Juventae Chasma as Potential MSL Landing Site

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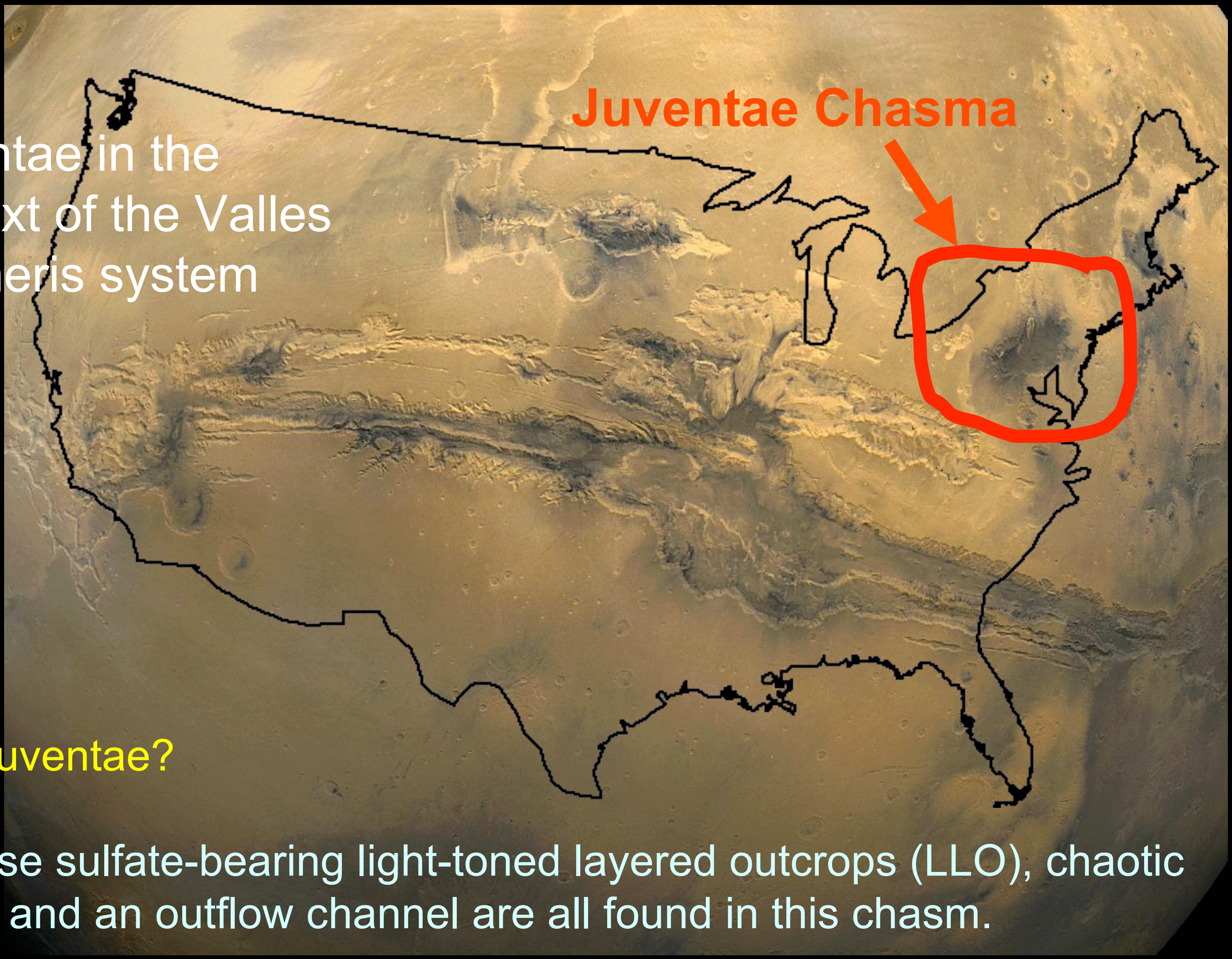
Juventae in the context of the Valles Marineris system

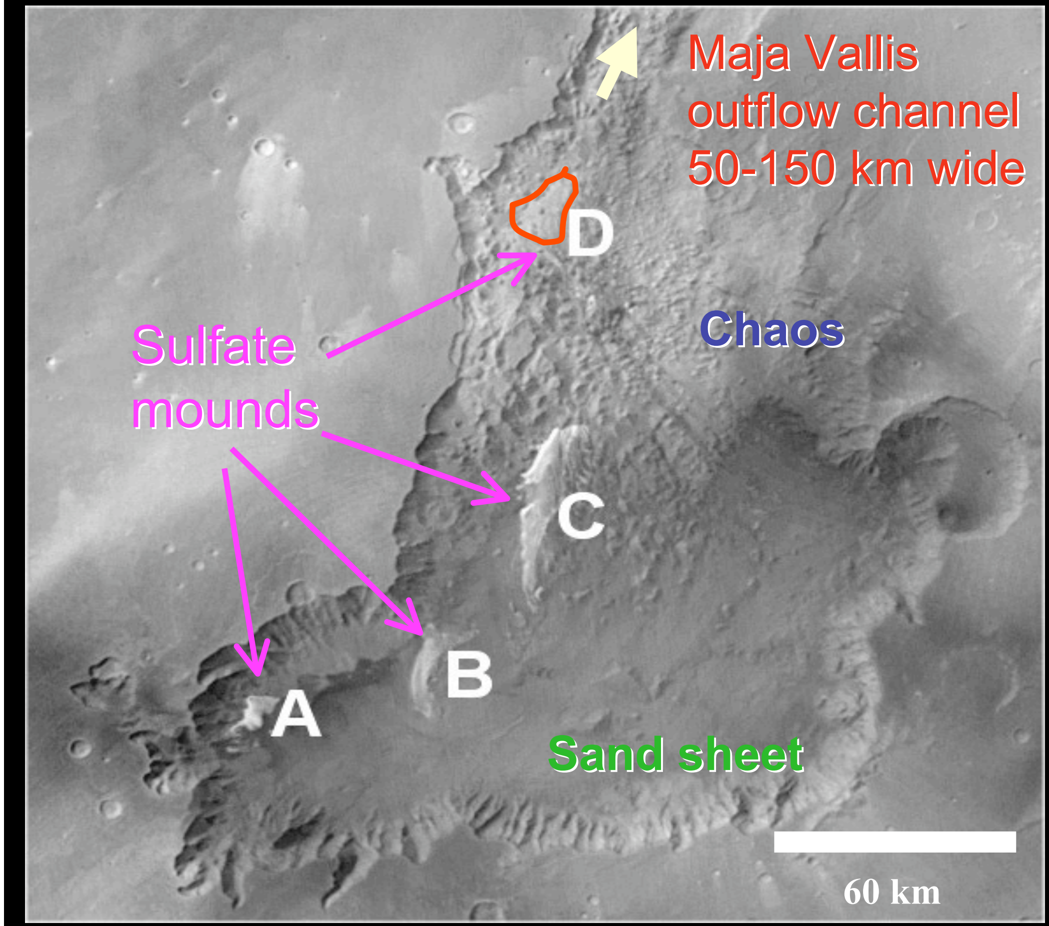


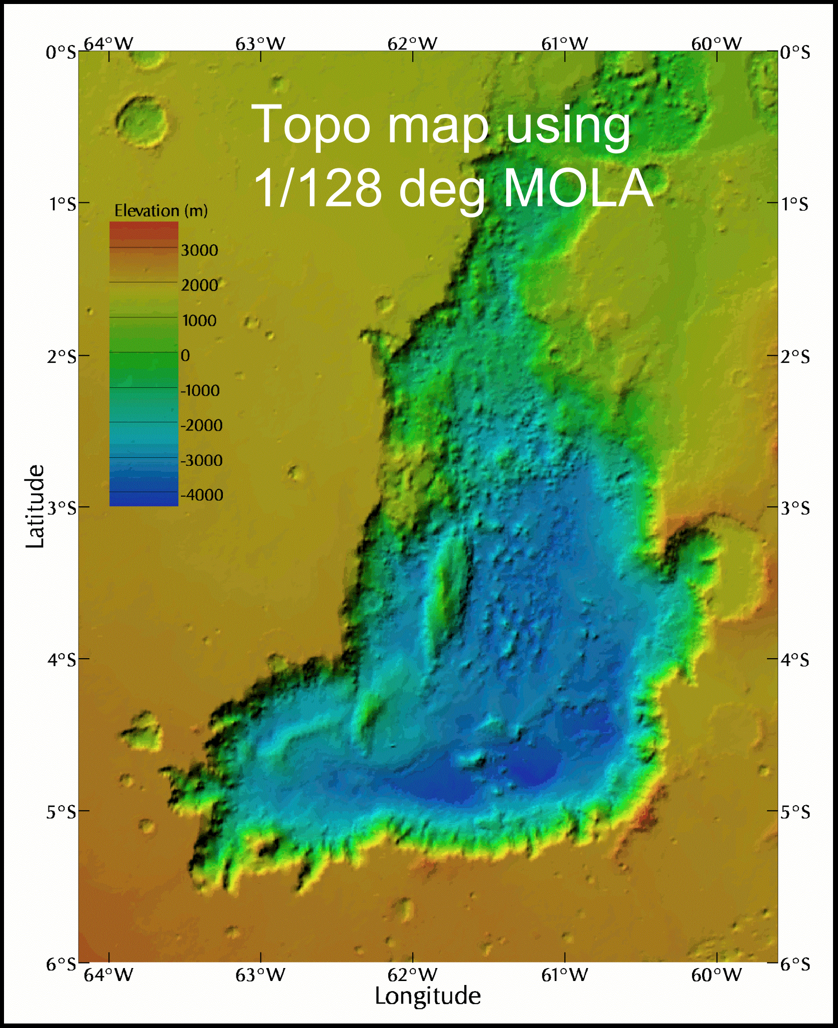
Why Juventae?

