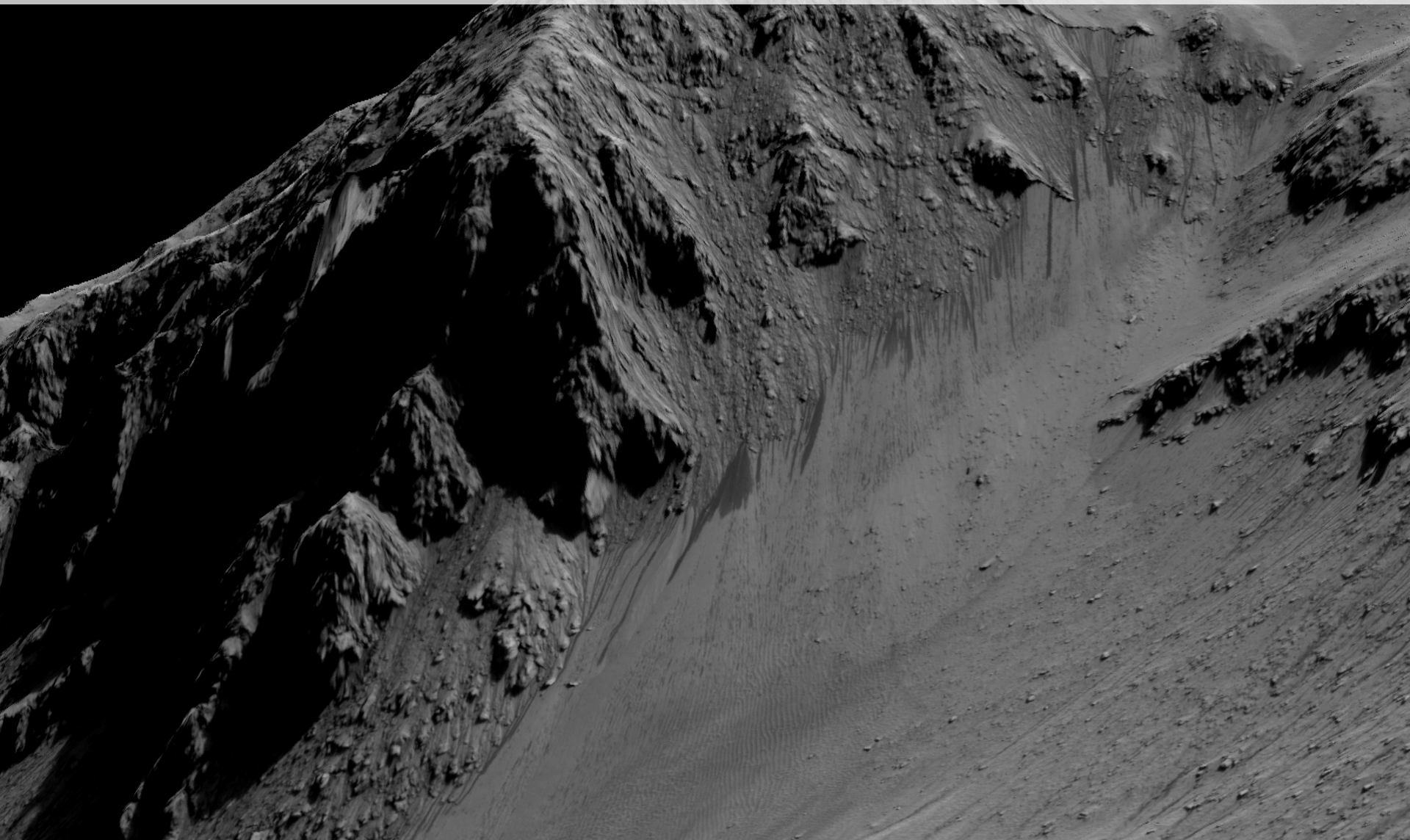
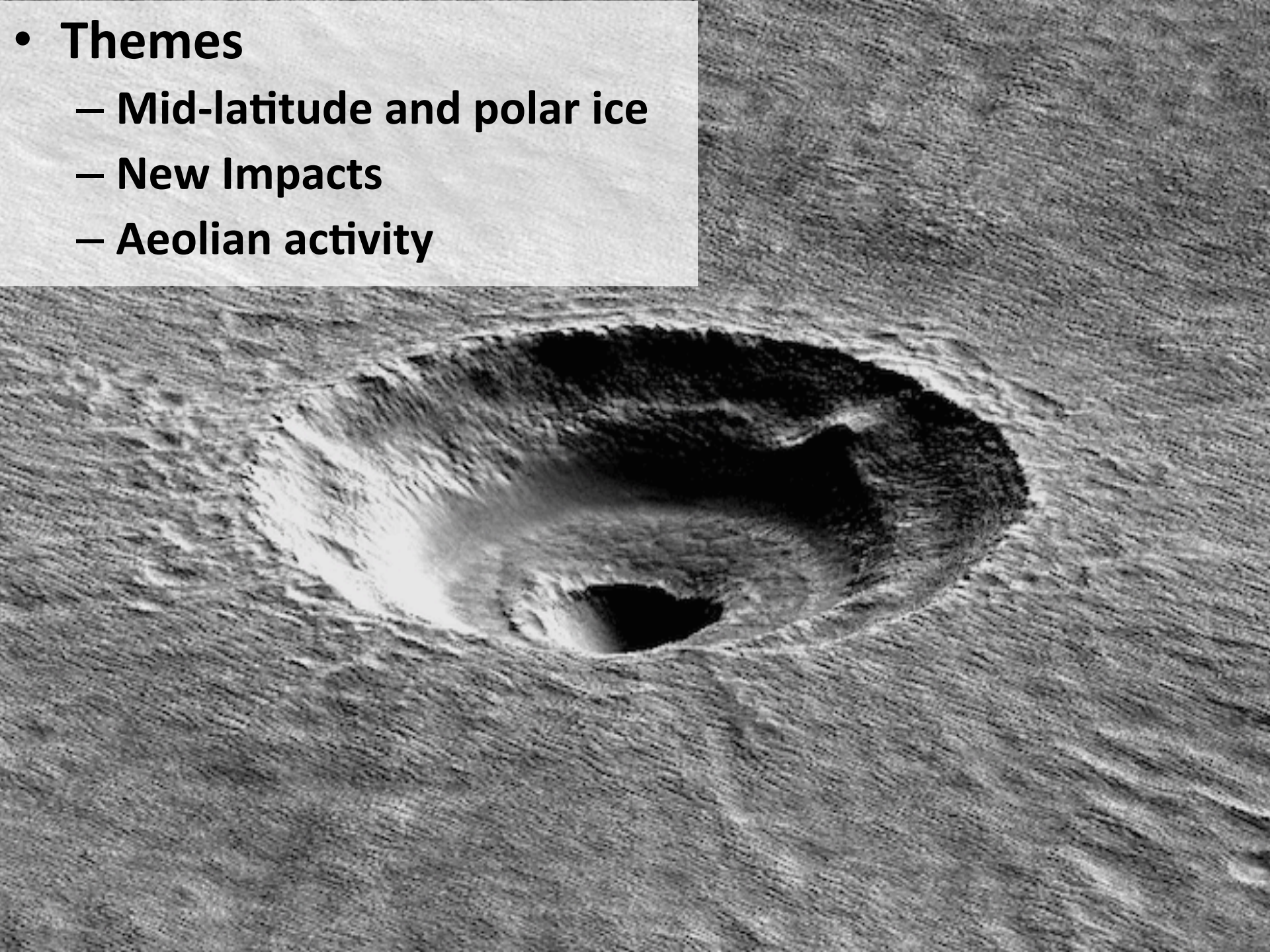
Recent HiRISE science results

