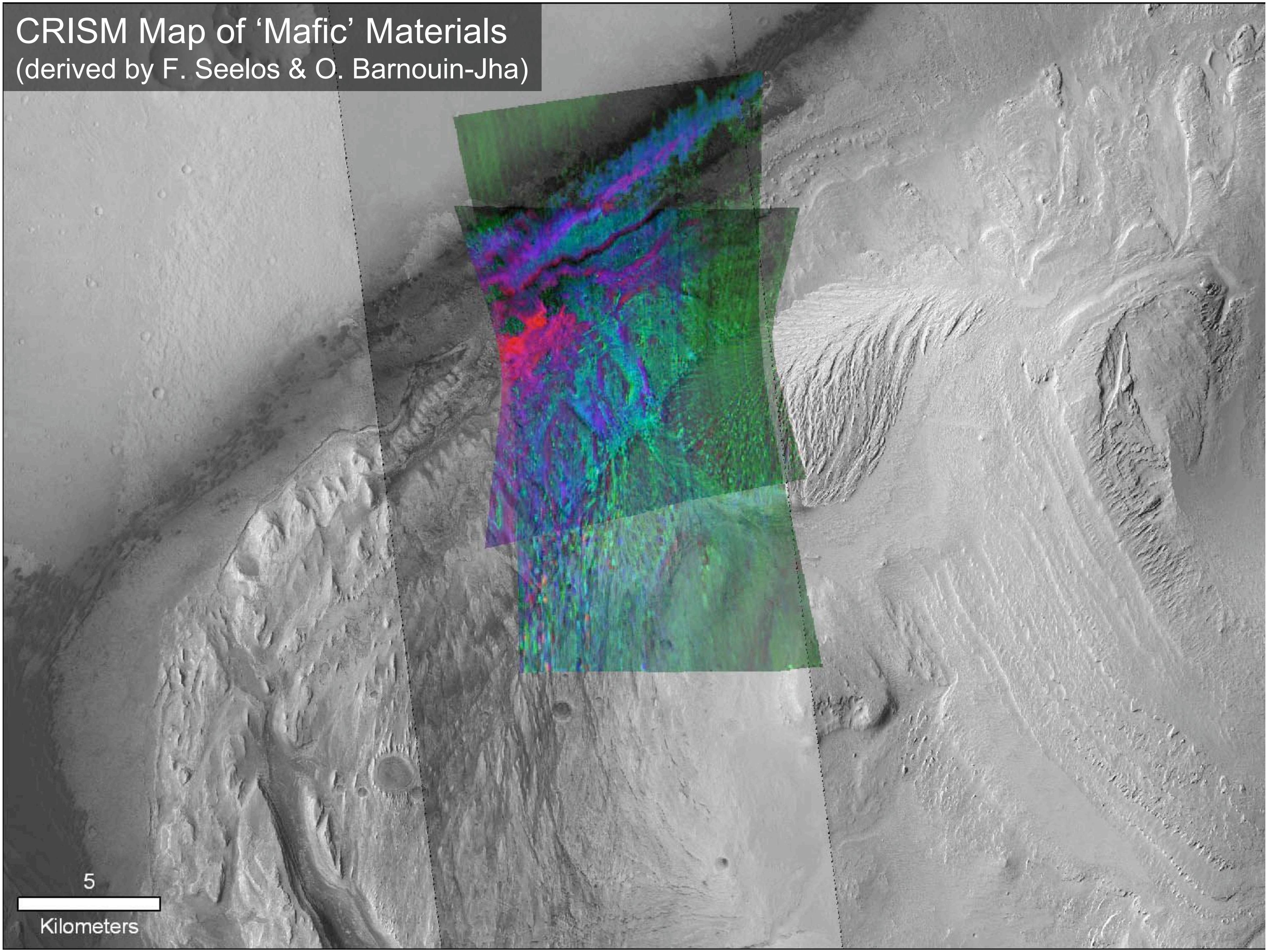
Summary

- Spectral unit with a composition similar to olivine basalt corresponds with low albedo dune forms in the crater

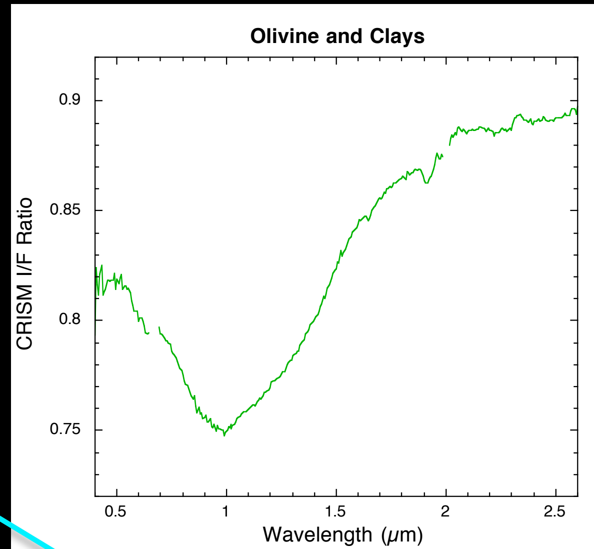
- TES/THEMIS data indicate significant dust cover relative to classic low albedo regions and other MSL sites
  - Landing ellipse and western portion of the mound shows moderate dust cover
  - Top of mound has high dust cover

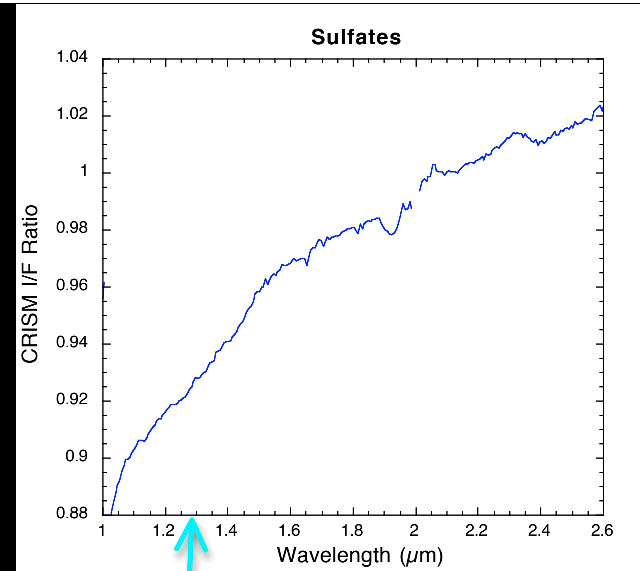
- Phyllosilicates/sulfates observed by CRISM are not detected with TES deconvolution, indices, or ratios
  - May be due to low abundance, texture/particle size effects, or small outcrop size relative to TES field of view

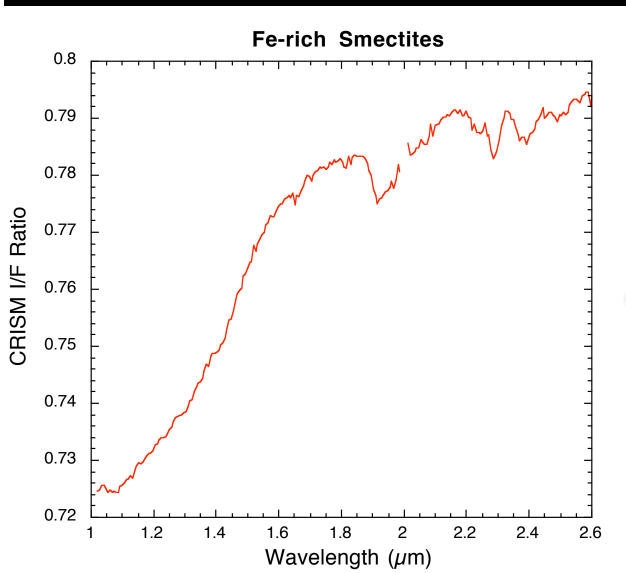

CRISM Map of Fe-bearing Materials
(derived by F. Seelos & O. Barnouin-Jha)
5
Kilometers

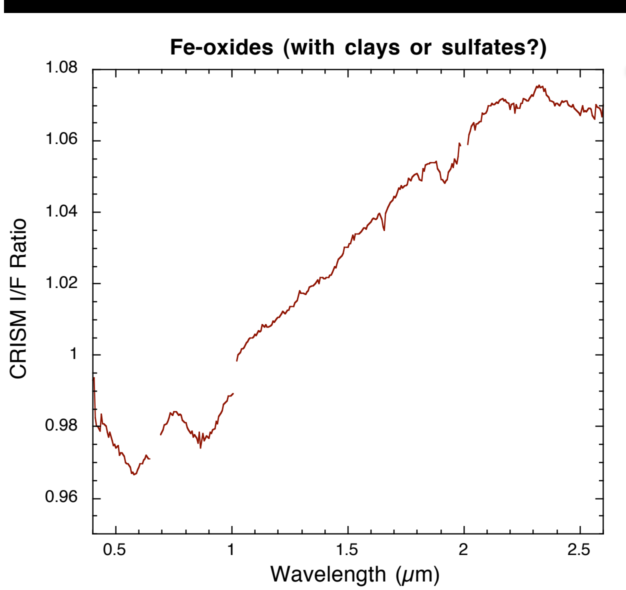

CRISM Map of ‘Mafic’ Materials
(derived by F. Seelos & O. Barnouin-Jha)
5
Kilometers

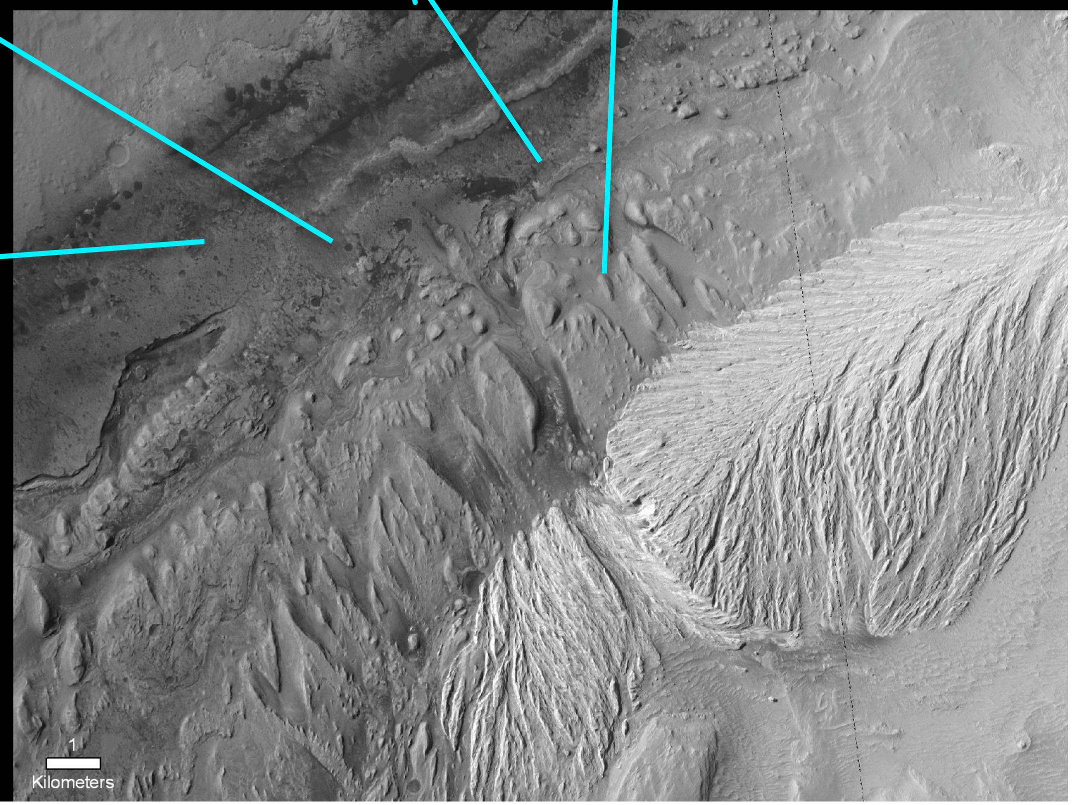
Mineral assemblages vary through the stratigraphic section and thus through time.