Because sulfate-bearing light-toned layered outcrops (LLO), chaotic terrain and an outflow channel are all found in this chasm.

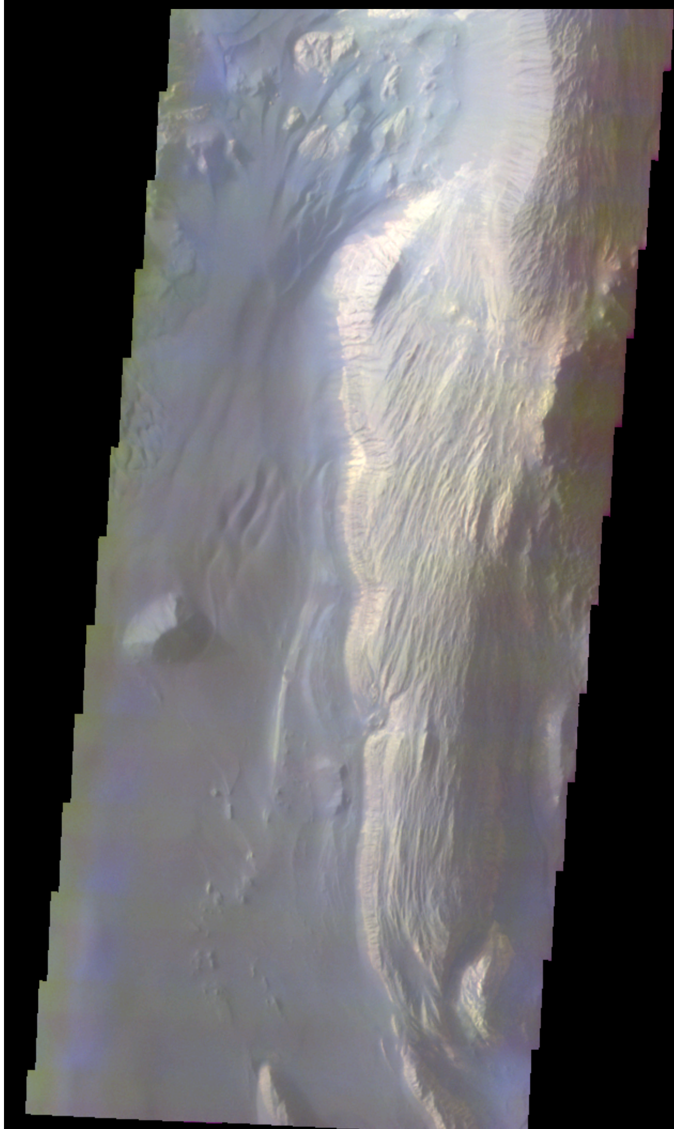
Geography of Juventae Chasma

- ~500 km north of Vallis Marineris, ~4°S
- low point: -4.4 km (6-7 km below sloping plateau)





Deposits are mountain-sized



50 km long, 20 km wide, 3.3 km high

Roughly similar in scale to the Tetons in Wyoming

Location of potential landing site in relation to available CRISM and HiRISE images

CRISM images: HRL000028A6 HRL0000444C FRT00005633 FRT00005C2B MSW000040D5 MSW00006671

HiRISE images: TRA_875_1765 PSP_2590_1765

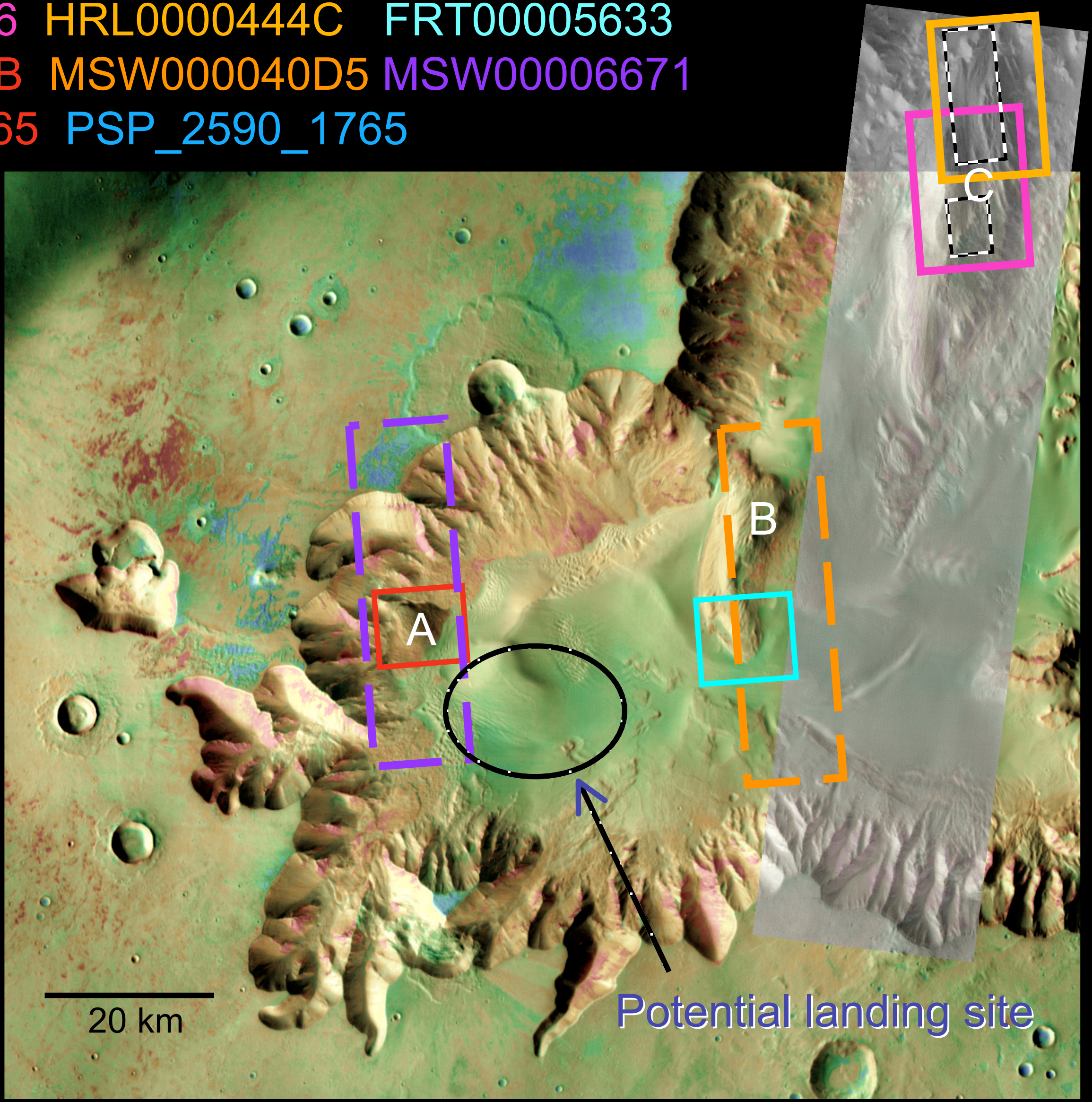
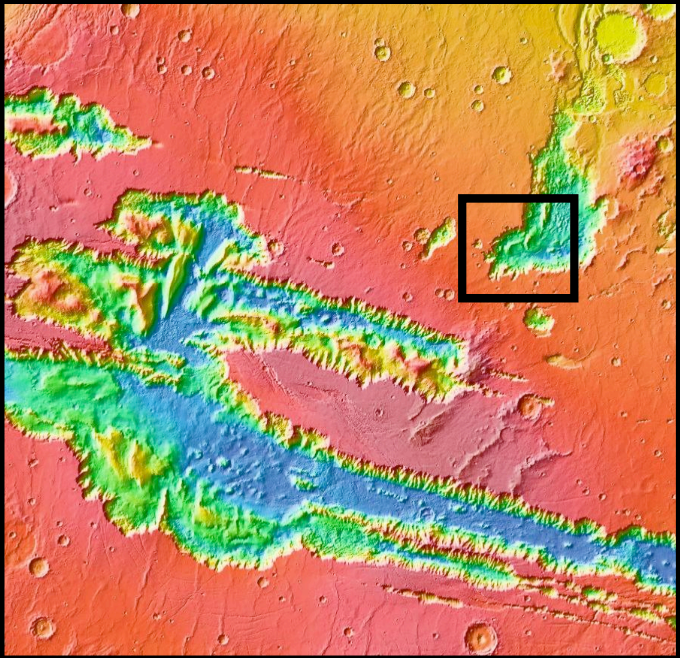