MRO PSG, October 2015



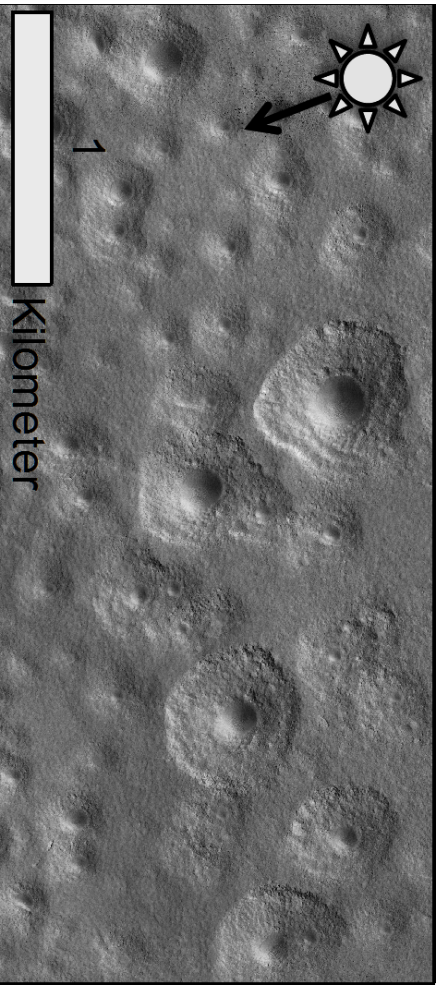


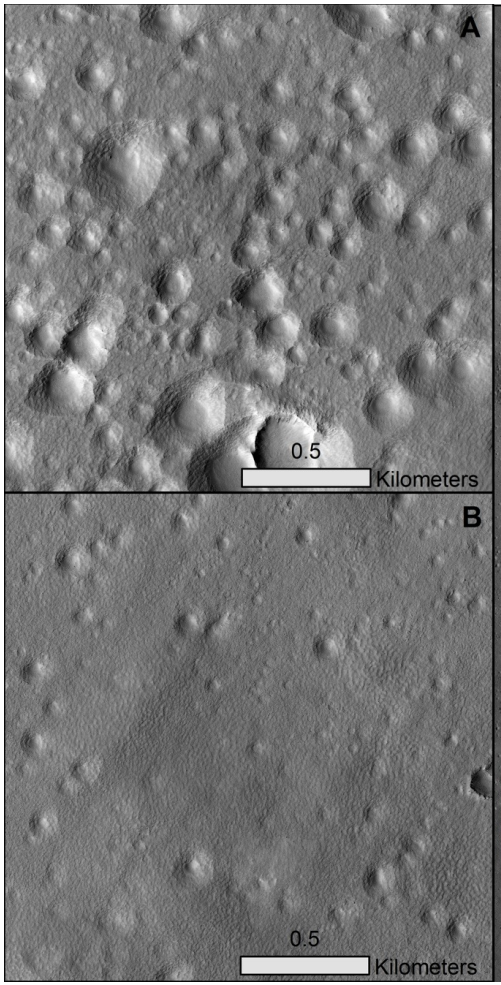
- **Themes**
  - **Mid-latitude and polar ice**
  - **New Impacts**
  - **Aeolian activity**

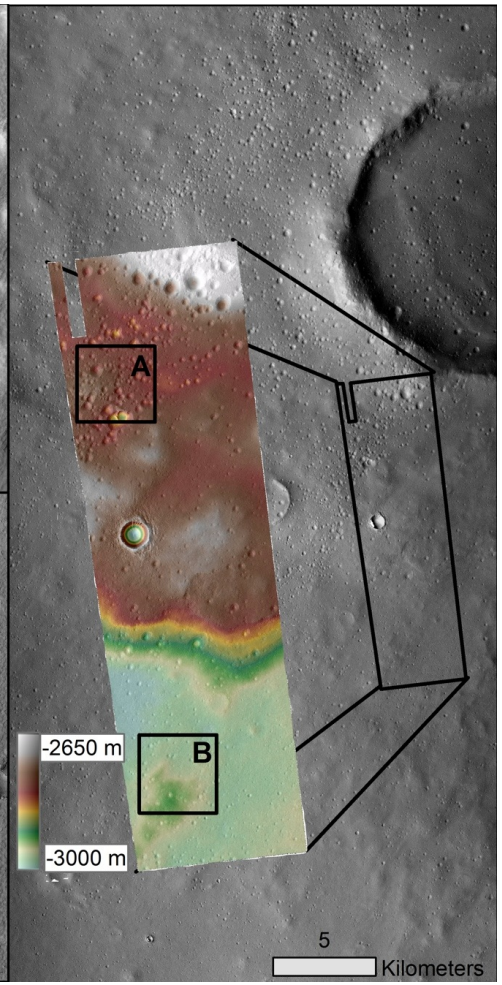
Expanded Secondary Craters as Evidence for Ancient Subsurface Ice

The source of these expanded secondaries appear to be four larger craters that are between 20 and 70 million years old based on crater counts.

Estimated that there is at least 6000 cubic kilometers of ancient ice remains in the near subsurface of Arcadia Planitia



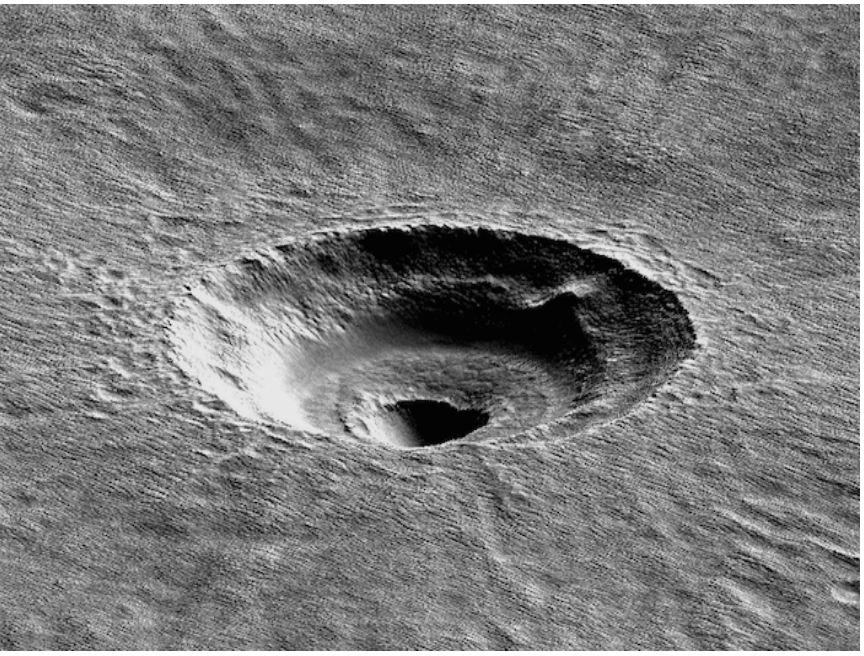


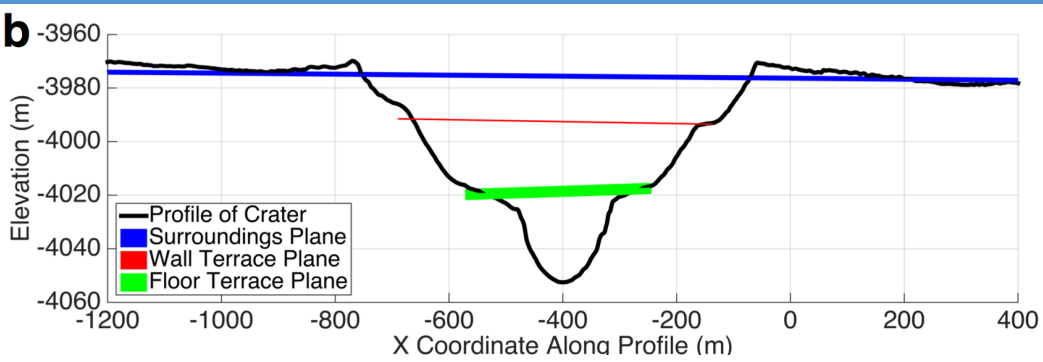


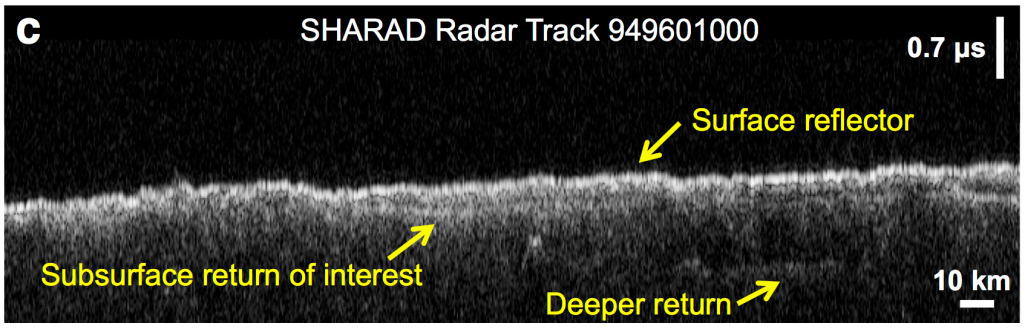
Viola et al. (2015). Icarus 248, pp.190-204.