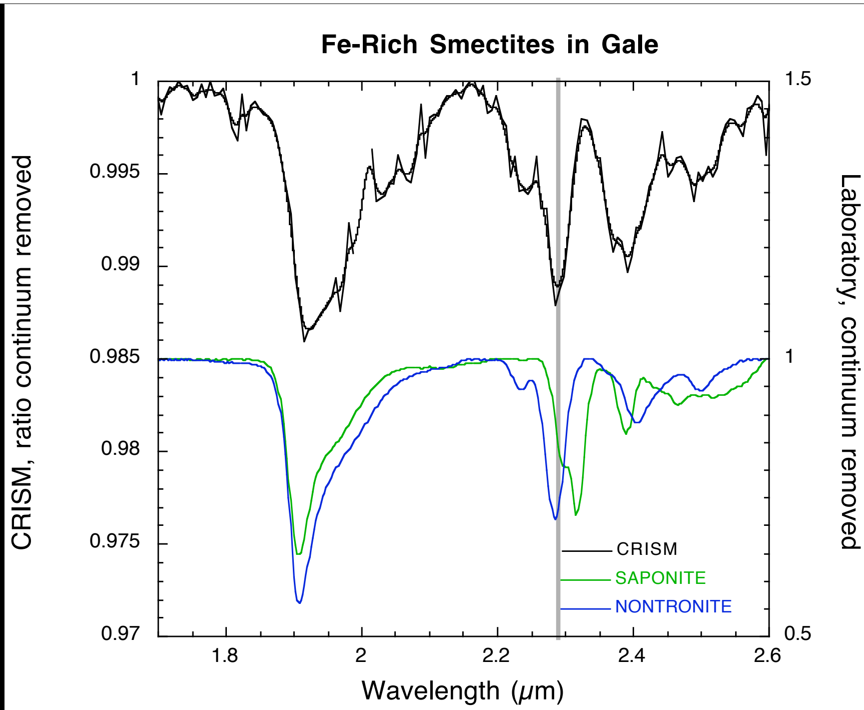


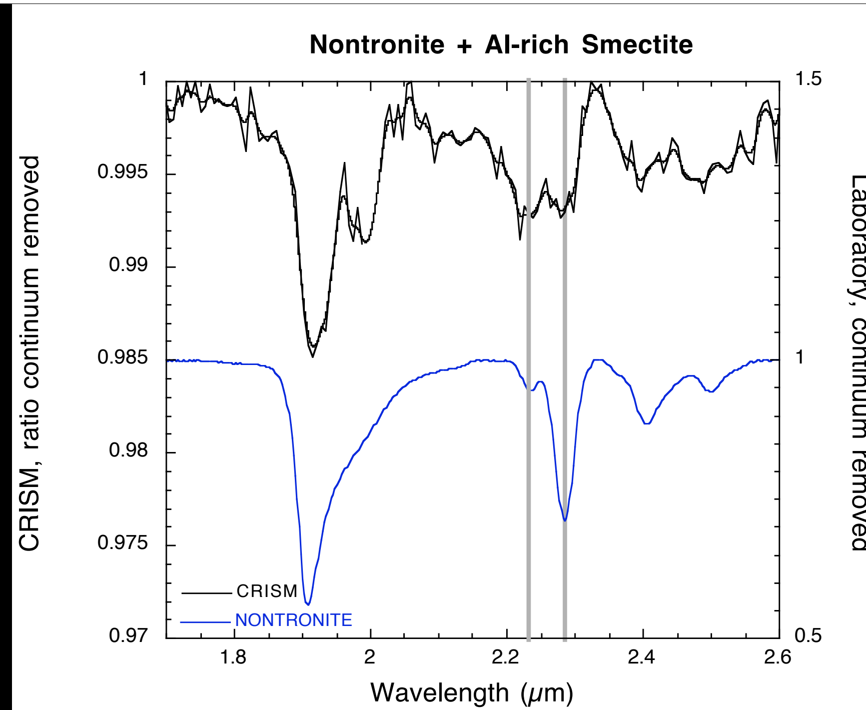


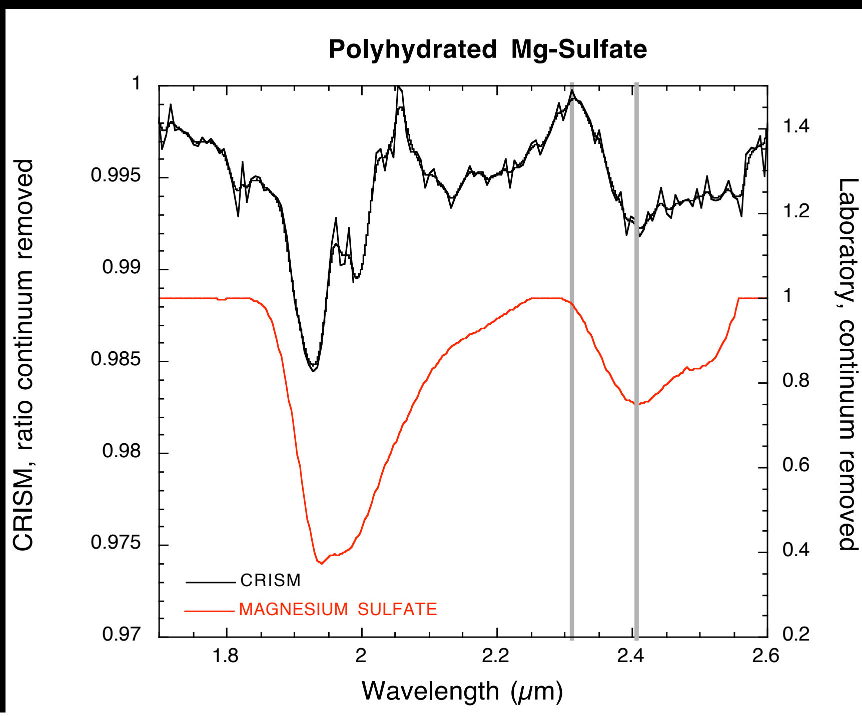






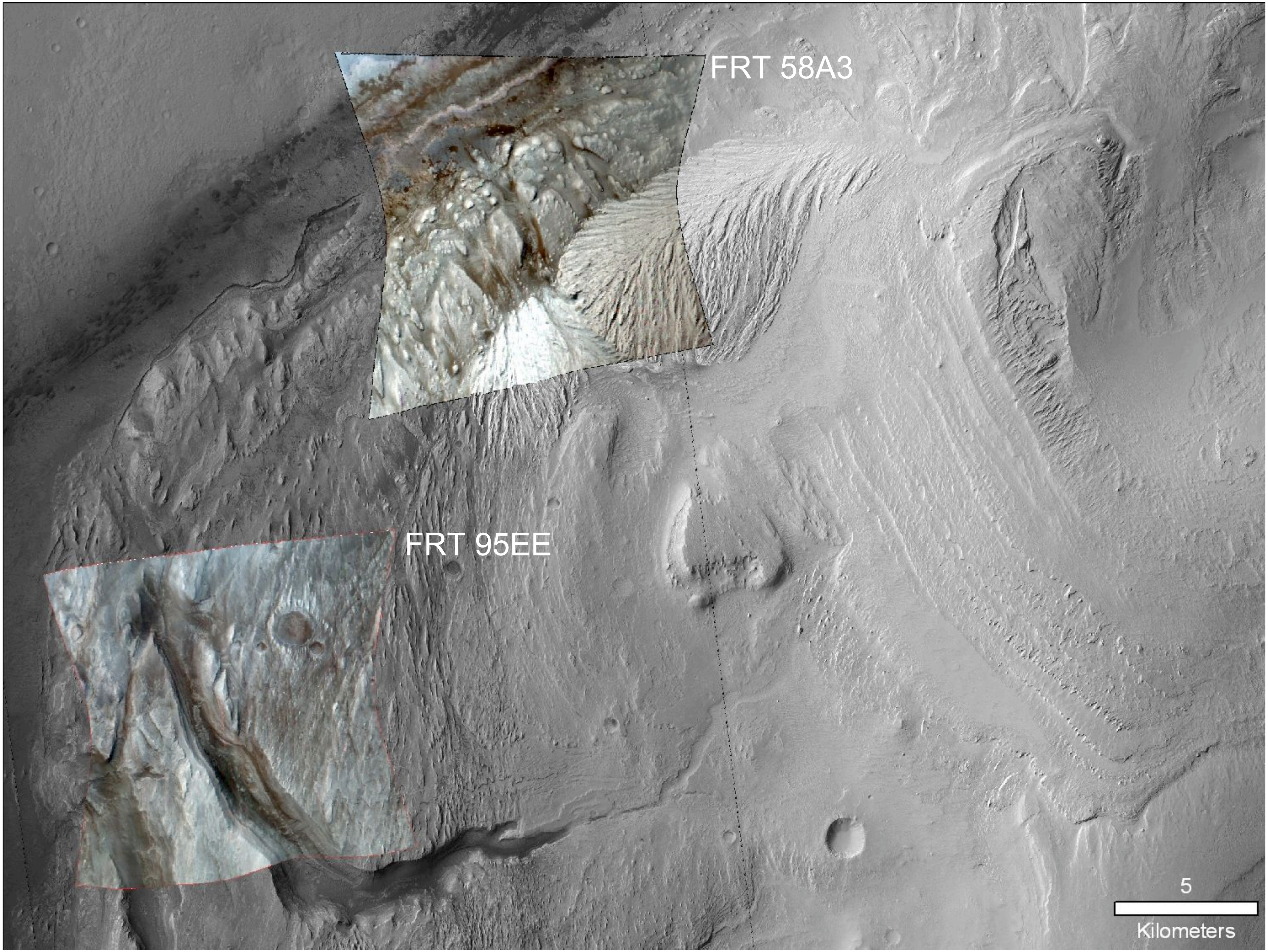