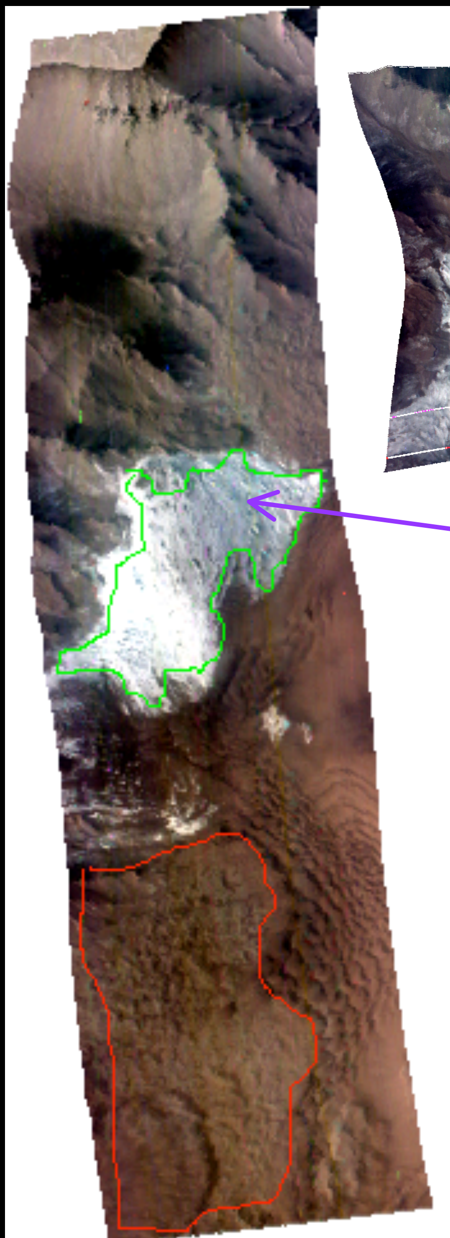
Image Credits:
Right: THEMIS Science Team/ NASA/ JPL/ASU.
Below: google.com/mars; MOLA science Team/NASA/ GSFC/ASU.

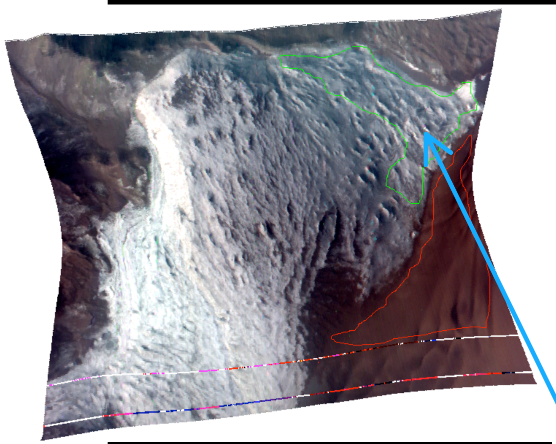


CRISM image processing and analyses

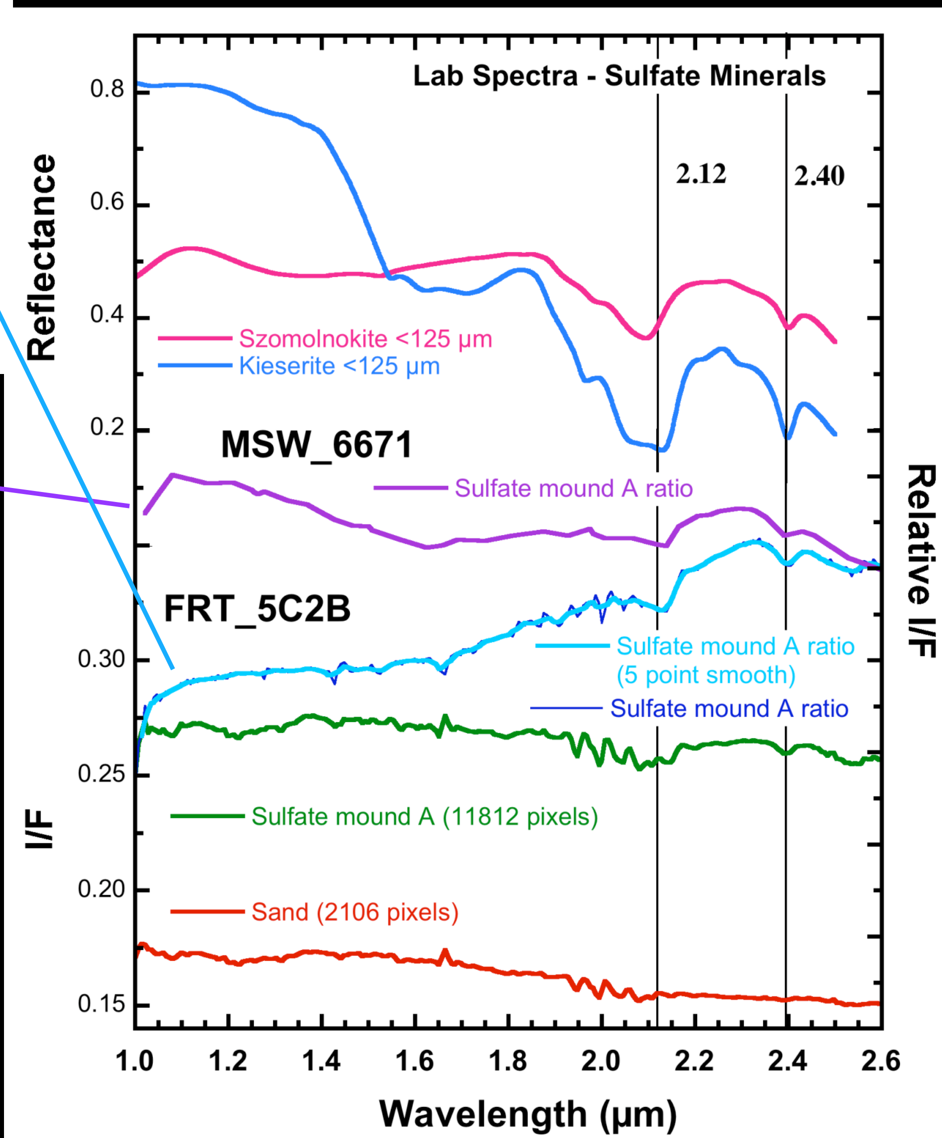
- TRR2 calibrated images corrected for atmospheric features using a volcano scan and cosi corrected for geometry.
- Georeferenced false color images typically shown with R 2.5 μm, G 1.5 μm, B 1.1 μm.
- Mineral indicator maps produced using spectral band parameters.
- Spectra extracted from non-georeferenced images in order to ratio locations of interest to another spot in the same column.
- Region of interest (ROI) sites selected on non-georeferenced images using statistical methods to determine regions; ratios performed on averaged spectra for mineral sites to spectrally bland sites.
- CRISM spectra compared to lab spectra of monohydrated sulfate minerals.