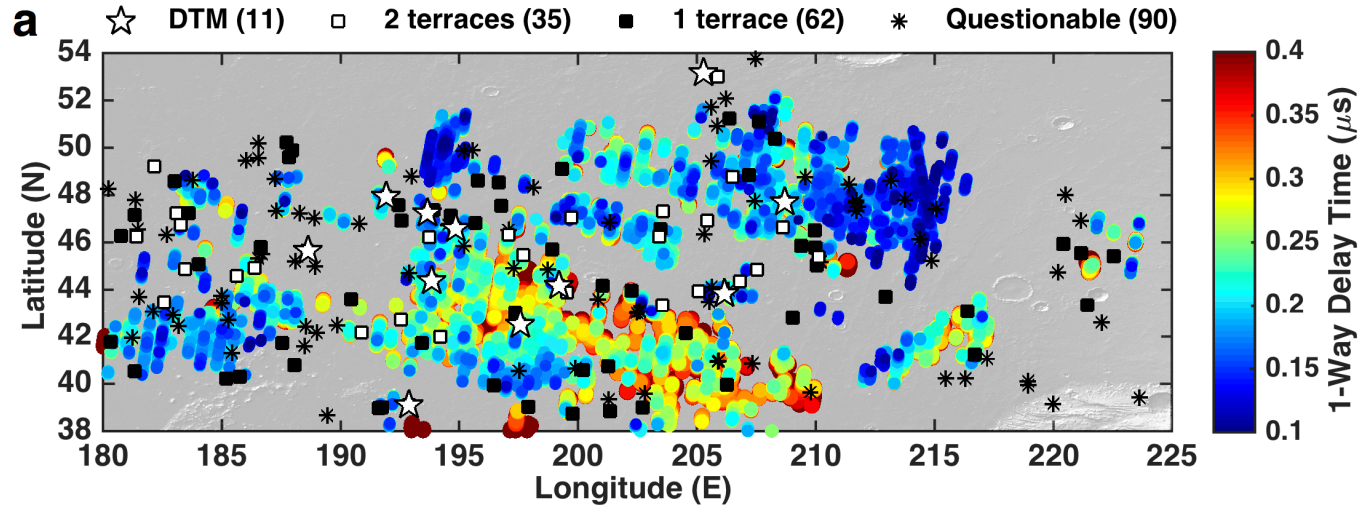
Widespread Ice in Arcadia Planitia on Mars

Combined SHARAD/HiRISE data finds decameters of excess ice over 10^6 km^2









Results published in:

Bramson, A. M., S. Byrne, N. E. Putzig, S. Sutton, J. J. Plaut, T. C. Brothers, and J. W. Holt (2015), Widespread excess ice in Arcadia Planitia, Mars, Geophys. Res. Lett., 42, doi: 10.1002/2015GL064844.

Analysis of most equatorward perennial surface ice

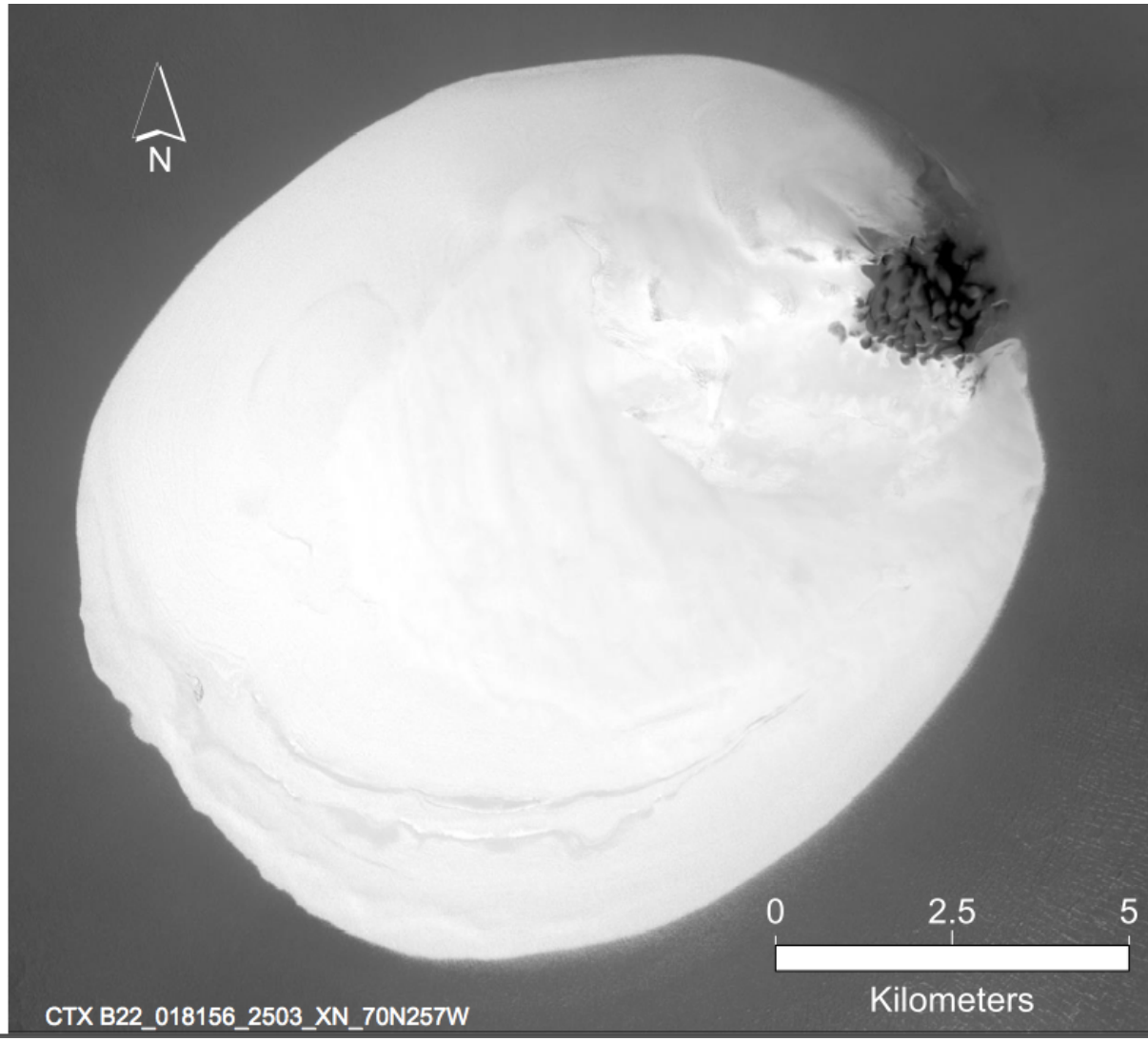
Louth crater ice mound (~12km across) is stable over many Mars years

Sensitive climatic indicator at 70.5N

Louth Crater Ice Mound

- Observations
  - Only one region (~1 km) shows interannual variation
  - No clear trend
- Conclusion
  - Ice mound is close to equilibrium