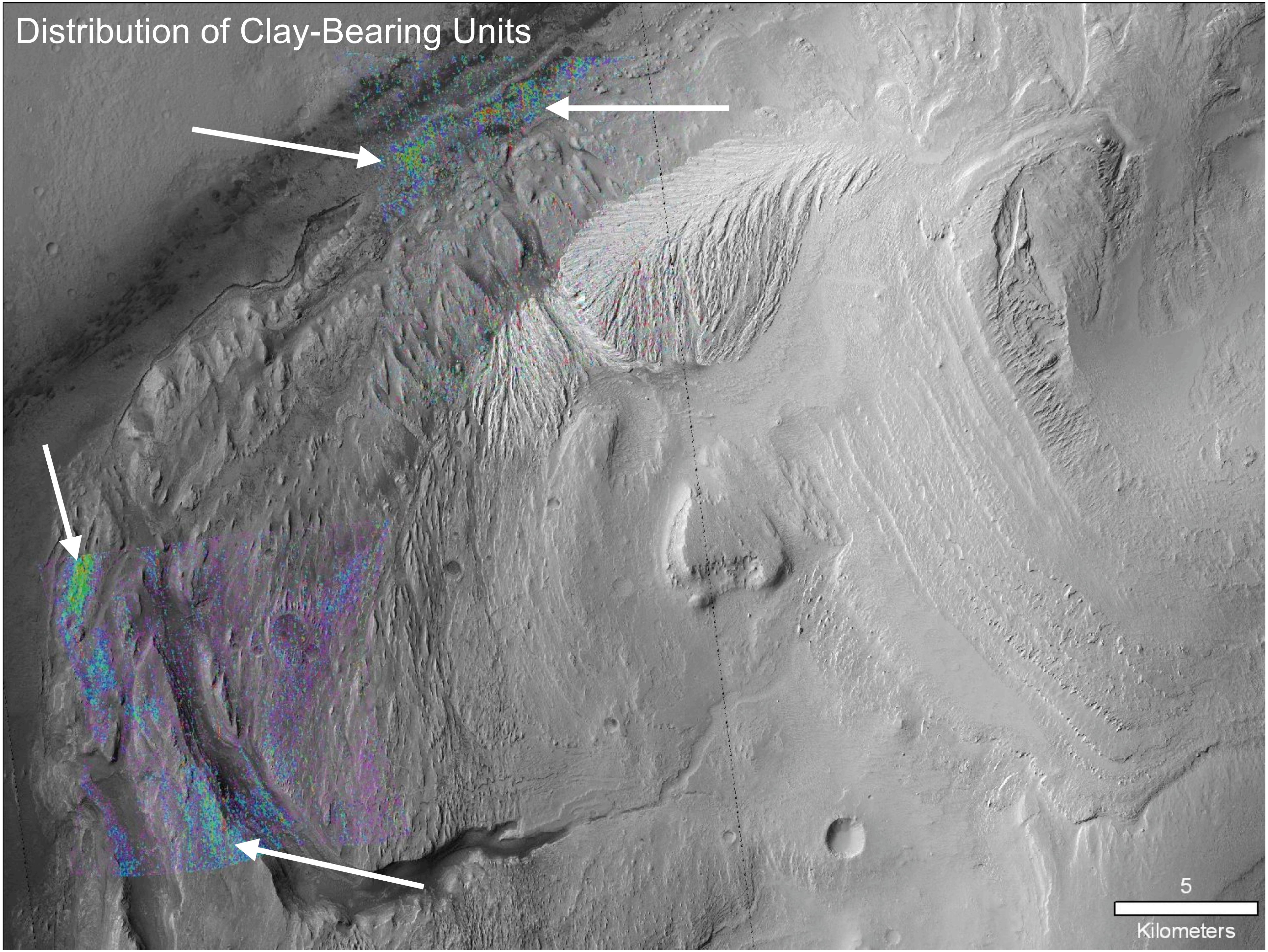


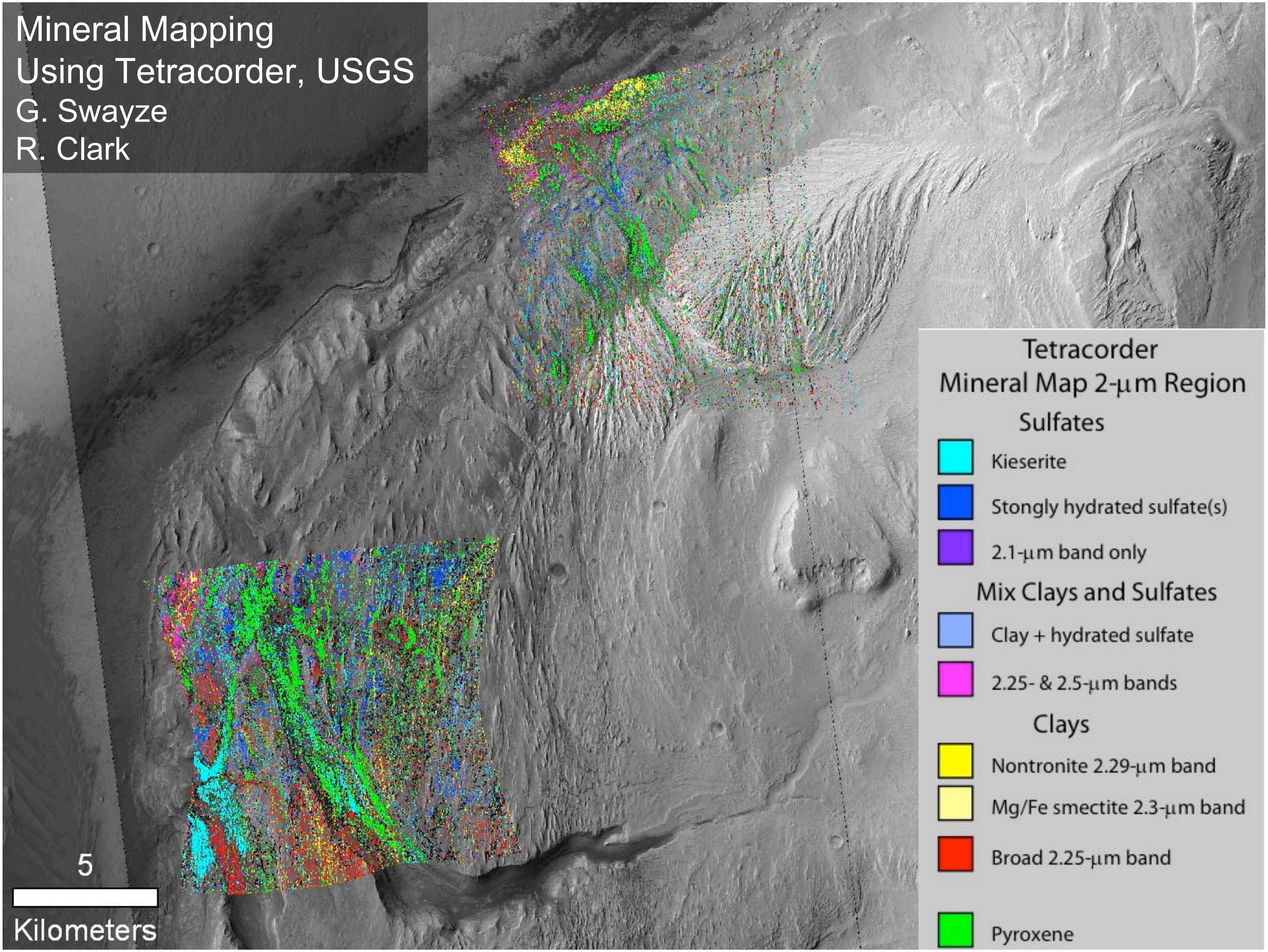


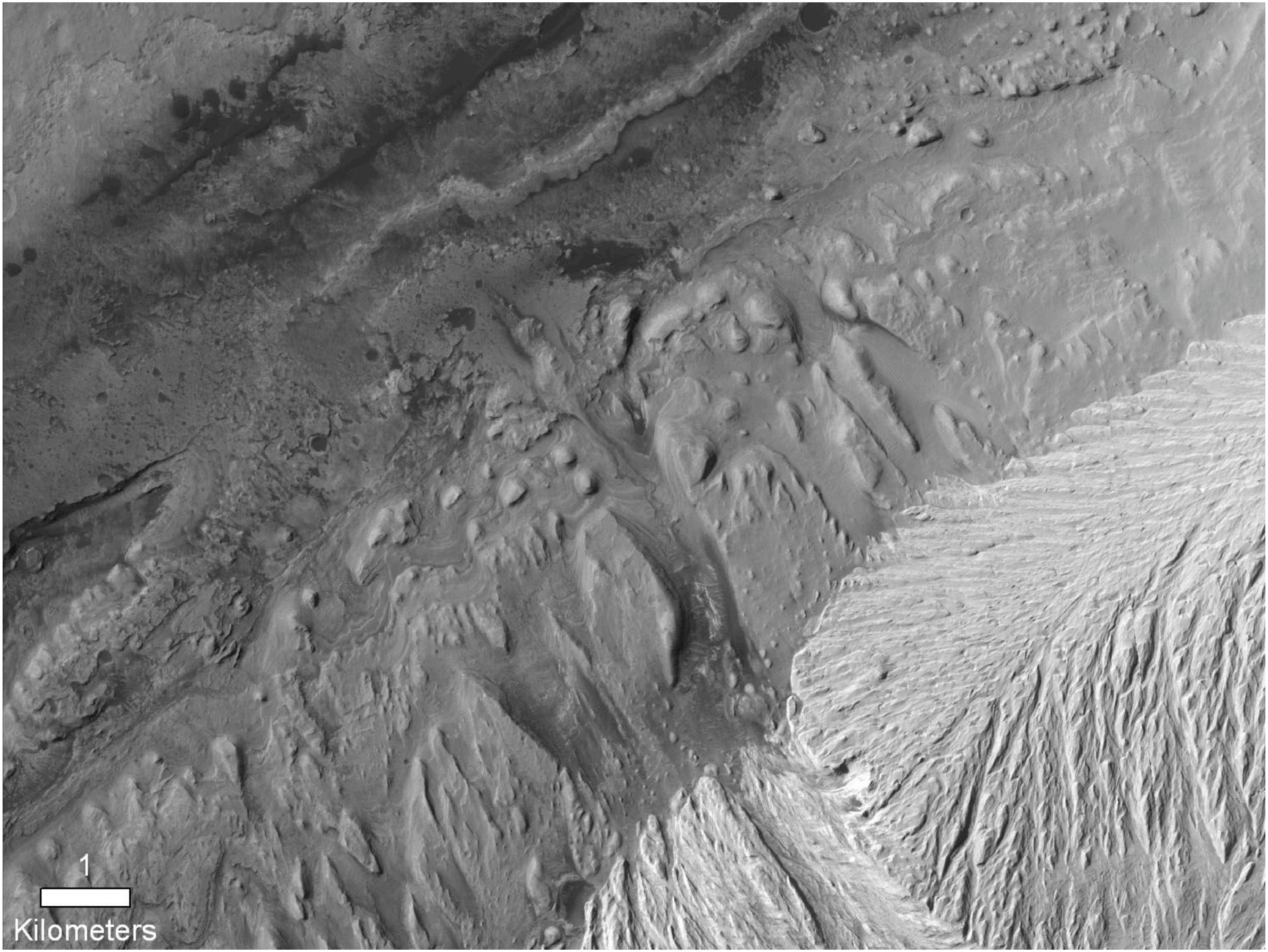
Removing the continuum slope from the spectra and comparing to laboratory spectra shows:

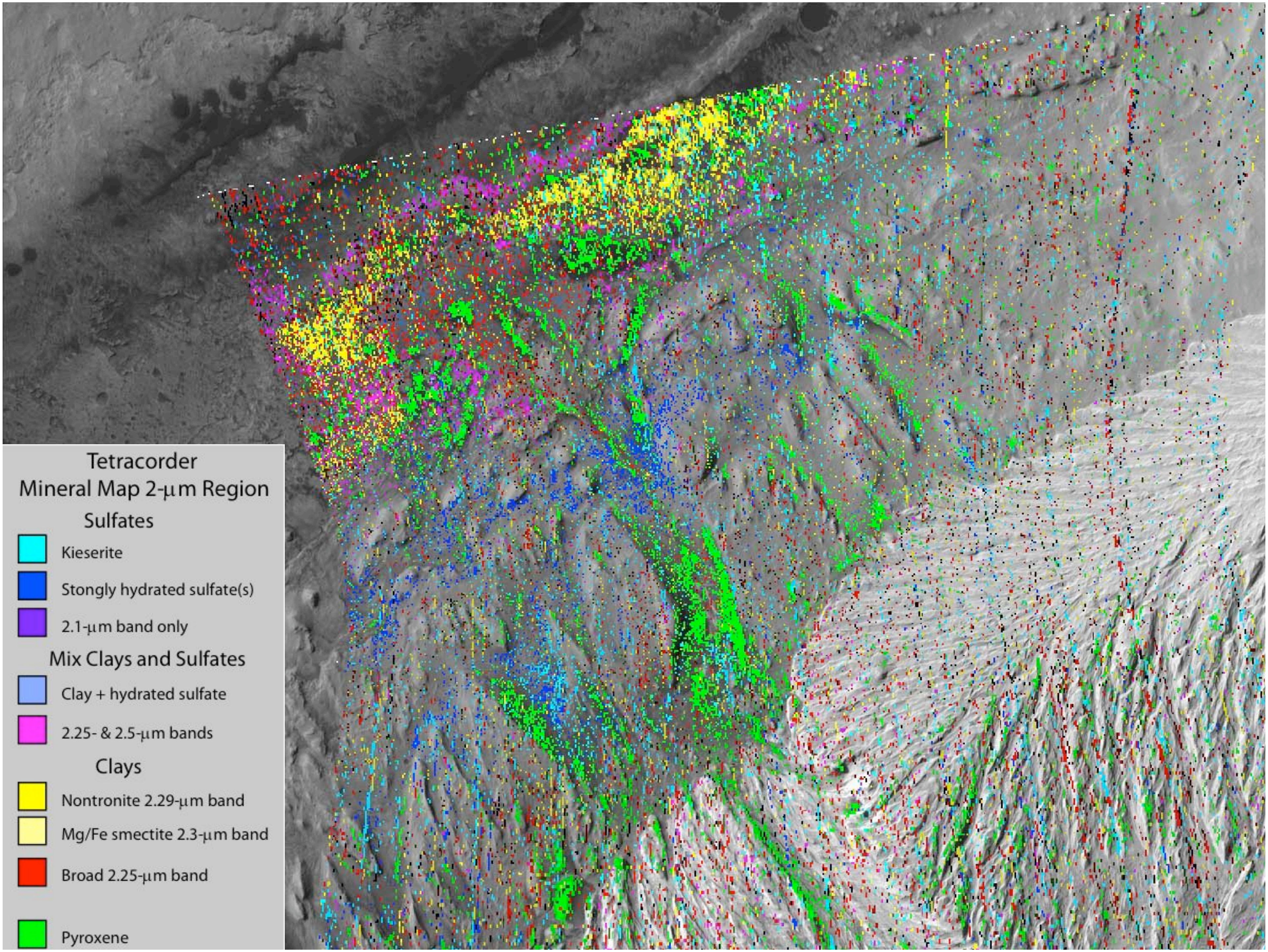
- Fe-rich smectites
- Fe/Mg smectites
- Al in octahedral sites of smectites
- Potential mixtures of Al and Fe smectites
- Mono and polyhydrated sulfates, most likely Mg
- Mixtures of smectites and sulfates
- Fe oxides
- Olivine


FRT 58A3
FRT 95EE
5
Kilometers

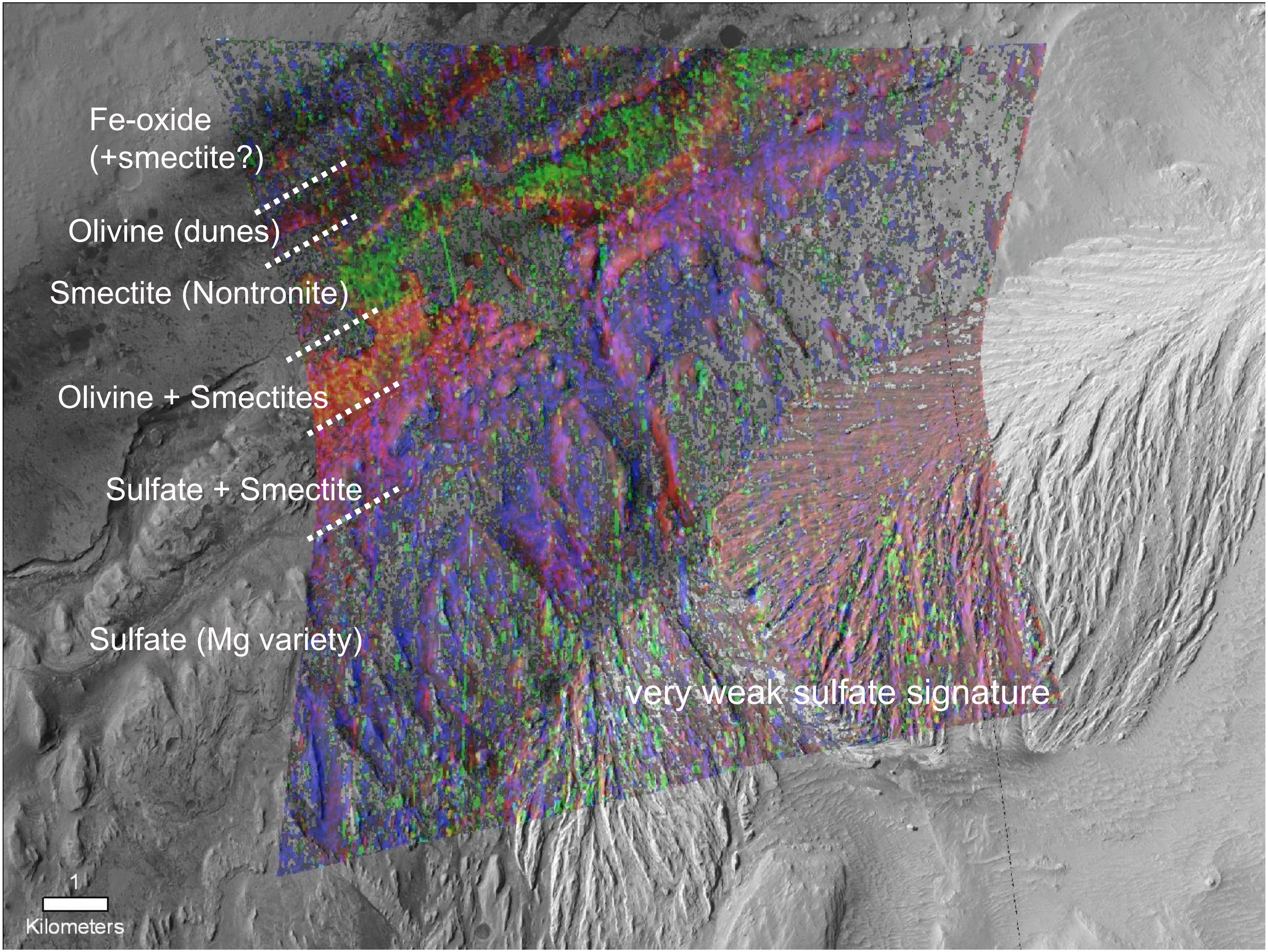

Distribution of Clay-Bearing Units
5
Kilometers

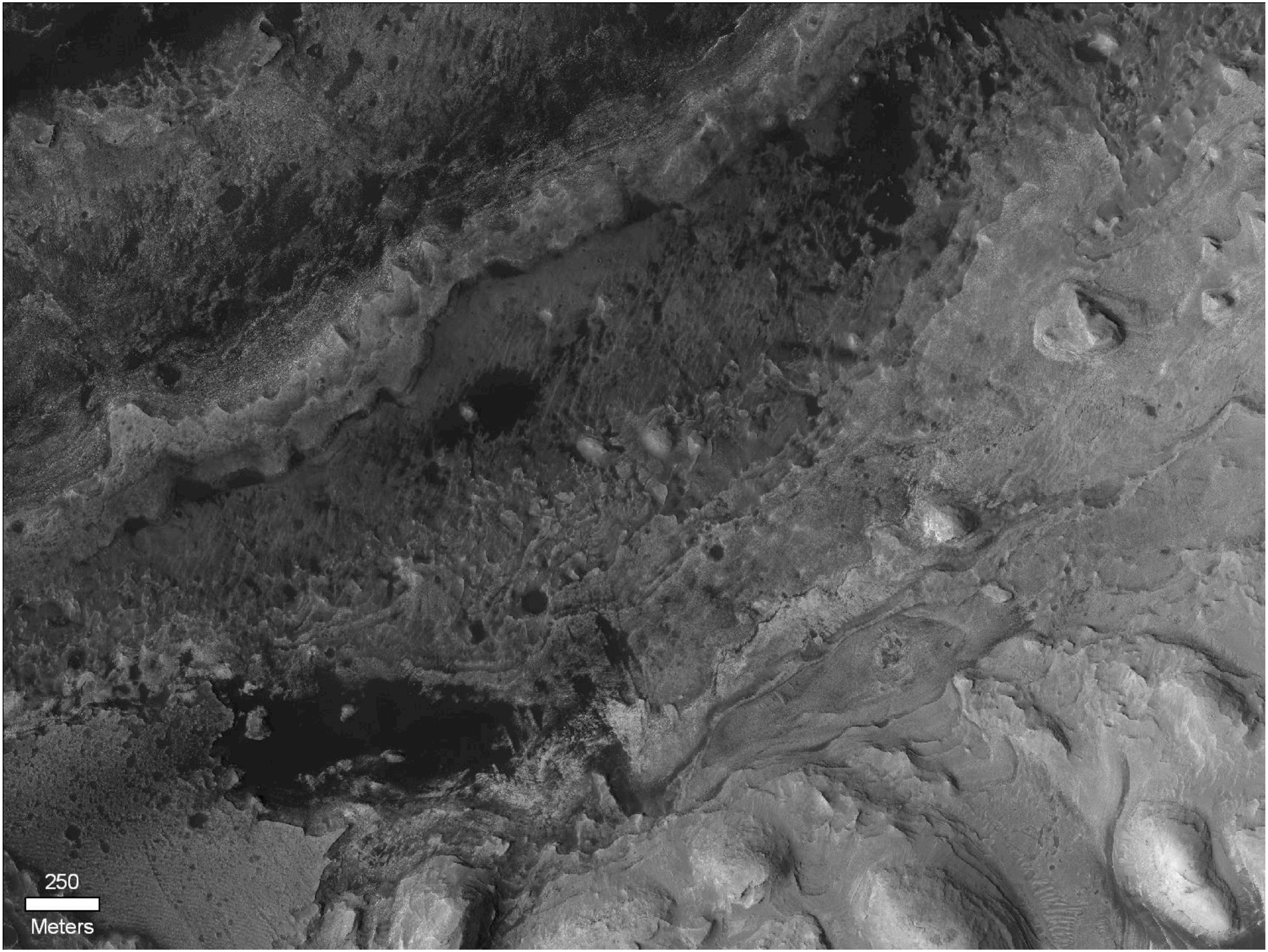

Mineral Mapping
Using Tetracorder, USGS
G. Swayze
R. Clark
Tetracorder
Mineral Map 2-µm Region
Sulfates
Kieserite
Stongly hydrated sulfate(s)
2.1-µm band only
Mix Clays and Sulfates
Clay + hydrated sulfate
2.25- & 2.5-µm bands
Clays
Nontronite 2.29-µm band
Mg/Fe smectite 2.3-µm band
Broad 2.25-µm band
Pyroxene
5
Kilometers