Mound A - MSW00006671, FRT00005C2B



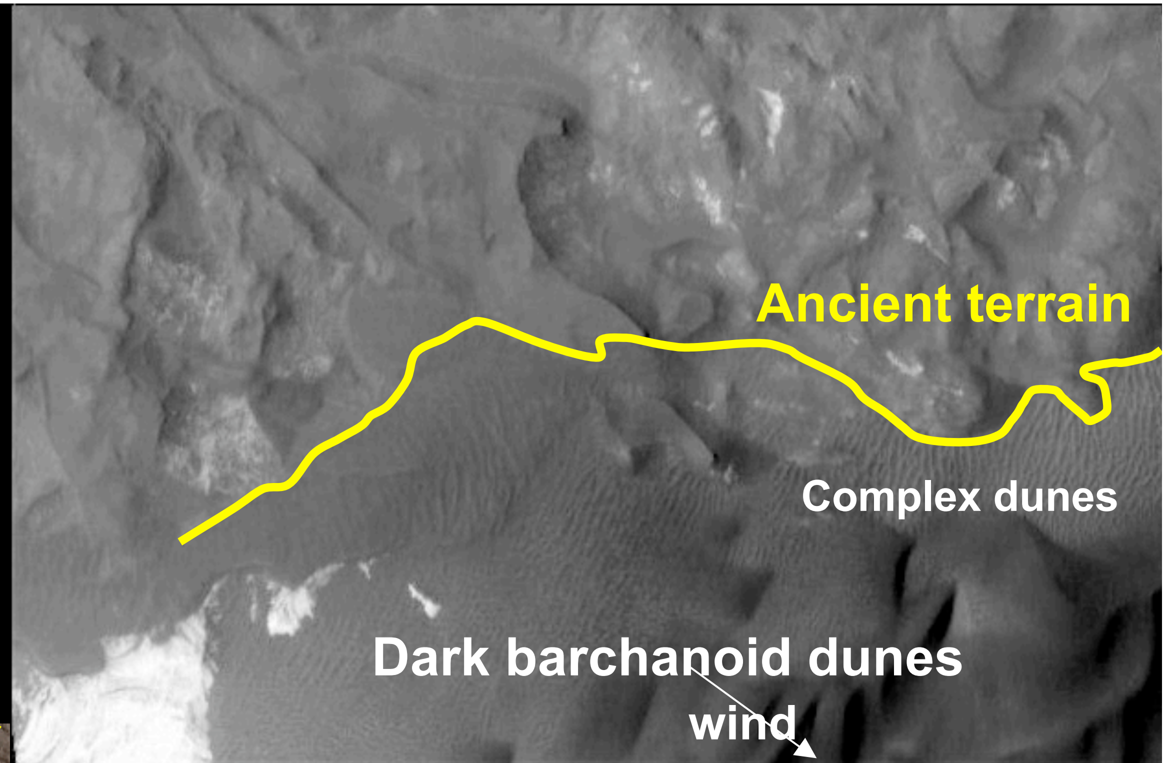


The sulfate mound ratio spectra (purple and blue) contain bands near 2.1 and 2.4 µm consistent with monohydrated sulfate minerals.

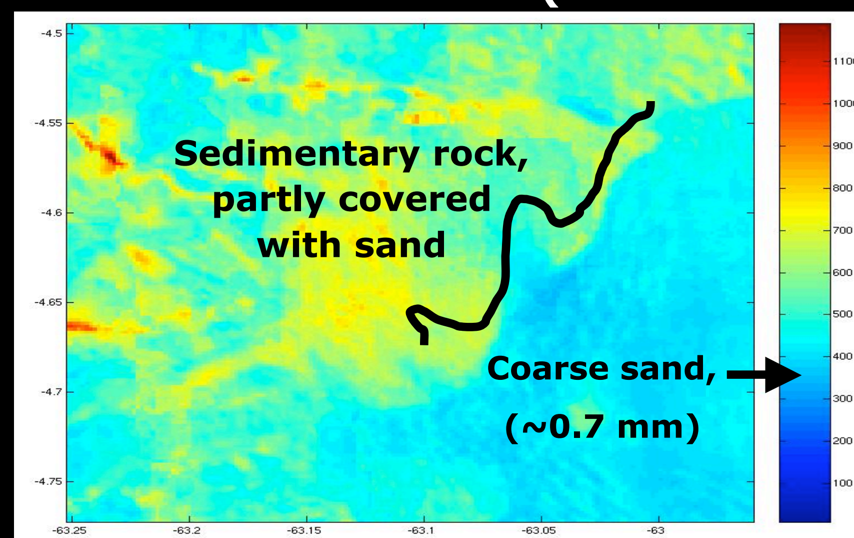


Mound A:

Sand sheet contact with other units

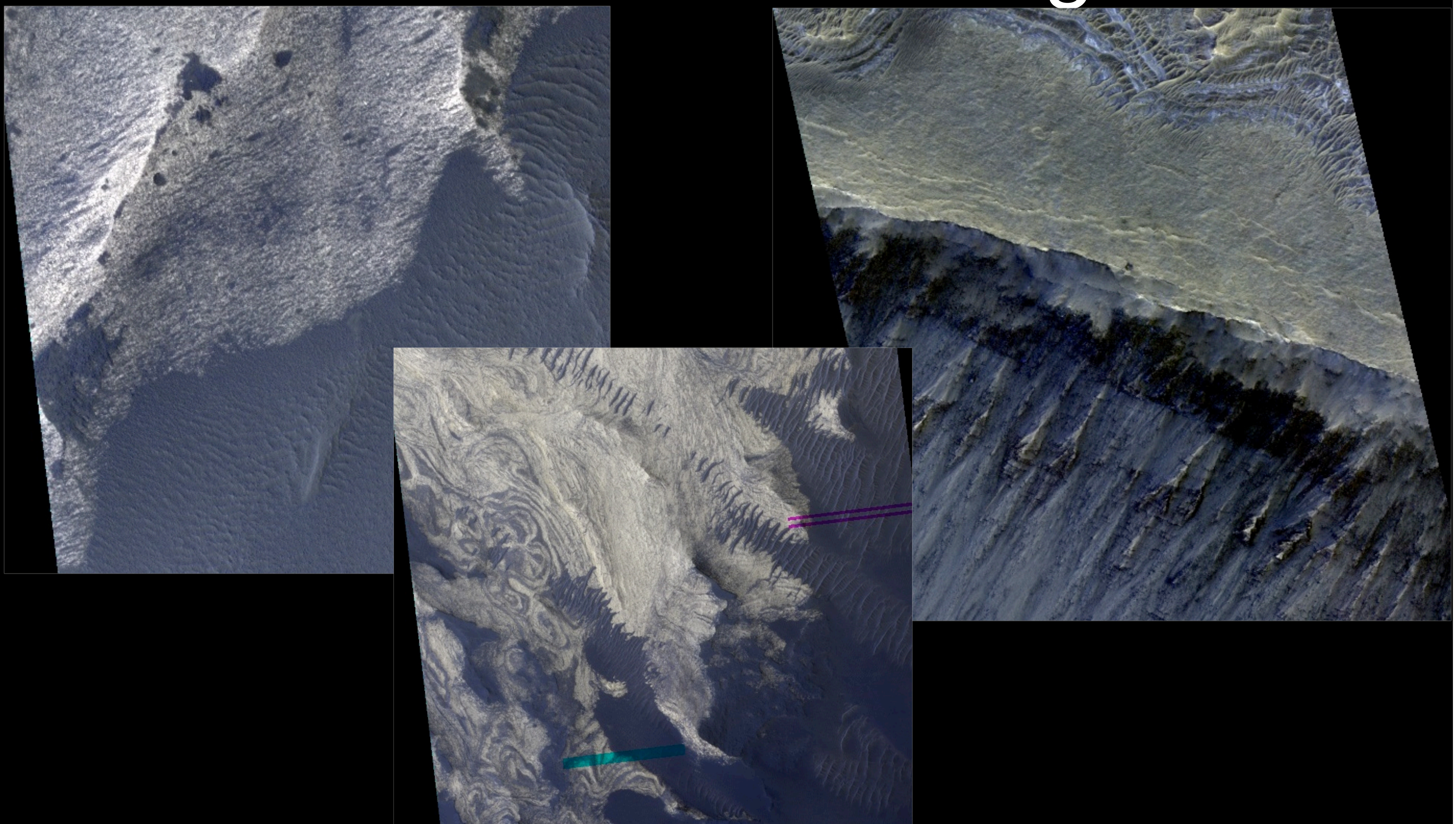


THERMAL INERTIA MAP (J m^{-2} K^{-1} s$^{-1/2}$)