  OR
  - Longer-term trend is unperceivable



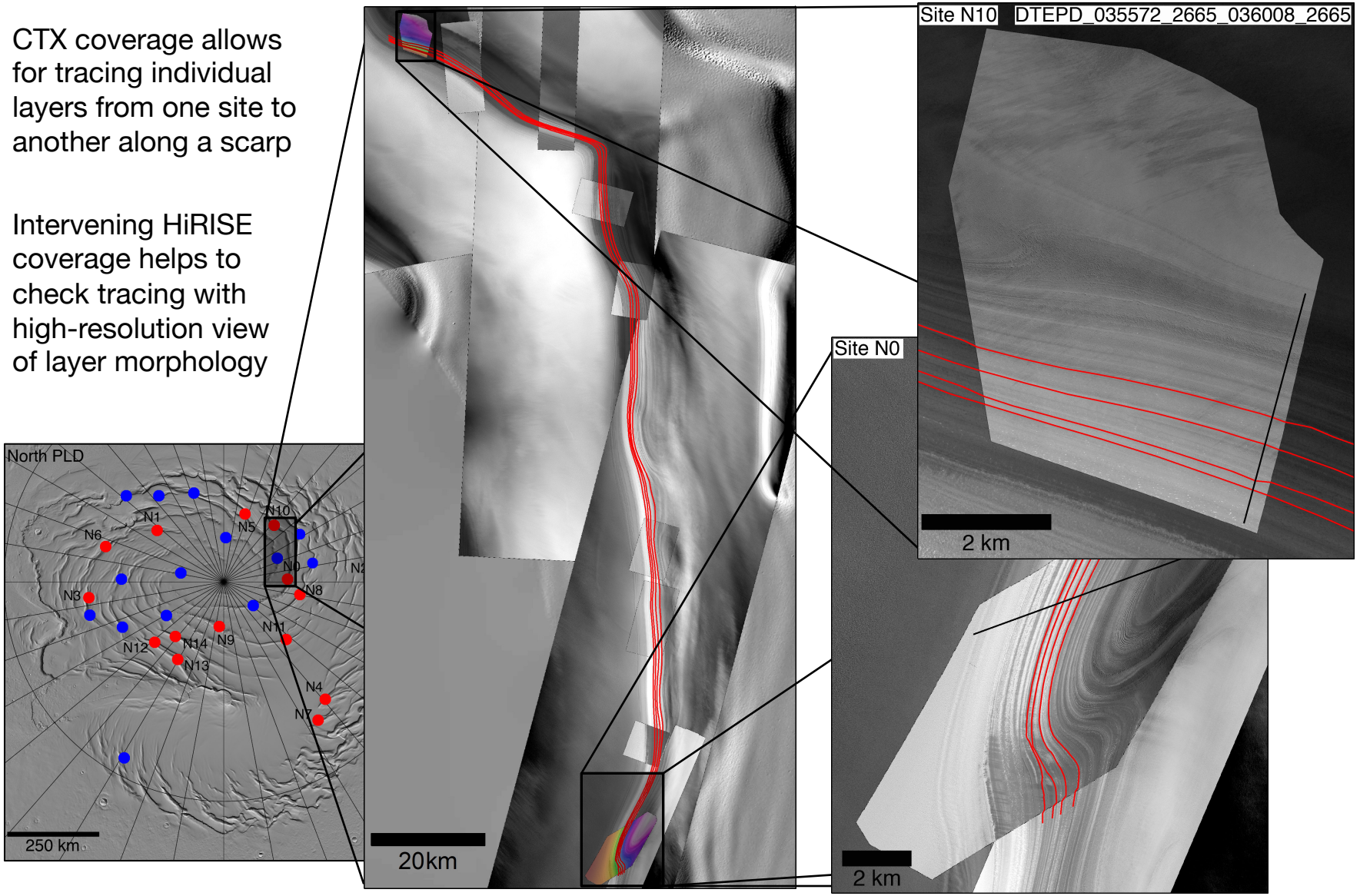
Bapst et al., LPSC, 2015.

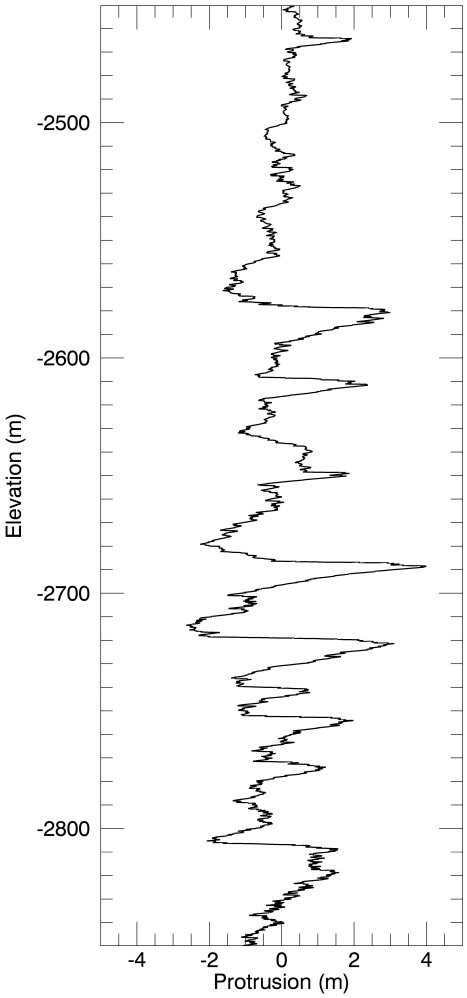
Correlation and analysis of NPLD layers with HiRISE DTMs

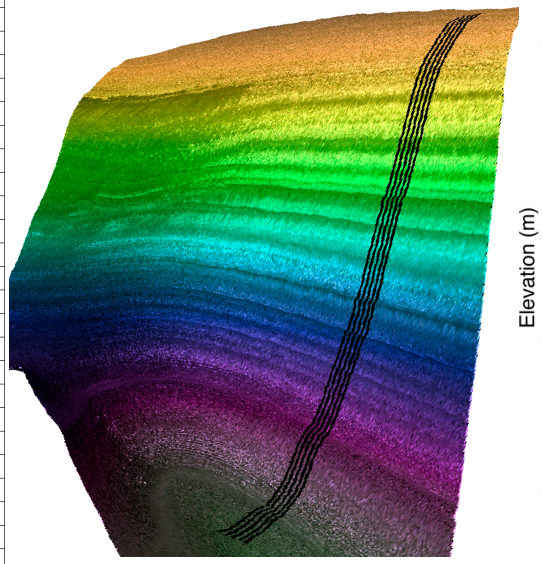
Becerra et al., LPSC 2015

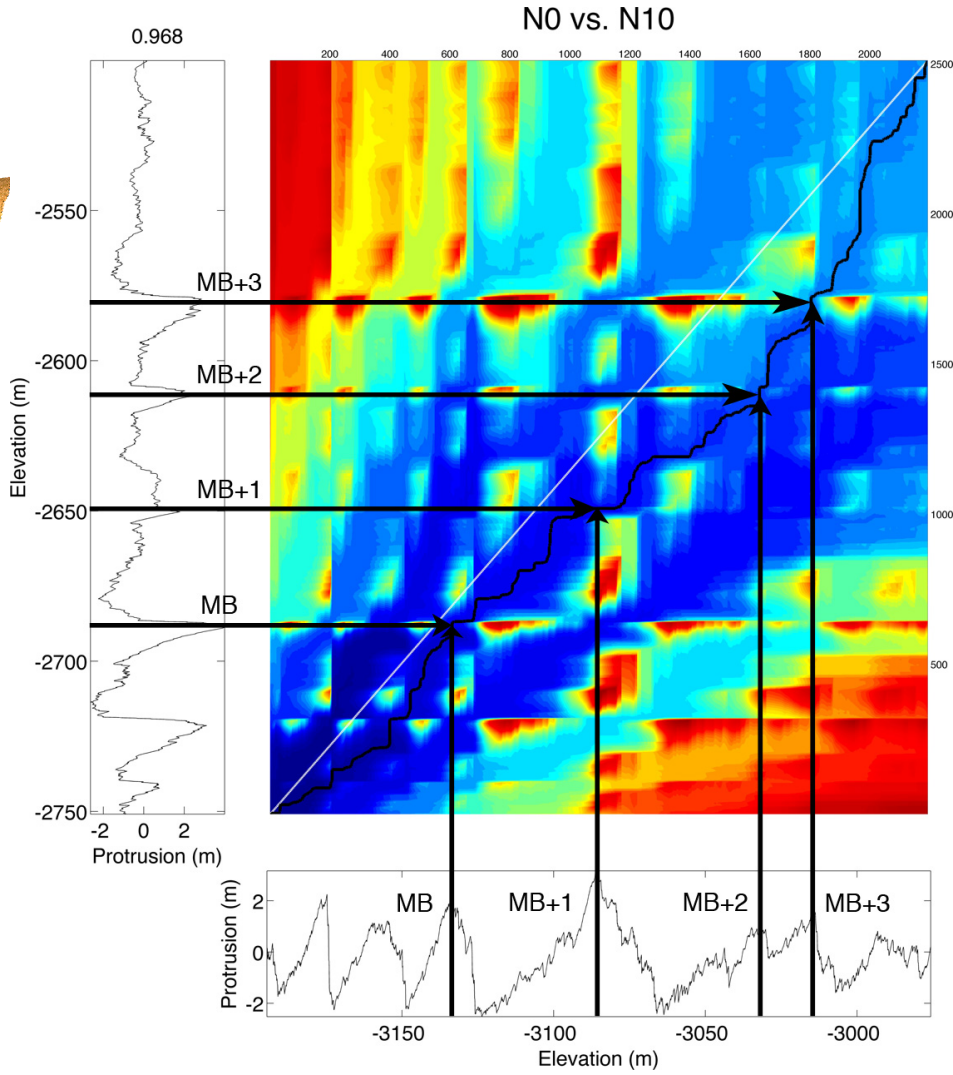
CTX coverage allows for tracing individual layers from one site to another along a scarp