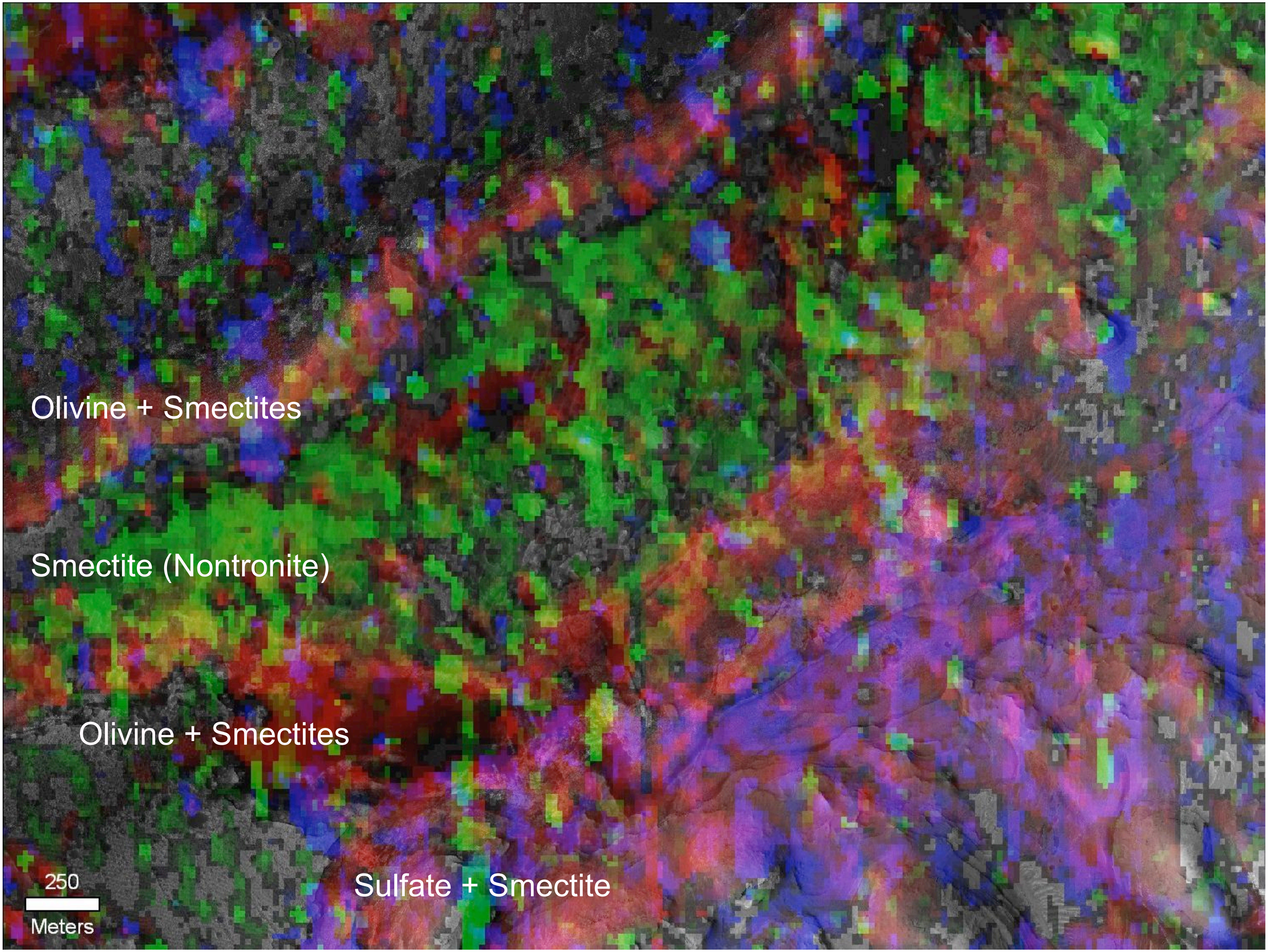

1
Kilometers


Tetracorder
Mineral Map 2-µm Region
Sulfates
Kieserite
Stongly hydrated sulfate(s)
2.1-µm band only
Mix Clays and Sulfates
Clay + hydrated sulfate
2.25- & 2.5-µm bands
Clays
Nontronite 2.29-µm band
Mg/Fe smectite 2.3-µm band
Broad 2.25-µm band
Pyroxene


1
Kilometers

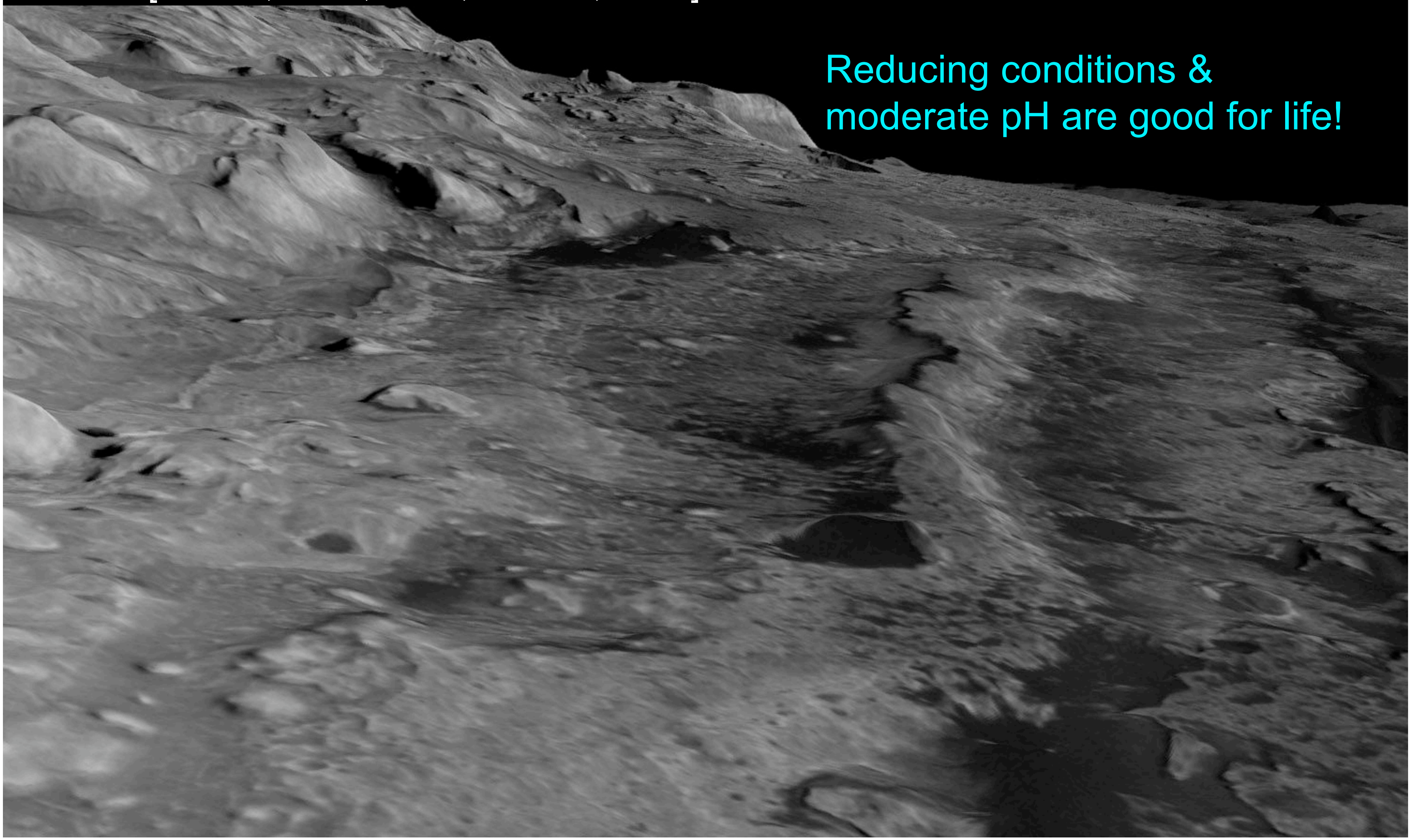

Fe-oxide
(+smectite?)
Olivine (dunes)
Smectite (Nontronite)
Olivine + Smectites
Sulfate + Smectite
Sulfate (Mg variety)
very weak sulfate signature
1
Kilometers


250
Meters


Olivine + Smectites
Smectite (Nontronite)
Olivine + Smectites
Sulfate + Smectite
250
Meters

The clay-rich (nontronite) unit is topographically and stratigraphically lower than the olivine & clay unit.

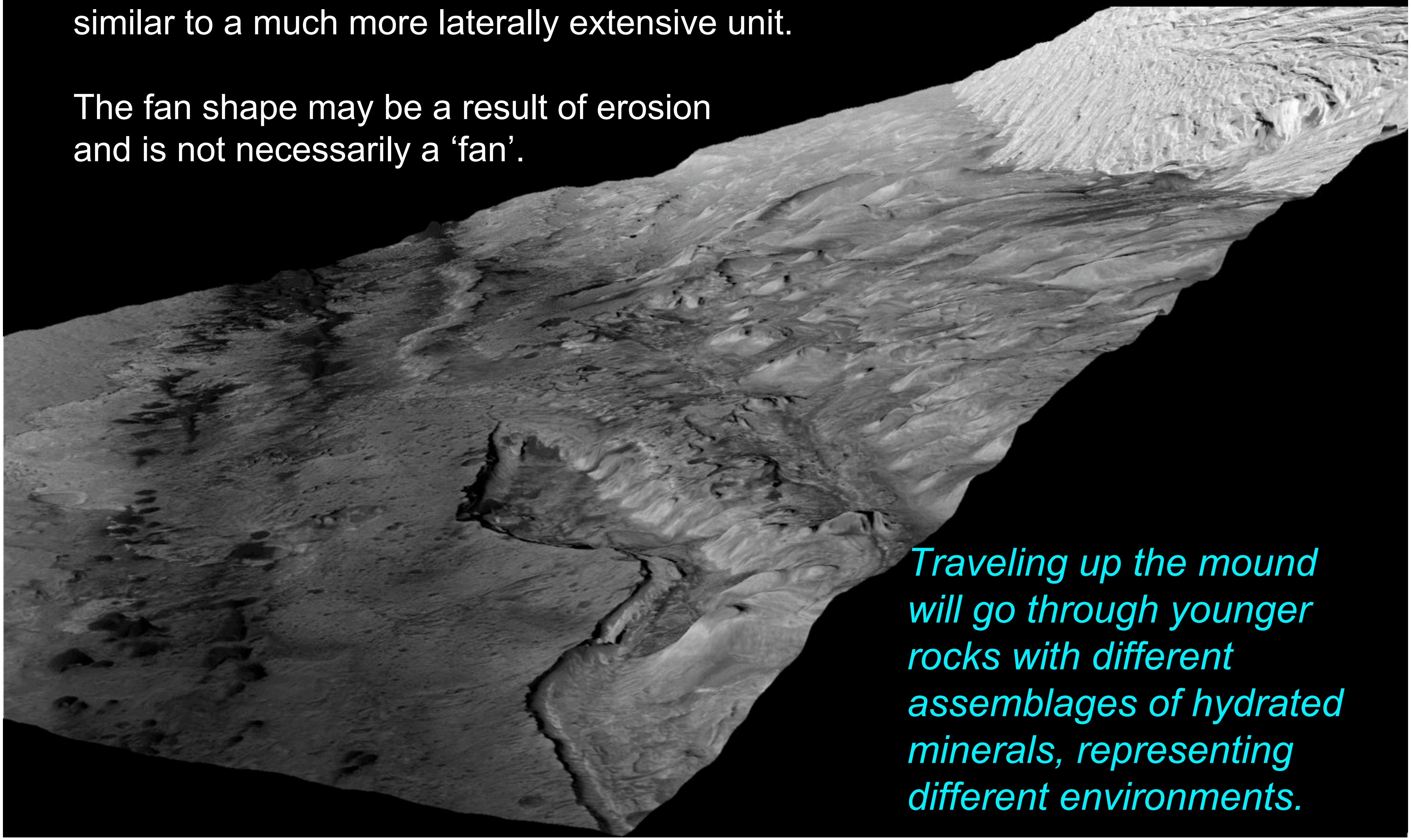
If formed under surface conditions, Fe-smectites require initially **reducing conditions** to form [Harder, 1972; 1978; Farmer, 1994].



The olivine & clay unit, and possibly some of the sulfate units, dip away from the mound to the north rim of the crater.