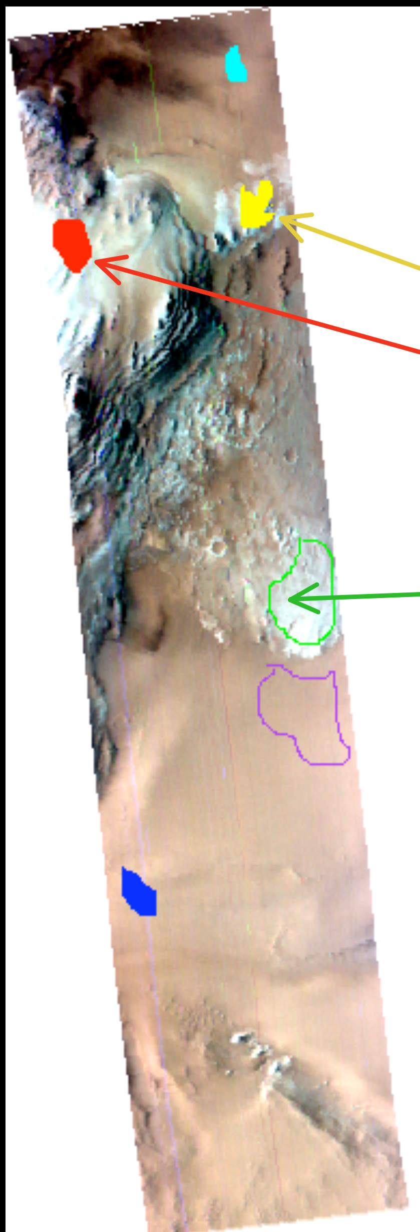


Thermal inertia = 500-850 (Catling et al. 2006, *Icarus)*

More Hirise coverage

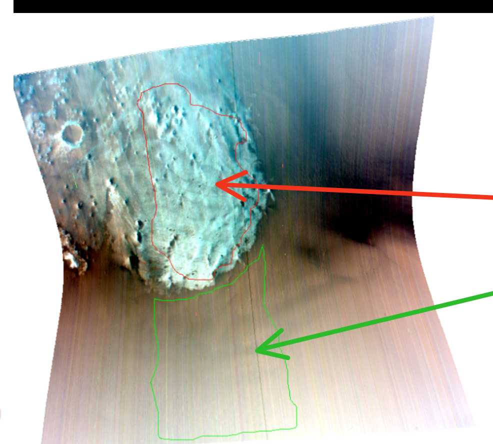


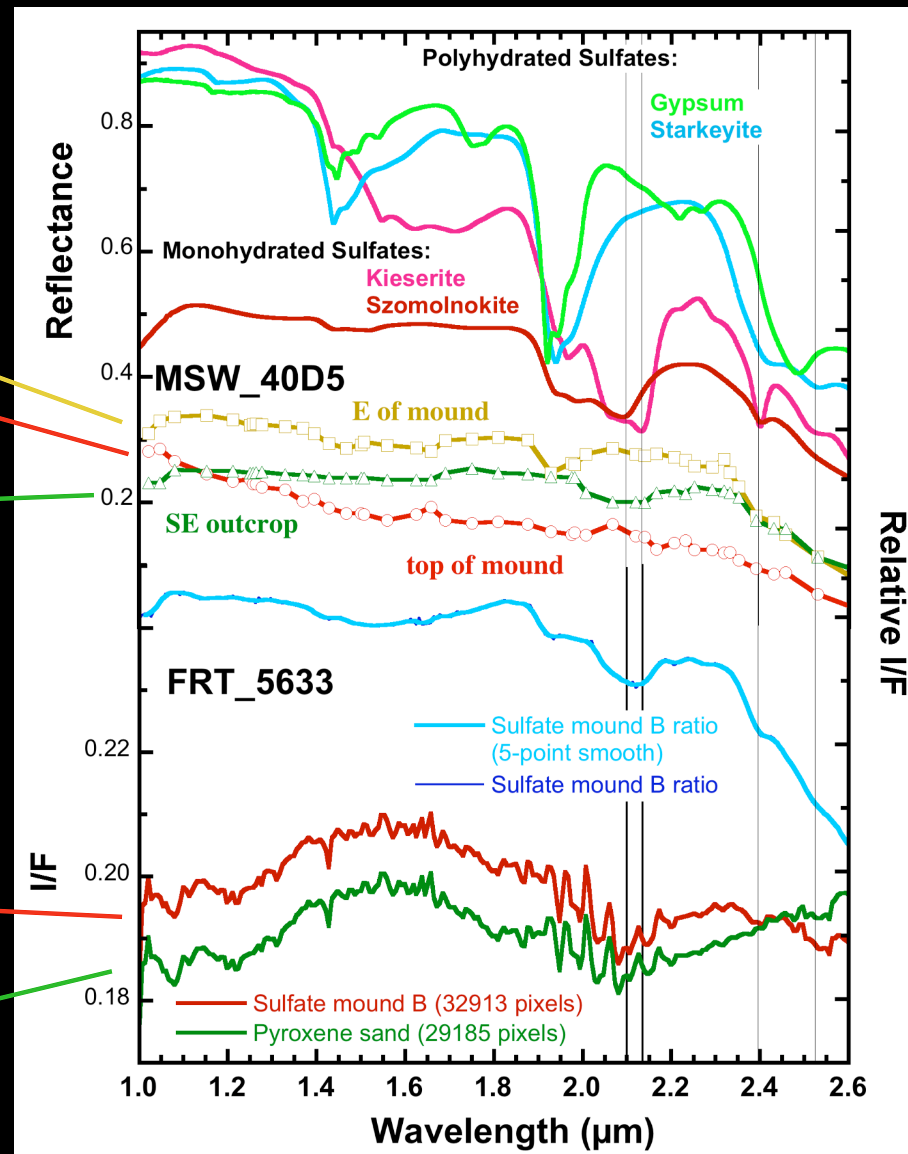
Mound B - MSW000040D5, FRT00005633



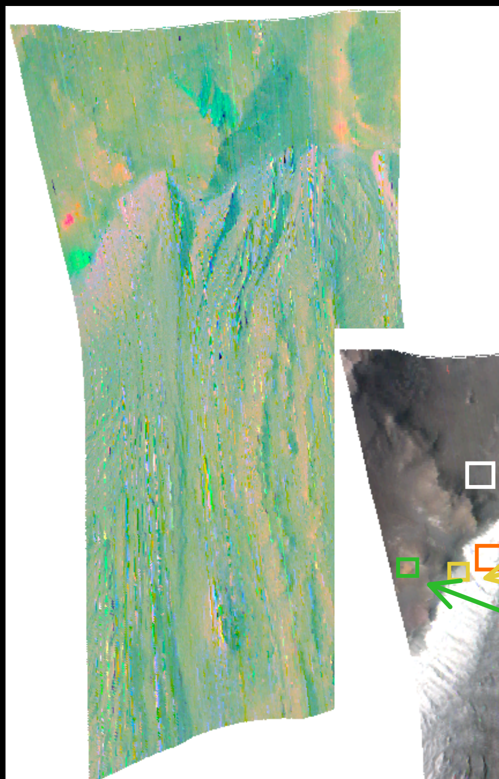
Mound B exhibits a variety of sulfate-bearing spectra in the MSW image. Ratio spectra of three regions consistent with monohydrated and polyhydrated sulfates are shown in the center right.

Raw and ratio spectra are shown at the bottom right for the SE outcrop. The sulfate mound ratio spectrum (light blue) has an artificial slope that is caused by the pyroxene band in the green spectrum.