Intervening HiRISE coverage helps to check tracing with high-resolution view of layer morphology









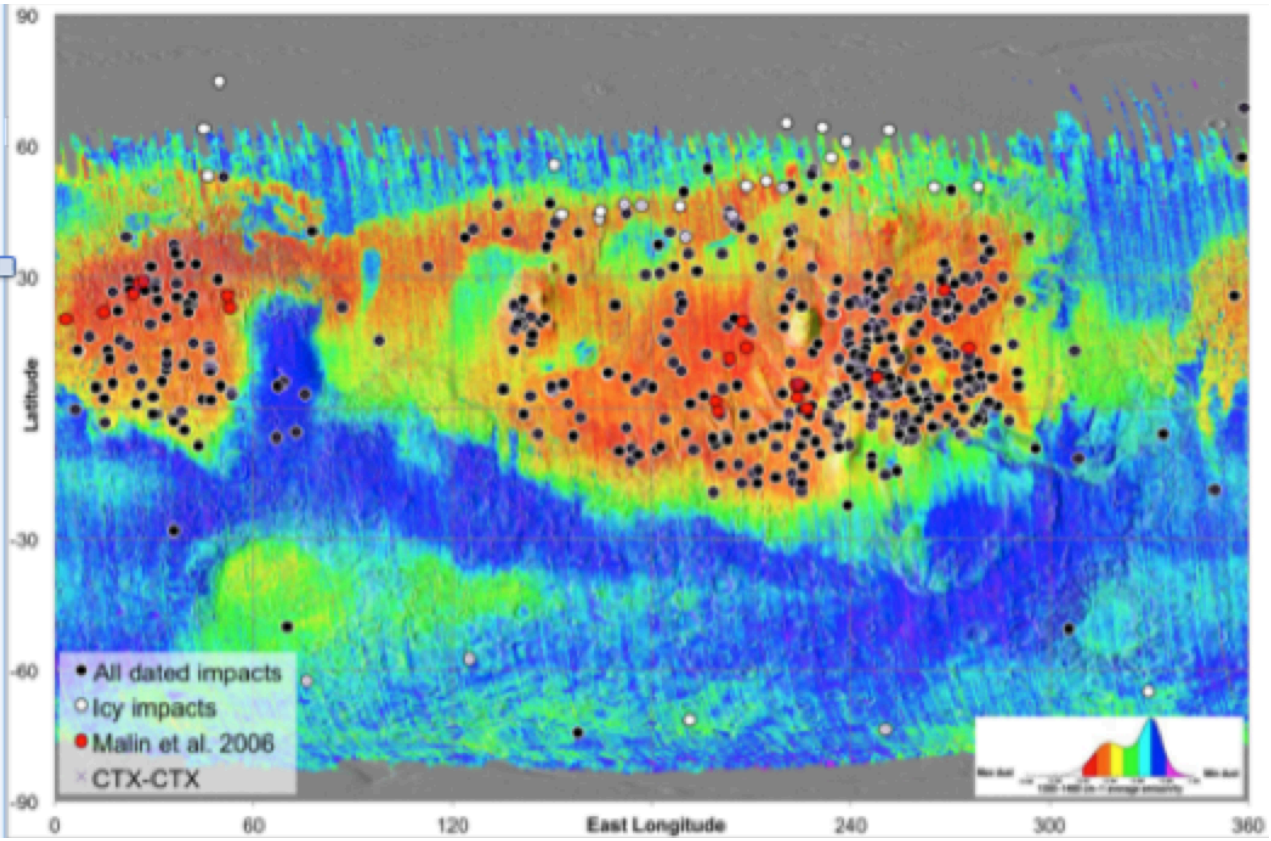
- Layer Protrusion used as stratigraphic signal
- Protrusion shown to be better than traditional layer brightness

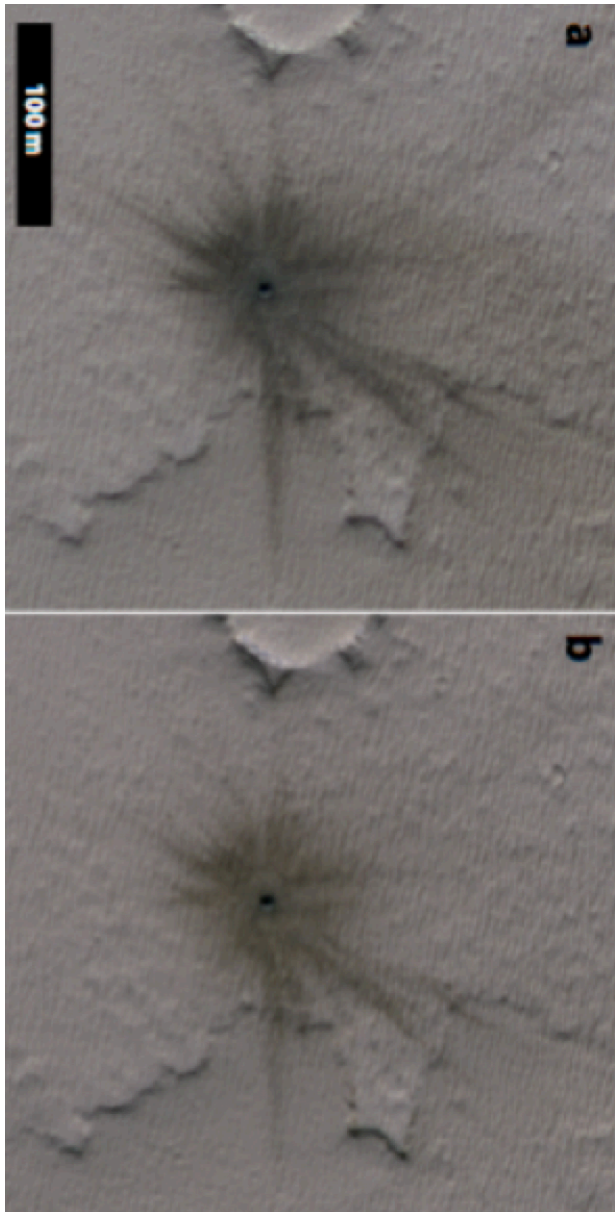
- Dynamic time warping can match signals and get relative accumulation rates as a function of depth
- Wavelet analysis (not shown) can tease out periodic signals that vary with depth