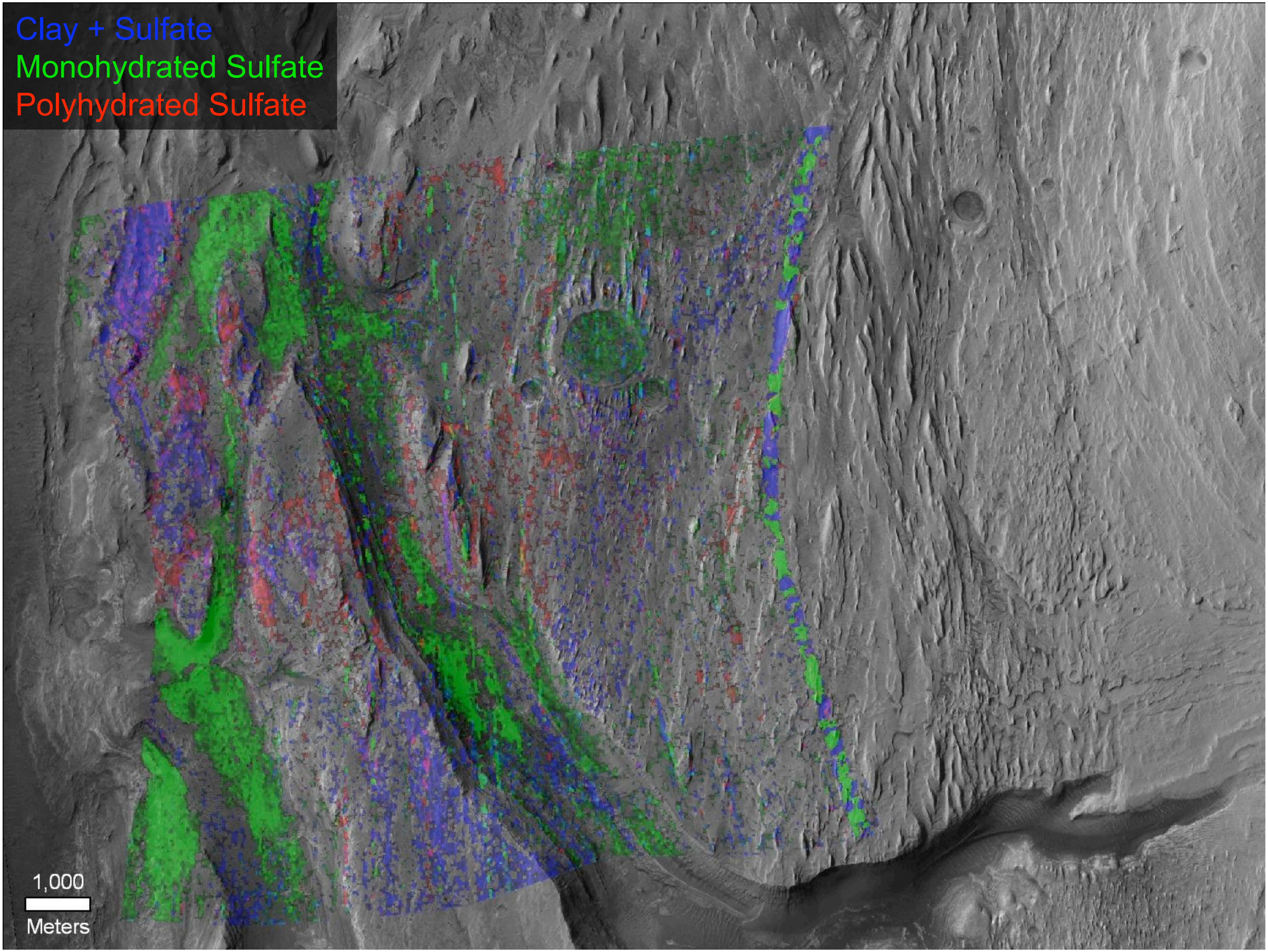
The ‘fan’-shaped deposit at the end of the channel is morphologically similar to a much more laterally extensive unit.

The fan shape may be a result of erosion and is not necessarily a ‘fan’.



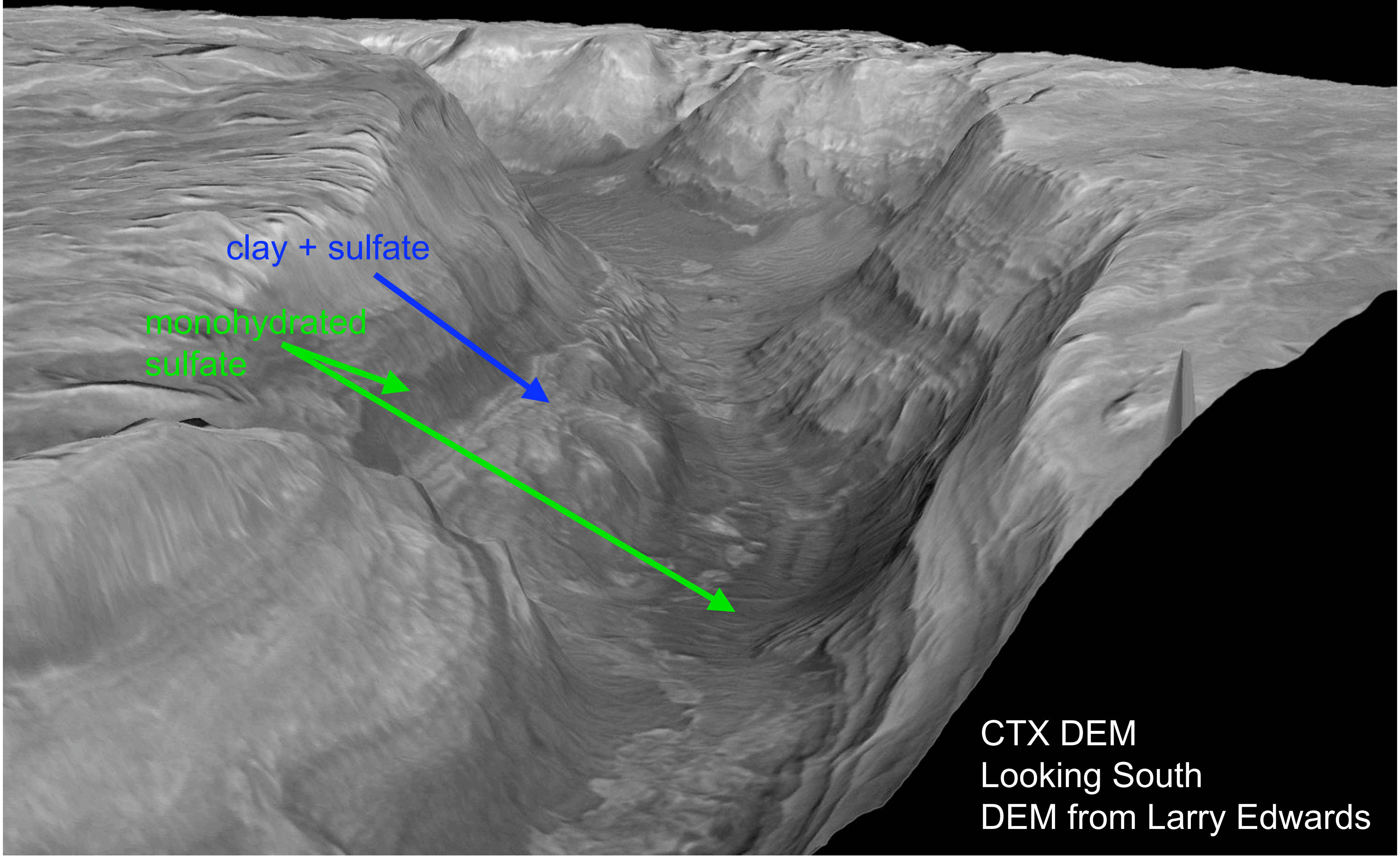
Traveling up the mound will go through younger rocks with different assemblages of hydrated minerals, representing different environments.

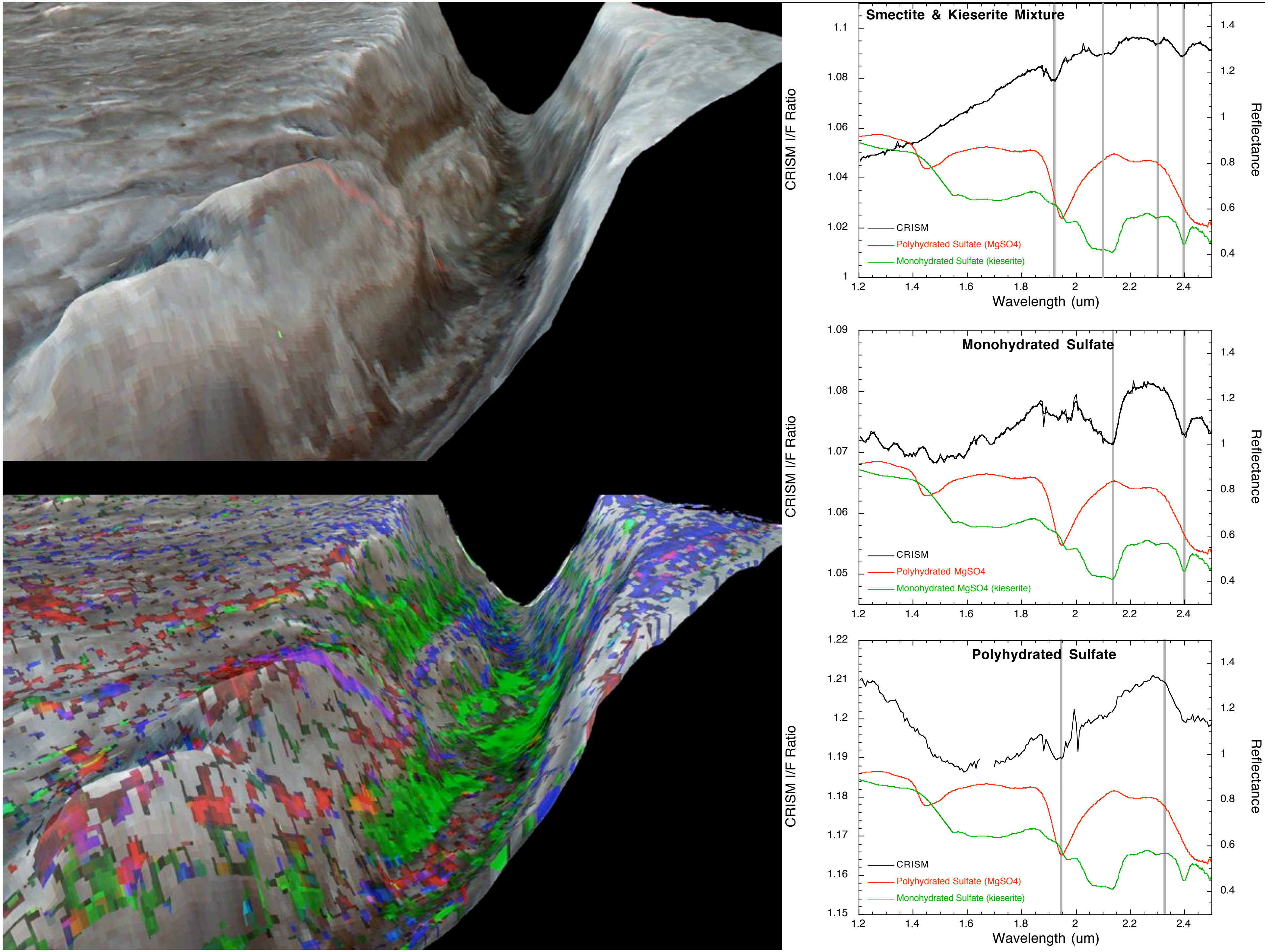

Strata exposed in the canyon exhibit sulfate and clay signatures.
Sulfate signatures are strong in erosional debris.
Some beds are mixtures of clays and sulfates.
1,000
Meters