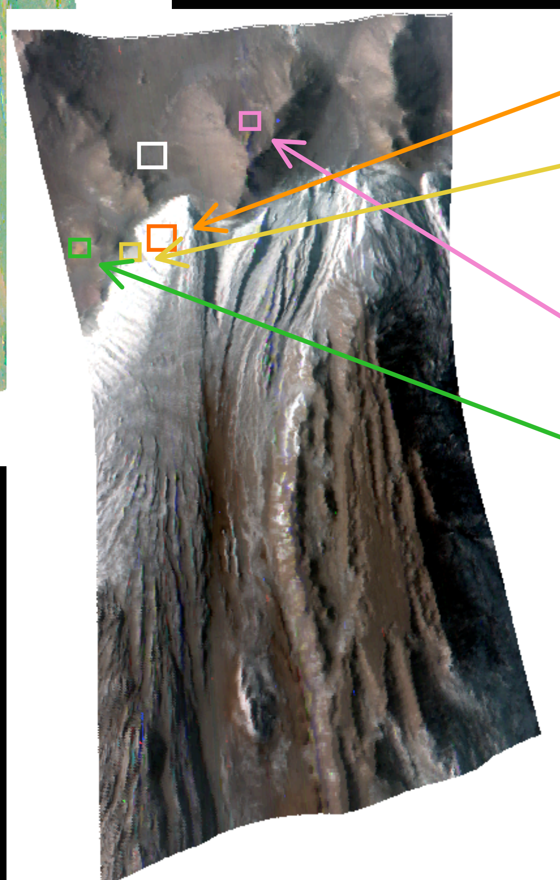


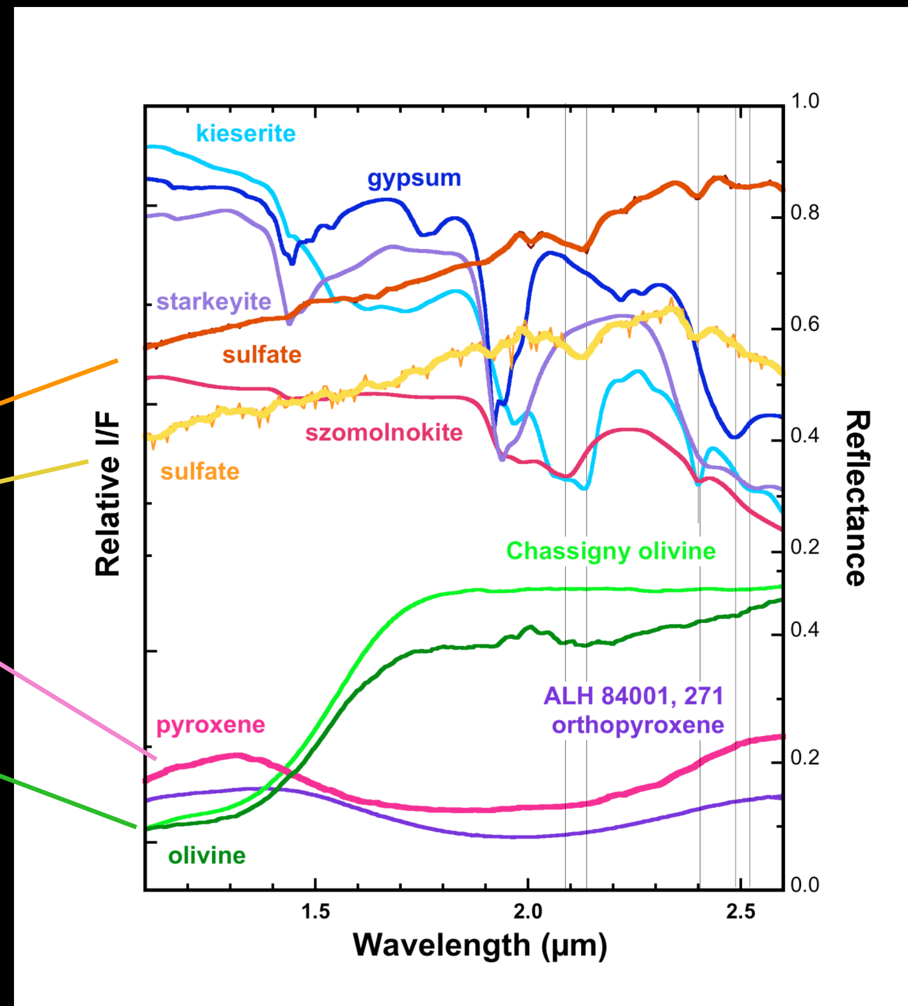


Mound C - HRL000444C



ROI 20X20 pixels:
orange - sulfate
white - sand
Ratio: orange/white





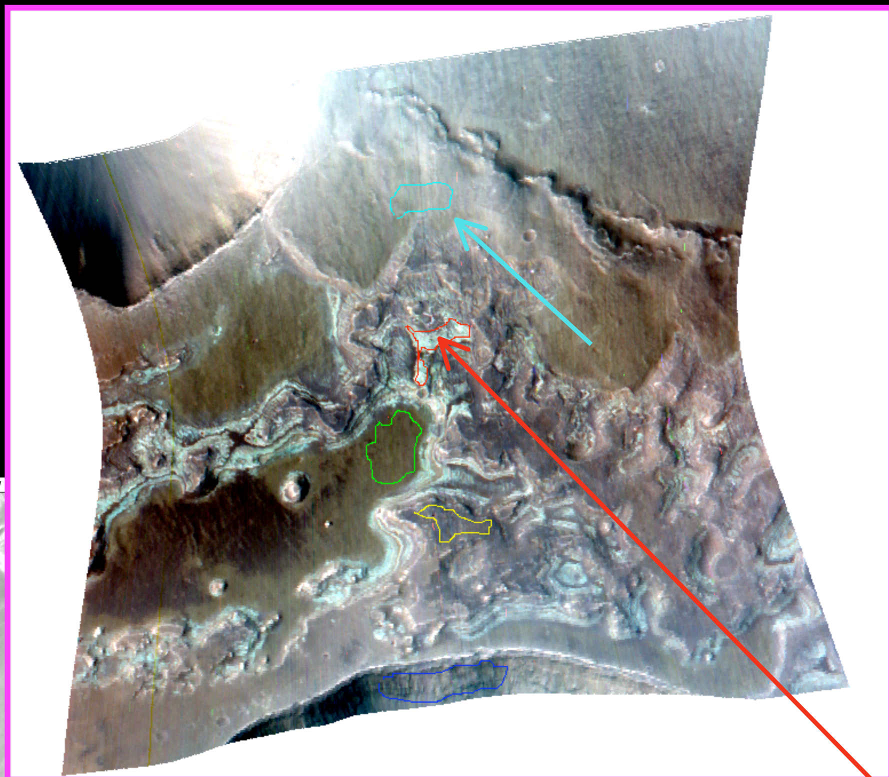
Above: Mineral indicator map:
pink - sulfate
red - olivine
green - LCP

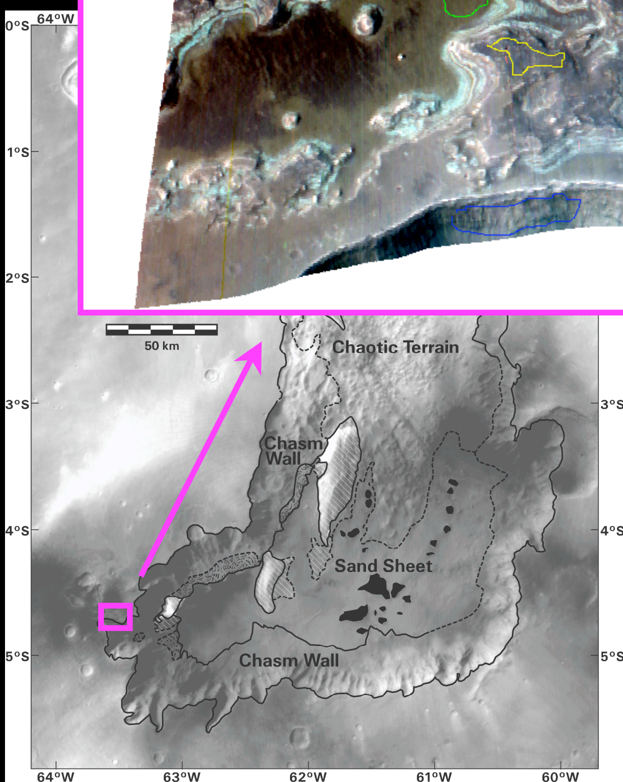
Right: false color IR map: R 2.5 µm, G 1.5 µm, B 1.1 µm.

ROI spectra cleaner and show clear monohydrated sulfate features. Other sulfate spots exhibit some monohydrated and some polyhydrated sulfate character.