New Impacts and Support for Insight

We now have >489 confirmed newly formed craters

Refinements to impact rates, subsurface ice distribution & surface dust activity

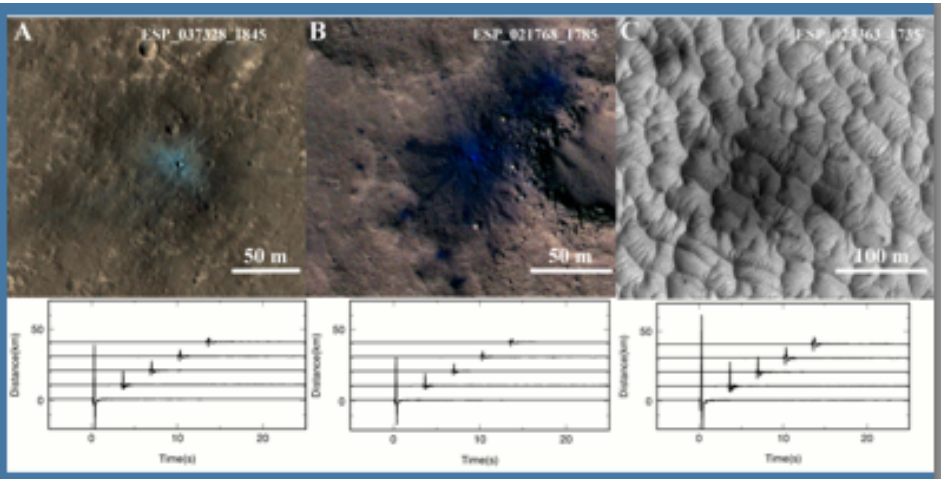




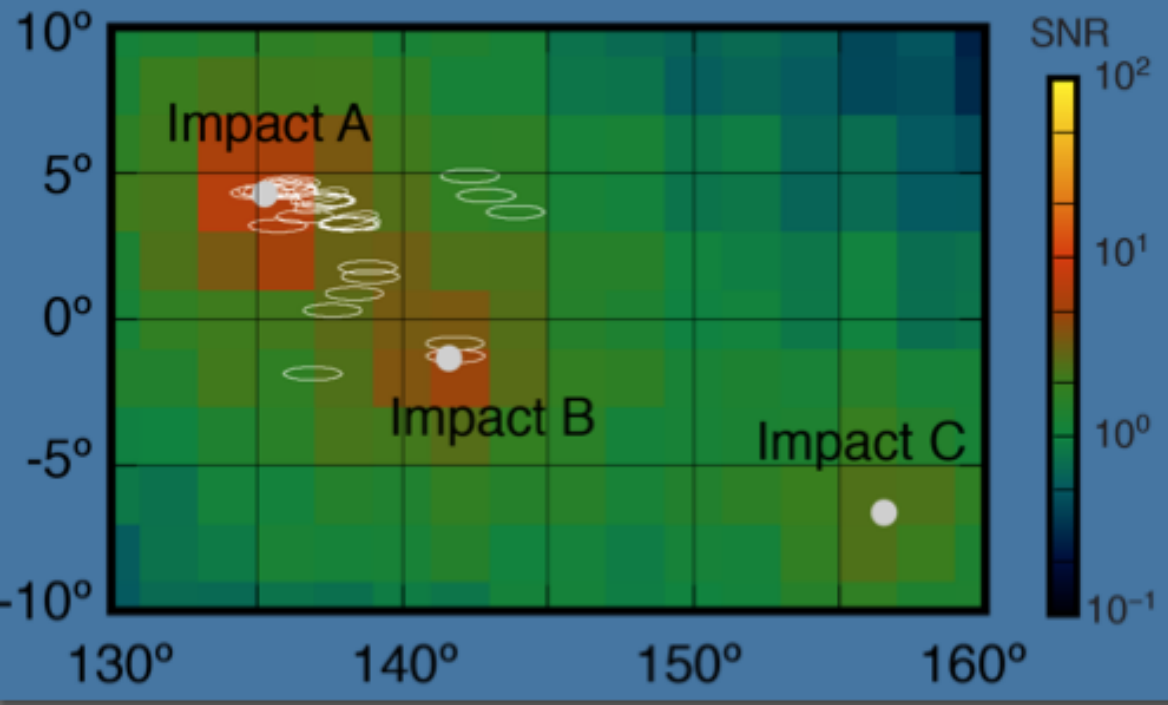
Daubar et al. 2015, Submitted to Icarus

Daubar et al., LPSC, 2015

- As long as the sensitivity of SEIS exceeds the background noise of Mars, we predict that impact A, possibly B, would have been detected by SEIS



- All other investigated impacts are too far away to have been detected.



Map of predicted SNR for impacts (white dots) located near InSight landing ellipses (shown before downselection). SNR is calculated using soft rock ($\eta=10^{-4}$), and an average background noise amplitude of 1 nm s^{-1} $Hz^{-1/2}$.

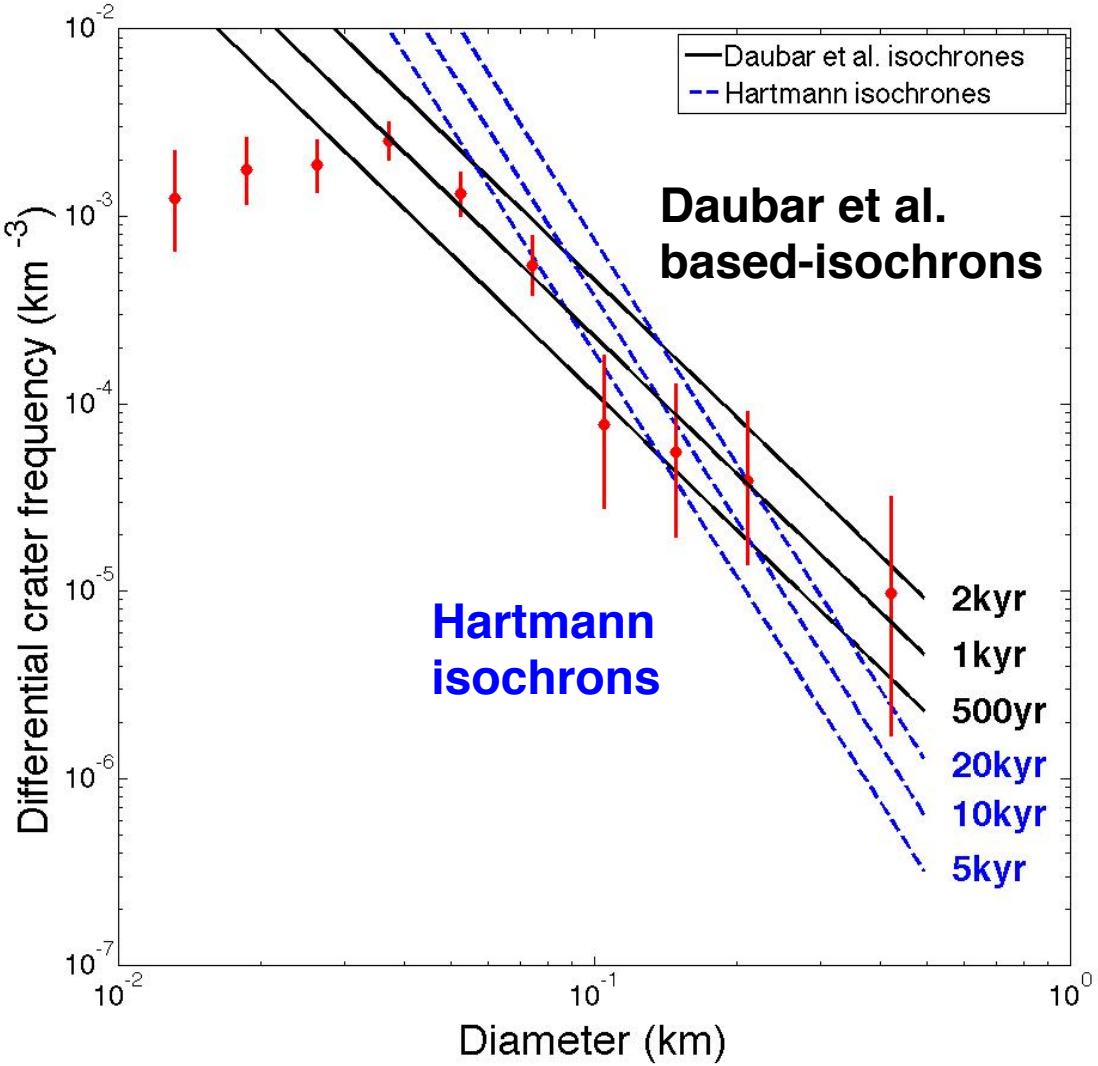
- Measured current and model production function CSFDs used to predict the number of impacts InSight will detect as a function of crater size: **~4-8 total impacts detected per Earth year (~8-16 in primary InSight mission)** [*Daubar et al., 2015]*

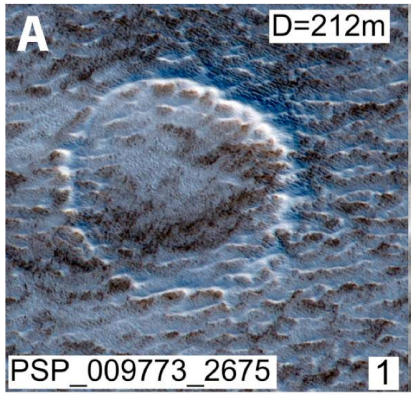
- Other factors that influence detectability, and that will continue to be investigated, are attenuation, scattering, impact velocity vector, topography, and further variations in target properties.

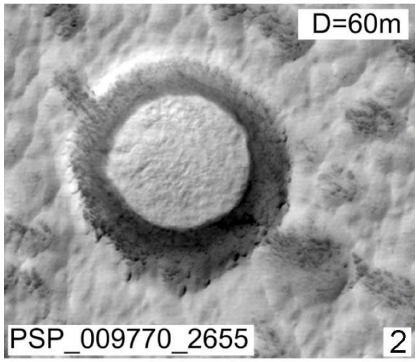
- This ongoing study will predict potential observations by future seismic missions such as InSight, and place constraints on the forms and amplitudes of seismic signals initiated by impacts.