Clay + Sulfate
Monohydrated Sulfate
Polyhydrated Sulfate
1,000
Meters

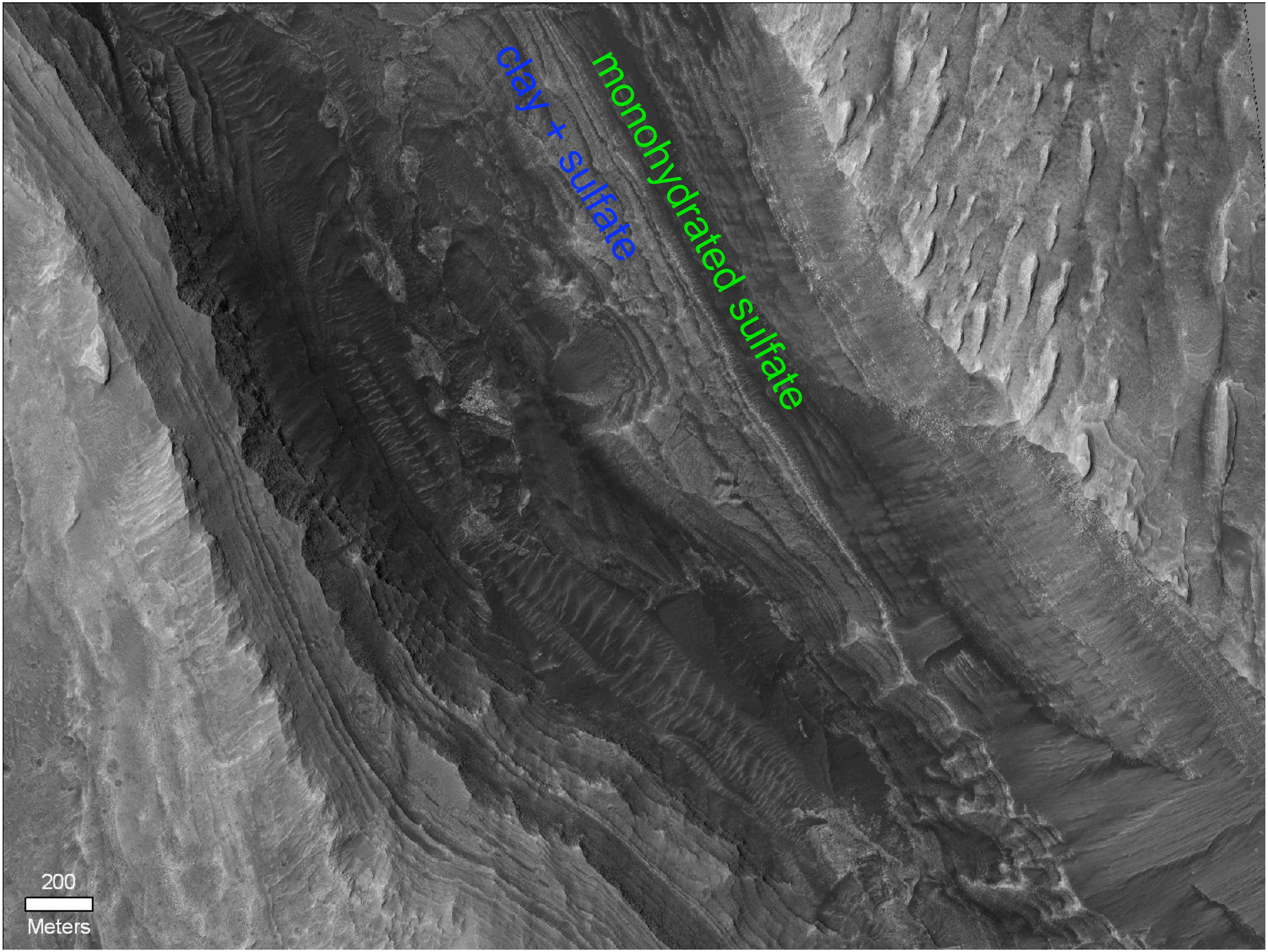
Sulfate signatures are strong in the dark erosional debris, similar to what is observed in Candor Chasma [Murchie et al., 2008; Milliken et al., 2007].

Light-toned strata closer to the bottom are mixtures of clay and sulfate.

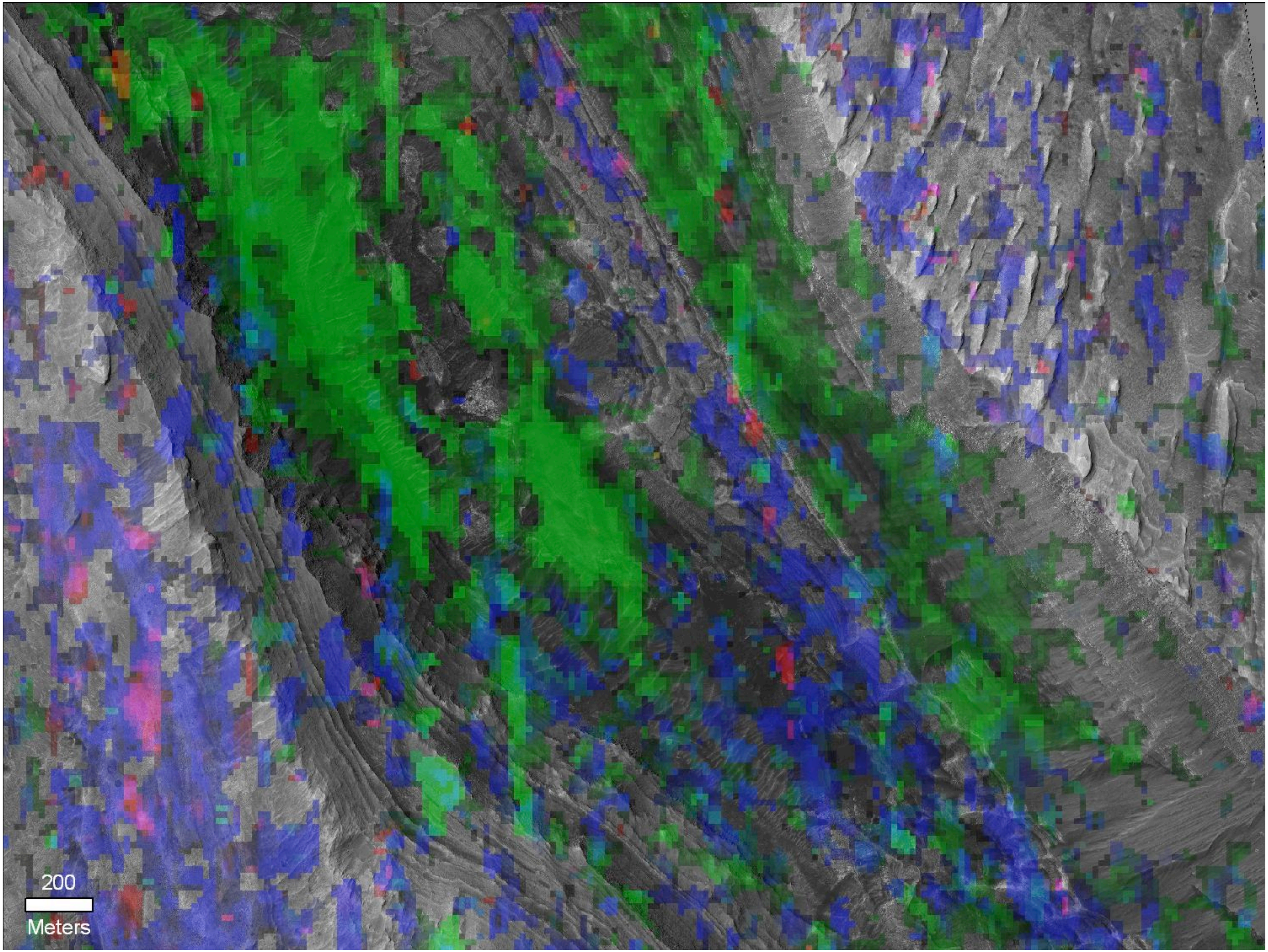




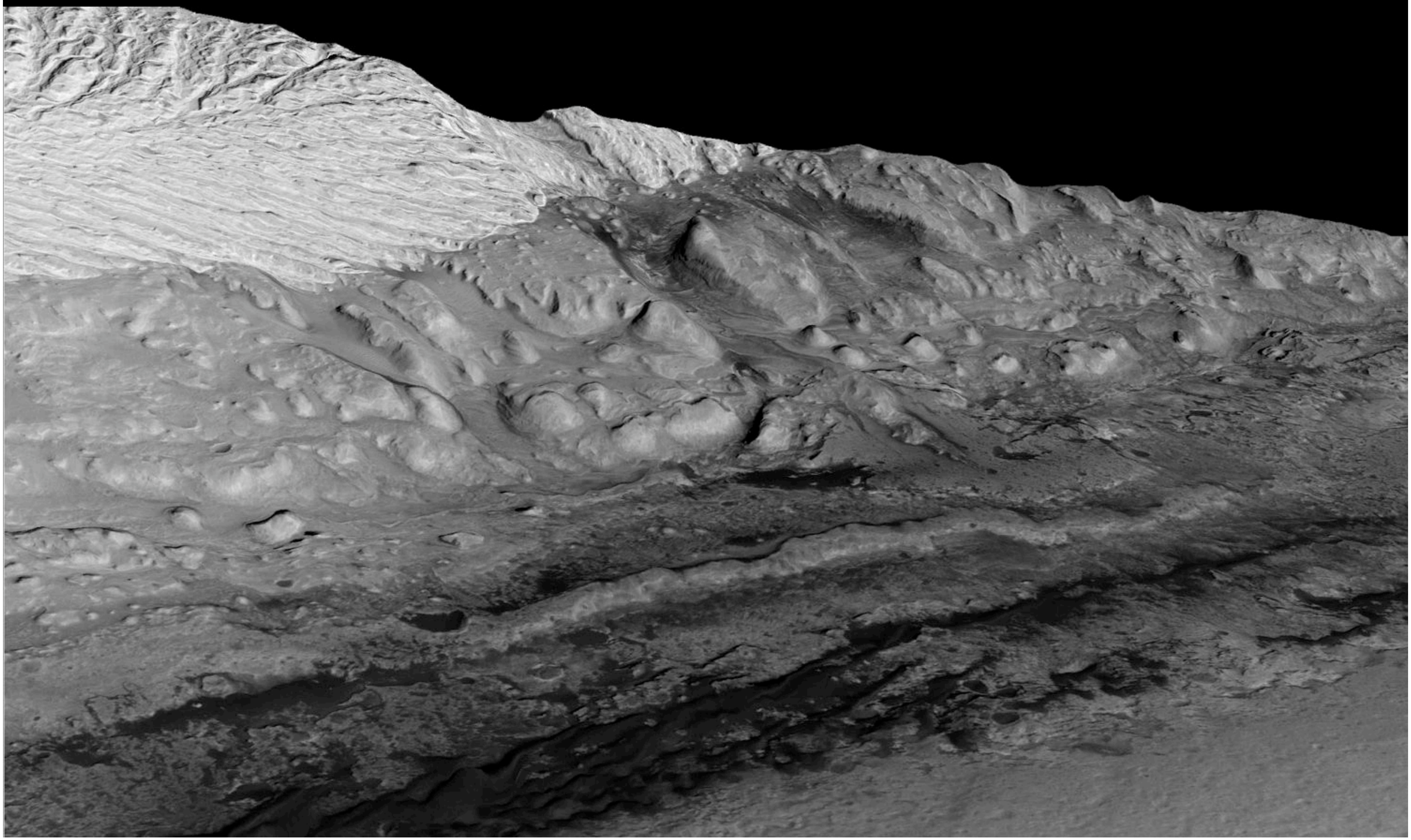
Smectite & Kieserite Mixture
CRISM I/F Ratio
Reflectance
Wavelength (um)
CRISM
Polyhydrated Sulfate (MgSO4)
Monohydrated Sulfate (kieserite)
Monohydrated Sulfate
CRISM I/F Ratio
Reflectance
CRISM
Polyhydrated MgSO4
Monohydrated MgSO4 (kieserite)
Polyhydrated Sulfate
CRISM I/F Ratio
Reflectance
Wavelength (um)
CRISM
Polyhydrated Sulfate (MgSO4)
Monohydrated Sulfate (kieserite)



clay + sulfate
monohydrated sulfate
200
Meters


200
Meters

The deposits in Gale are diverse in mineralogy and morphology.
There are clear stratigraphic relationships.
In many ways, Gale is a microcosm of geologic process on Mars.