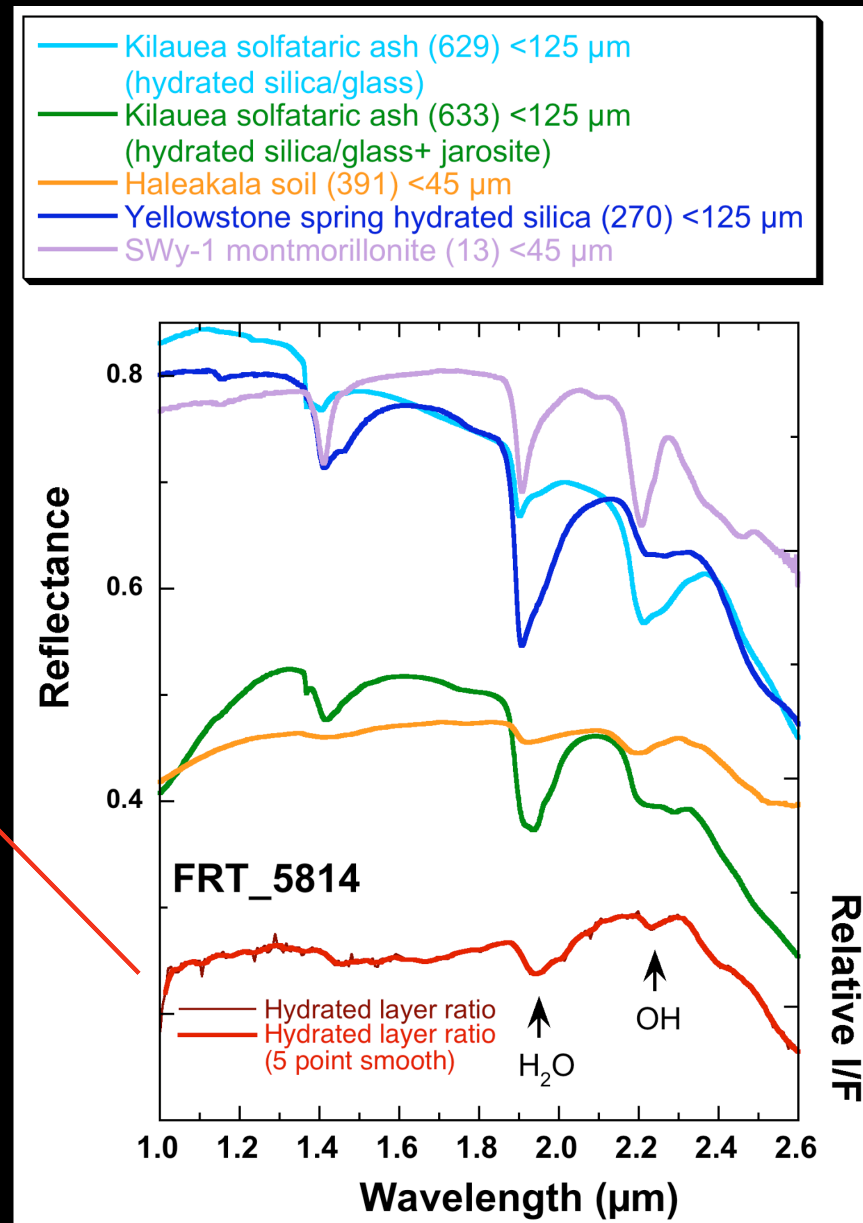
Olivine and pyroxene outcrops visible just N of mound.

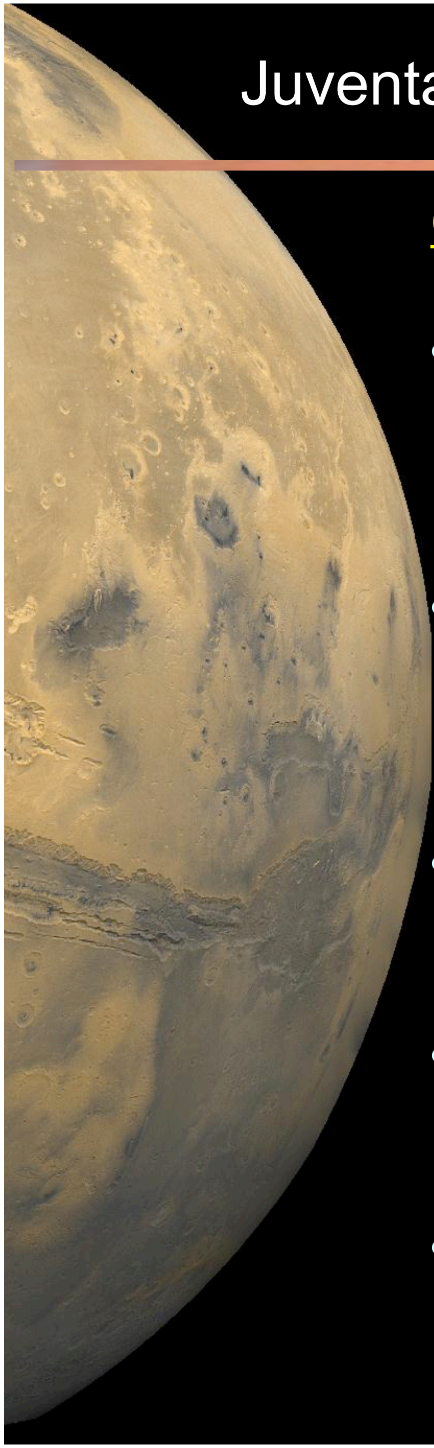
Light-toned region west of Mound A FRT00005814





- Hydrated layer spectrum is ratio of red ROI to cyan ROI.
- The OH band is more typical of hydrated silica than of phyllosilicates.



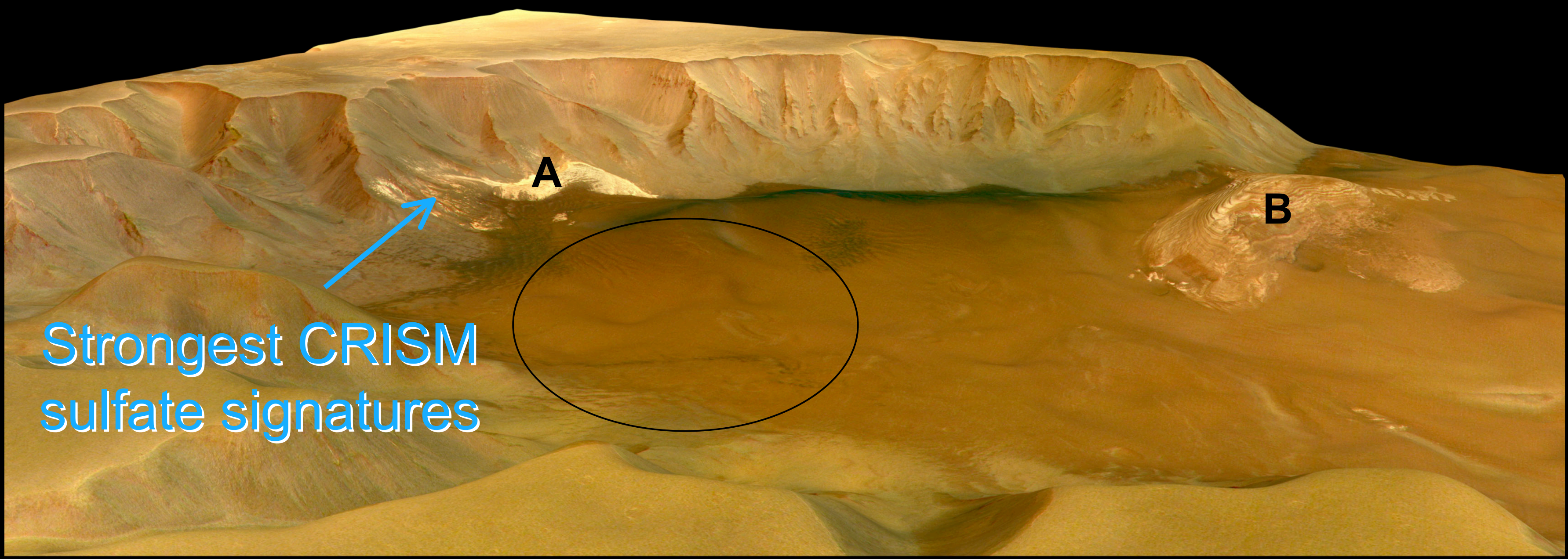


Juventae: Chasm, Chaos and Channels

Geomorphology:

- LLO material probably once extended over ~3.3 km vertically within the chasm + LLOs are found within the plateau above the chasm.
- Presence of monohydrated sulfates, polyhydrated sulfates, and hydrated silica implies complex aqueous activity.
- Bedded laminations likely indicates a non-volcanic sedimentary setting.
- An outflow channel implies an association with liquid water.
- Chaotic terrain, sometimes overlying the LLOs, suggests removal of LLO material and collapse, an evolution happening even today.