Application of New Cratering Rates

New crater production function is changing our understanding of recent accumulation on the NPLD – rates may be an order of magnitude higher



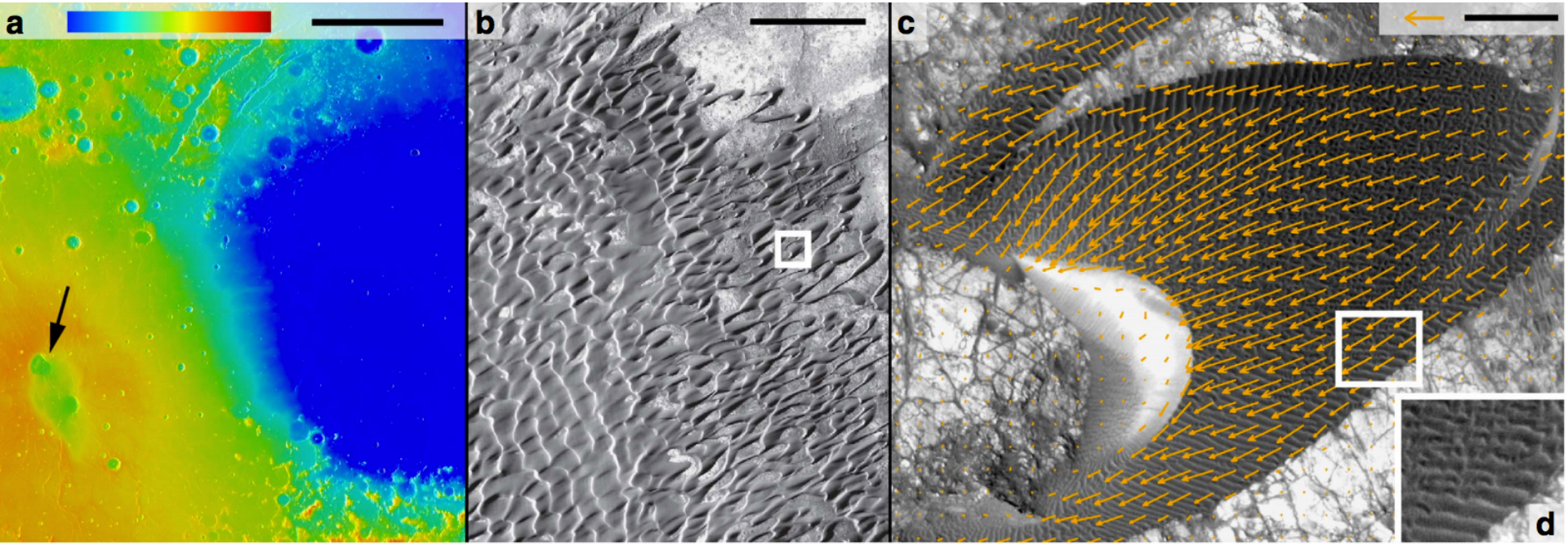




Landis et al., LPSC, 2015.

HiRISE Sand Flux Measurements and GCMs

Tracking features like ripple and dune motion yields sand fluxes.
Sand flux, and so wind strength, vary seasonally.
GCM comparison shows wind speeds needed to sustain saltation are only 1/10 of those required to initiate in a wind tunnel.



Nili Patera dune field (8°N, 293°E)
Ayoub et al., Nature Communications, 5, 5096.

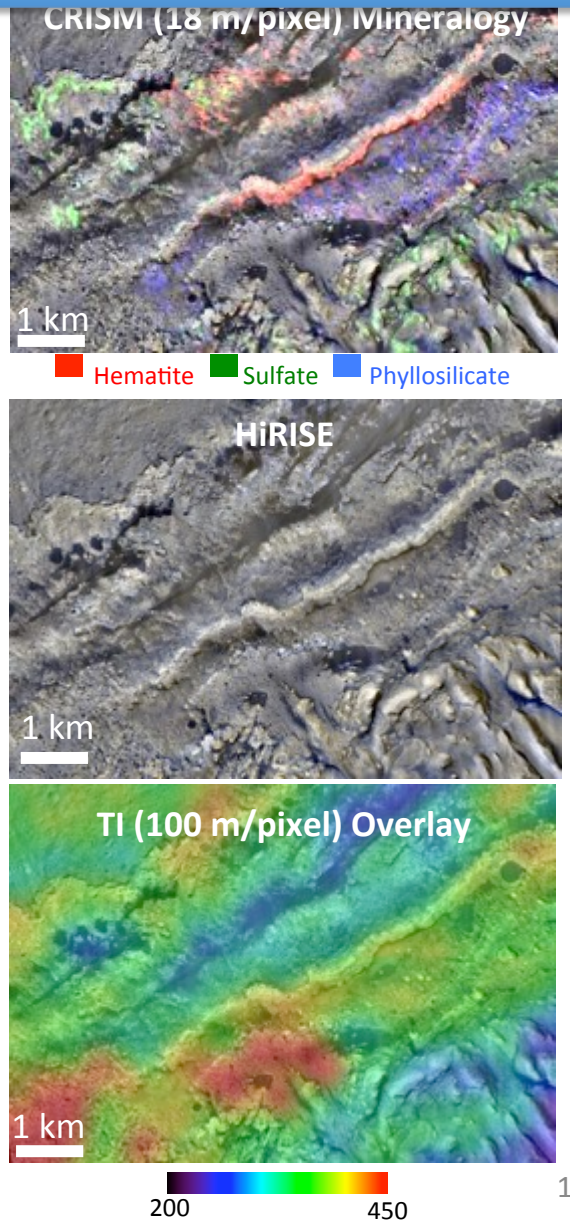
MSL dunes campaign underway now and showing ripple migration of ~1m/yr
Collaboration with CRISM to investigate dune material provenance

HiRISE/CRISM/Thermal analysis of Curiosity site

Association of Silica deposits with light-toned unit in HiRISE images (Fraeman, Ehlmann & Edwards)

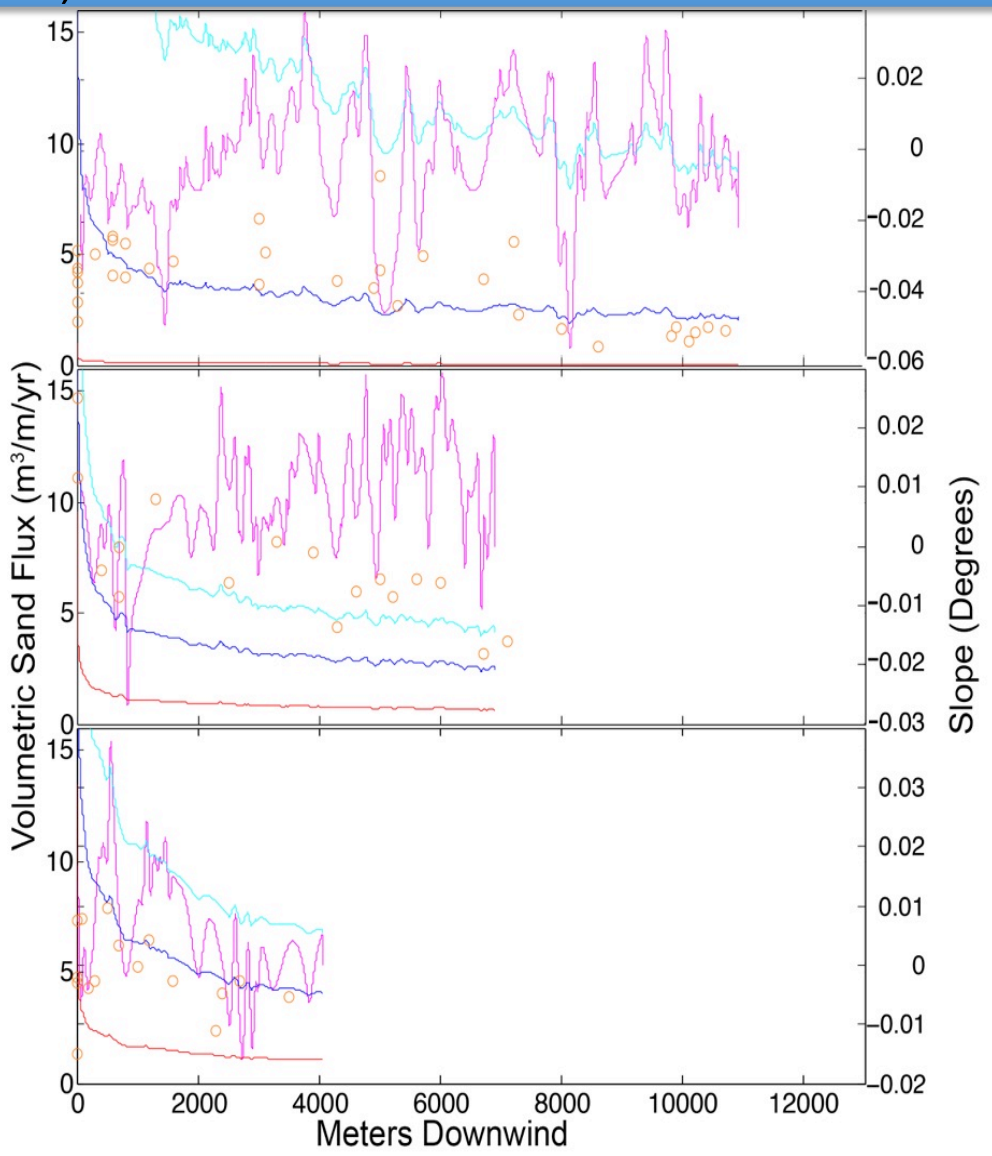
Goal: Detailed stratigraphic examination including mineralogy, morphology, thermophysical properties of units, with an emphasis on contact relationships