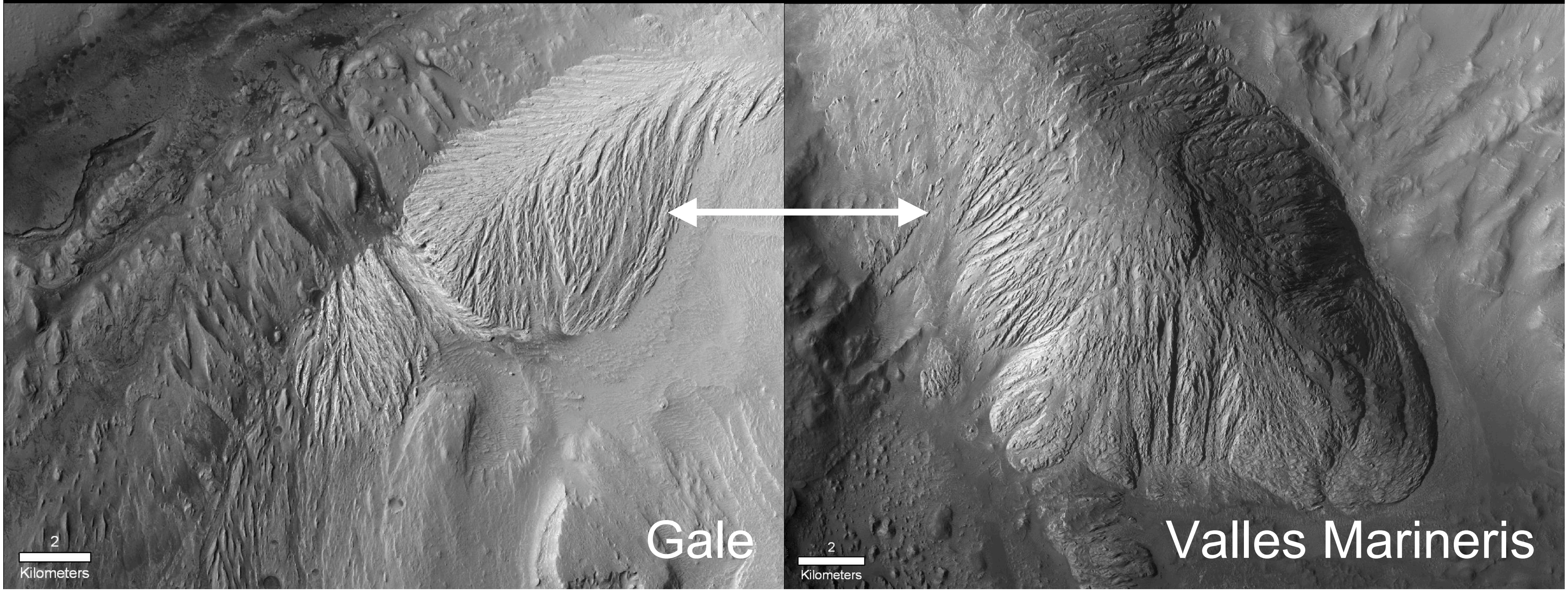


In addition to the mineralogy, the morphology of these deposits is also of great interest:

- The bright eroded mound in Gale exhibits weak sulfate signatures and is strikingly similar to the ILDs **in** Valles Marineris. Examining this site could provide insight into how these thick sulfate deposits formed. Eolian? Volcanic ash? Shallow seas?

- Thick, finely stratified deposits like those in Gale are found in numerous craters on Mars, including **Arabia Terra**. Examining the depositional and erosional history of these units will have implications on a local, regional, and potentially global scale.

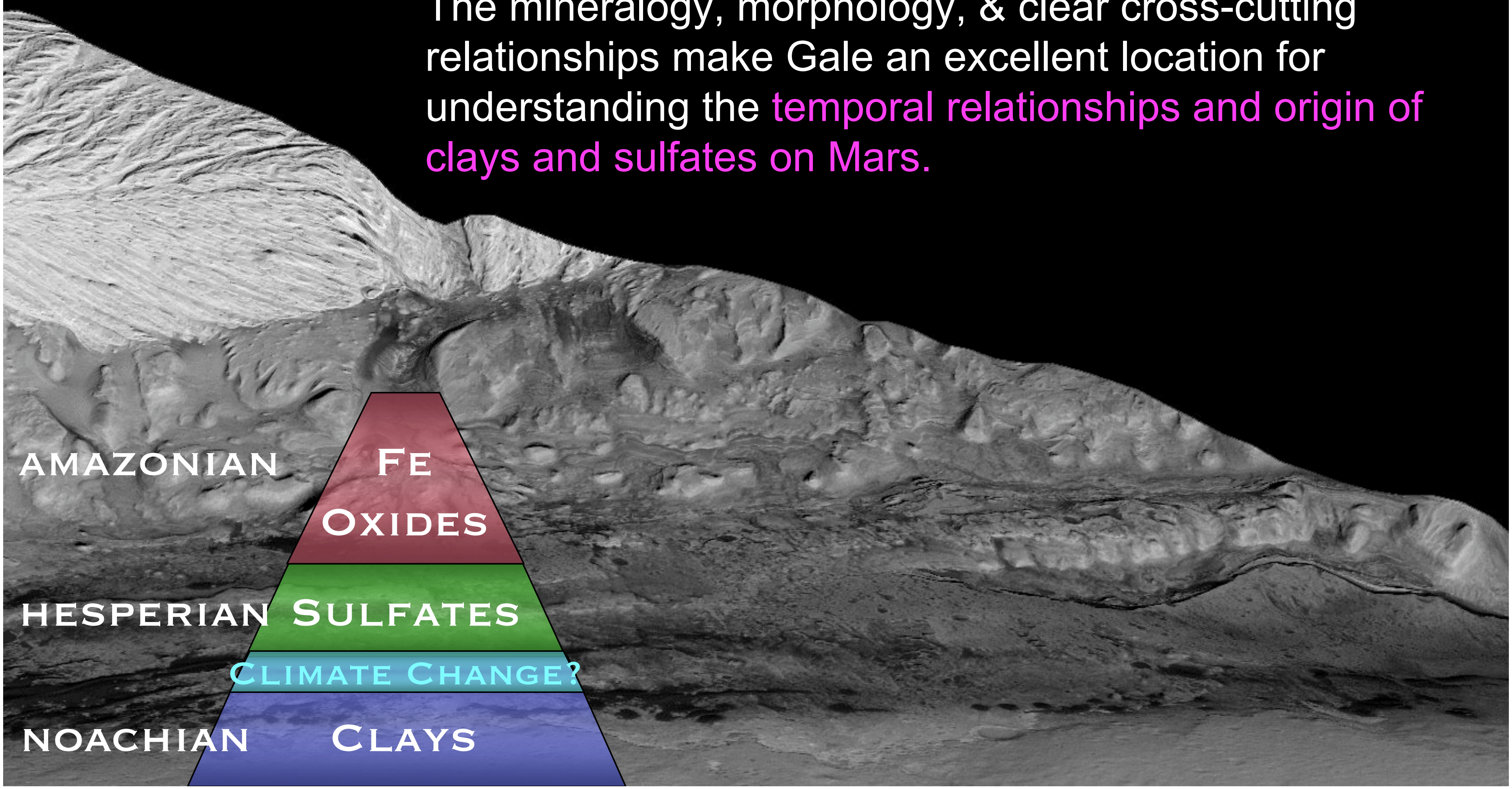
- Are such finely stratified deposits linked to climate and orbital variations?



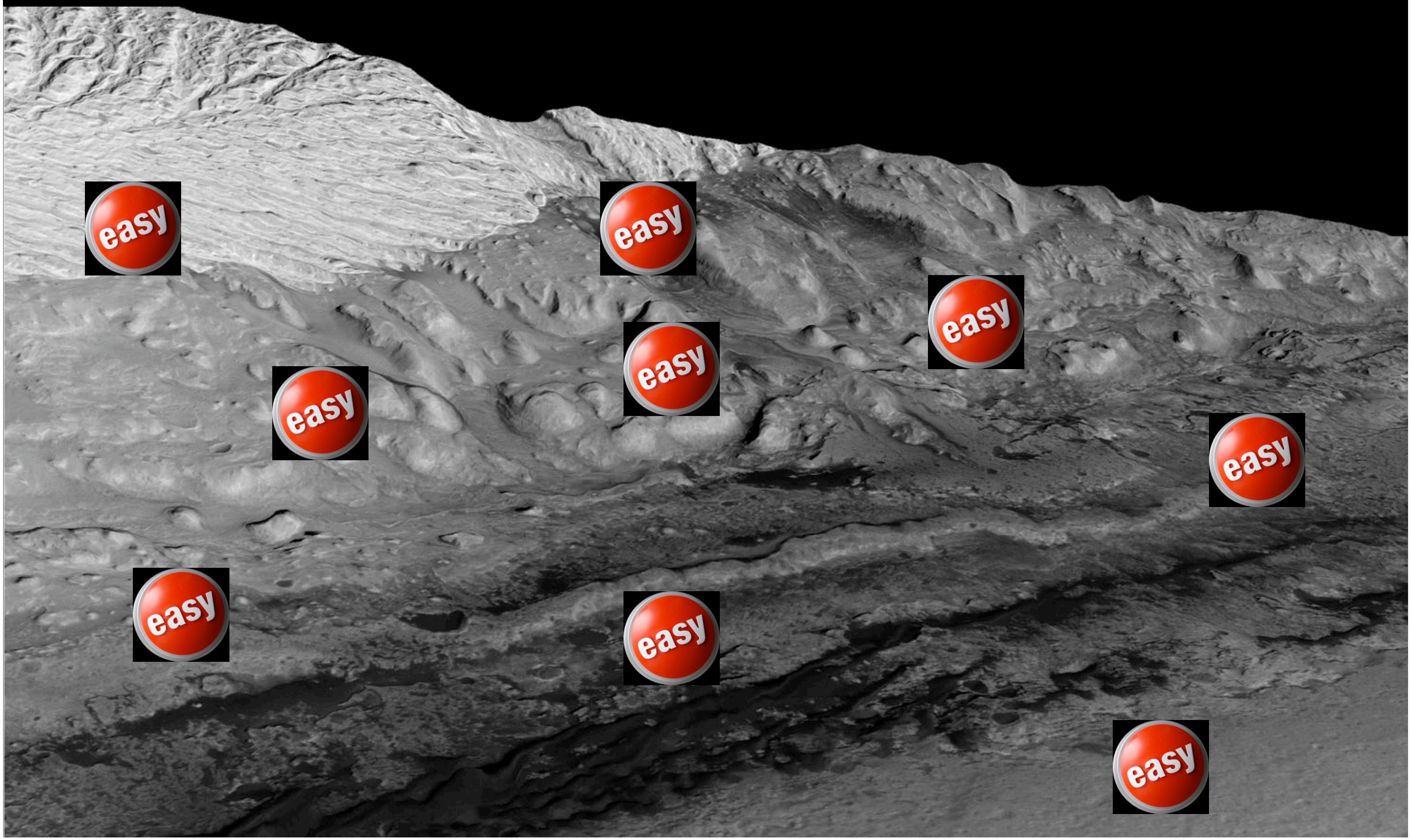
Gale Crater contains a thick sequence of diverse lithologies.

- These units are in a clear stratigraphic sequence.
- These units vary in chemical composition and mineralogy.
- A traverse up through the section represents a traverse through time.

The mineralogy, morphology, & clear cross-cutting relationships make Gale an excellent location for understanding the temporal relationships and origin of clays and sulfates on Mars.



Let’s push some buttons…



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