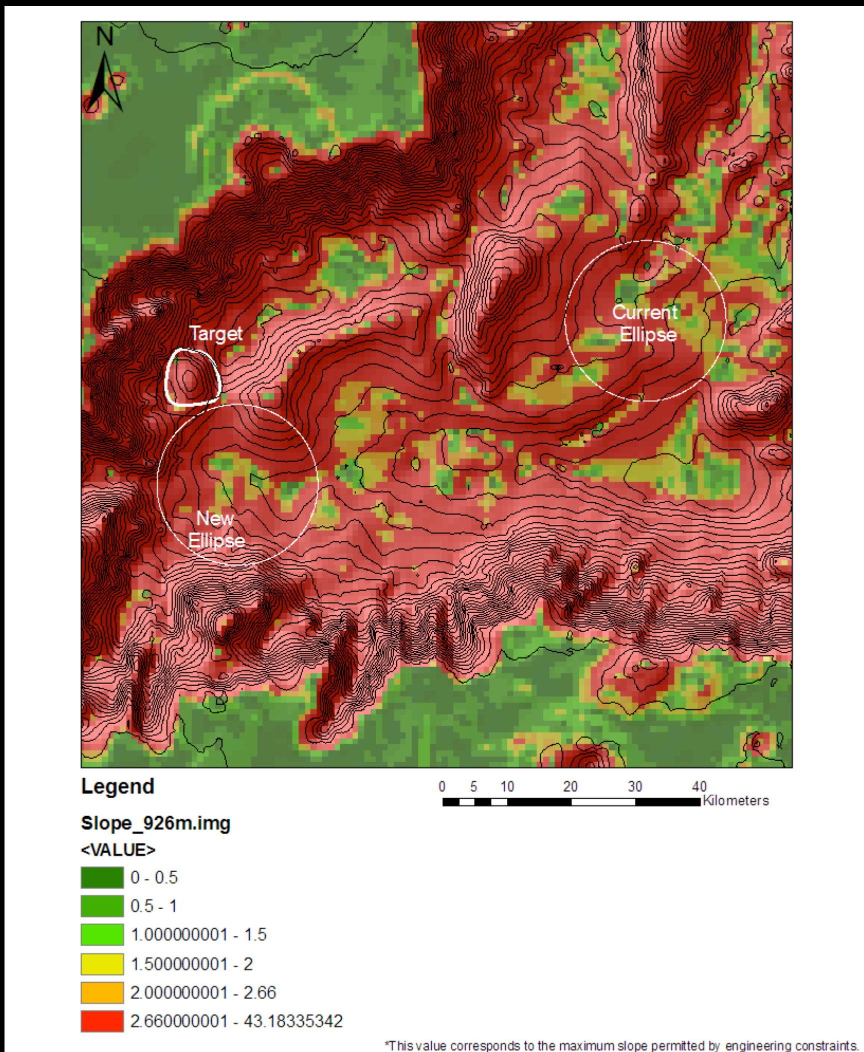
3-D View of Potential Juventae Landing Site Region

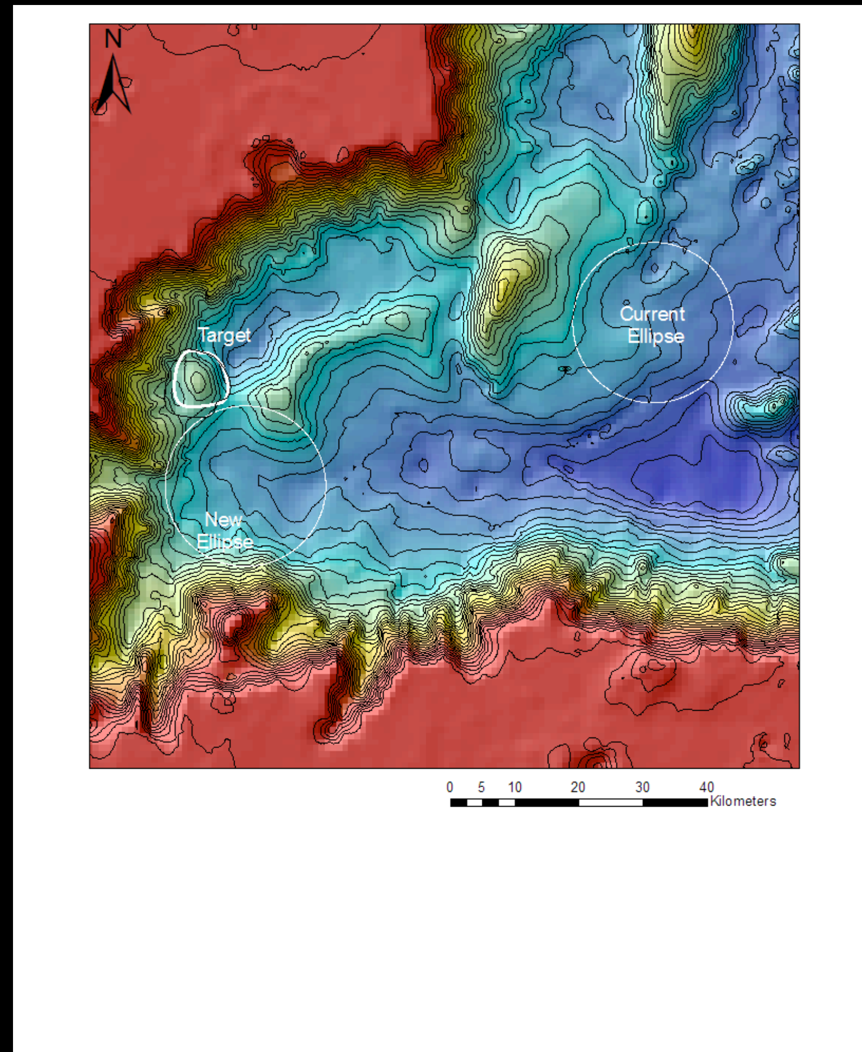


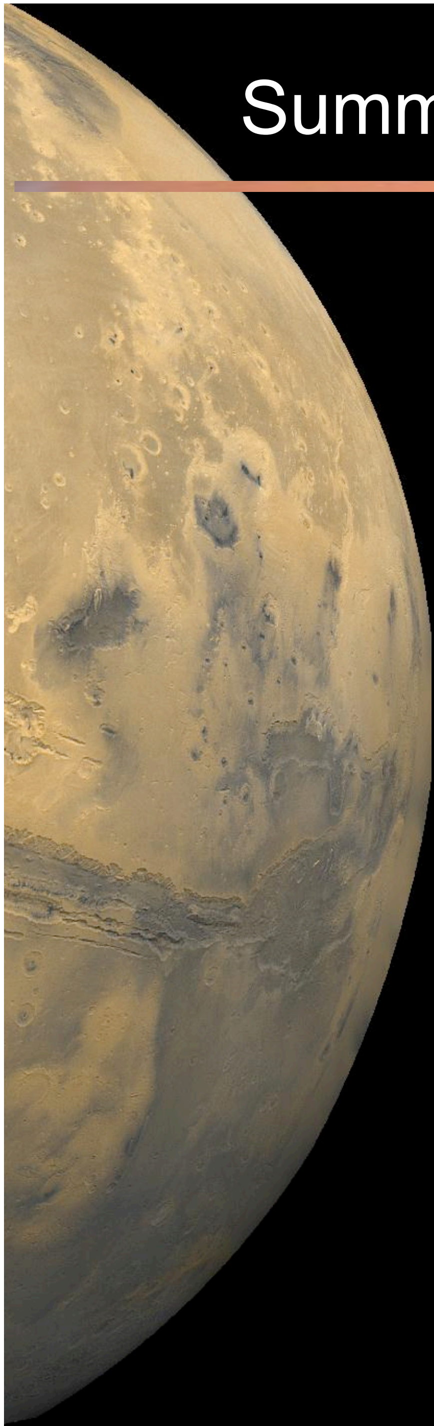
- **Analysis of CRISM images suggests that sulfate minerals are present in the chasma walls and mounds and that they are partially covered by dust.**
- **Spectral features are most consistent with the monohydrated sulfate mineral kieserite, polyhydrated sulfate minerals such as gypsum or starkeyite, and hydrated silica (e.g. found at Kilauea in solfataric sites and Yellowstone spring).**
- **Olivine and pyroxene found in outcrops near mounds.**

MOLA slope maps of Juventae

The "new" ellipse near mound A, where the strongest sulfate spectral features are observed in CRISM data, looks safer than the "current" ellipse near mound B.







Summary of Juventae Chasma Landing Site

Why Juventae?

Because bright outcrops containing sulfates and hydrated silica, chaotic terrain and an outflow channel are observed in this chasm.

Because spectral evidence for unaltered mafic rocks (olivine, pyroxene) are observed near sulfate mounds.

What are the sulfate sediments?

Hypothesis 1: Evaporitic remnant of former massive sea; consistent with elevation and associated outflow channel; does not explain LLOs above chasm on sloping plain that may contain hydrated sulfate.

Hypothesis 2: Airfall sediments; analog is Atacama desert salts; consistent with polar wandering and former polar ice deposit.

Science questions for MSL:

1) Seek link between light-toned hydrated silica outcrops, sulfate-bearing layered mounds, chaos and channels.
2) Examination of sulfate mineralogy and other salts (XRD & LIBS) together with sedimentology from in situ imagery will place constraints on the enigmatic origin of the light-toned layered outcrops.