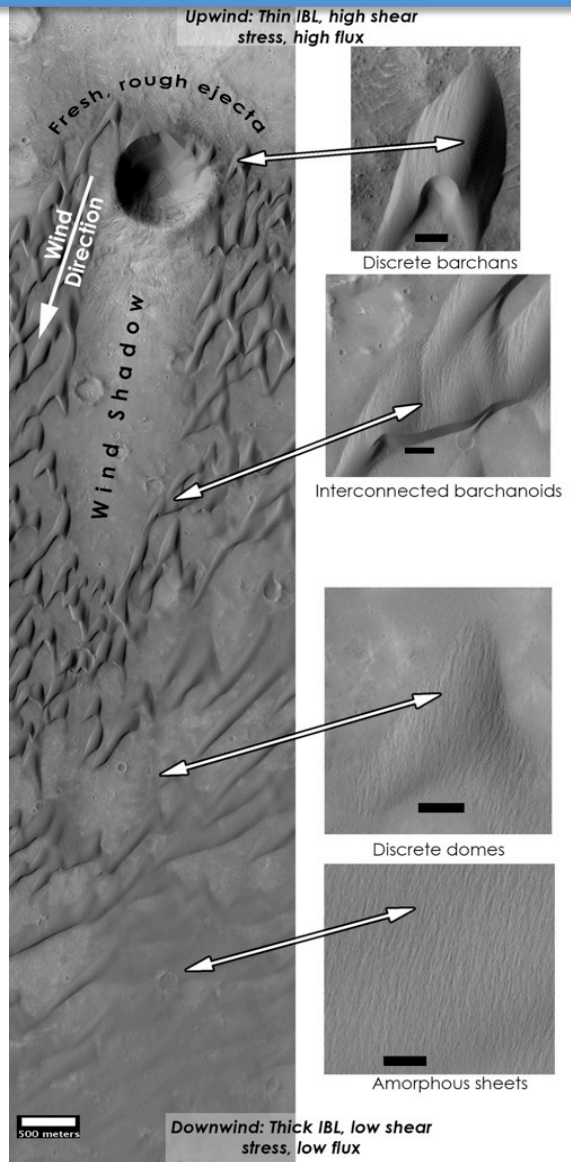
- **CRISM**: Normal CRISM observations + along-track oversampled datasets
- **HiRISE**: color mosaic of 8 normalized, orthorectified and georeferenced color images (Edwards et al., *JGR* 2011; Ashogan et al., *LPSC* 2014) and gray-scale images where no color coverage
- **TI:** new thermal inertia calculations to account for local slope, albedo, elevation



HiRISE Sand Flux Measurements and Dune Types

Volumetric Fluxes can now be broken up by individual dune type (Bridges and Runyon)



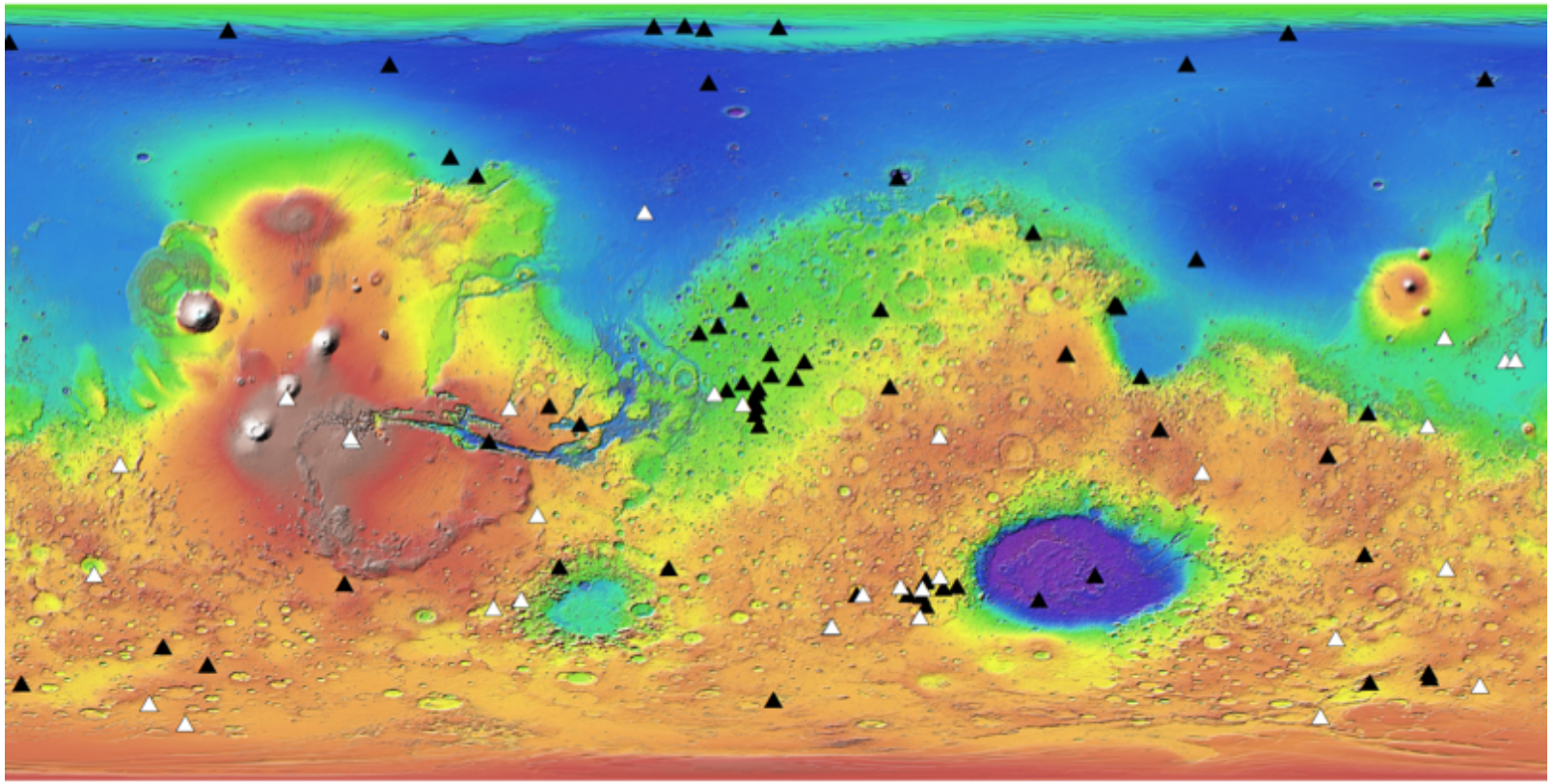


Dune motion is global

Concentrated in low albedo regions (Maria Banks)

Sediment flux is constant: migrating dunes are in steady-state (Matt Chojnacki)

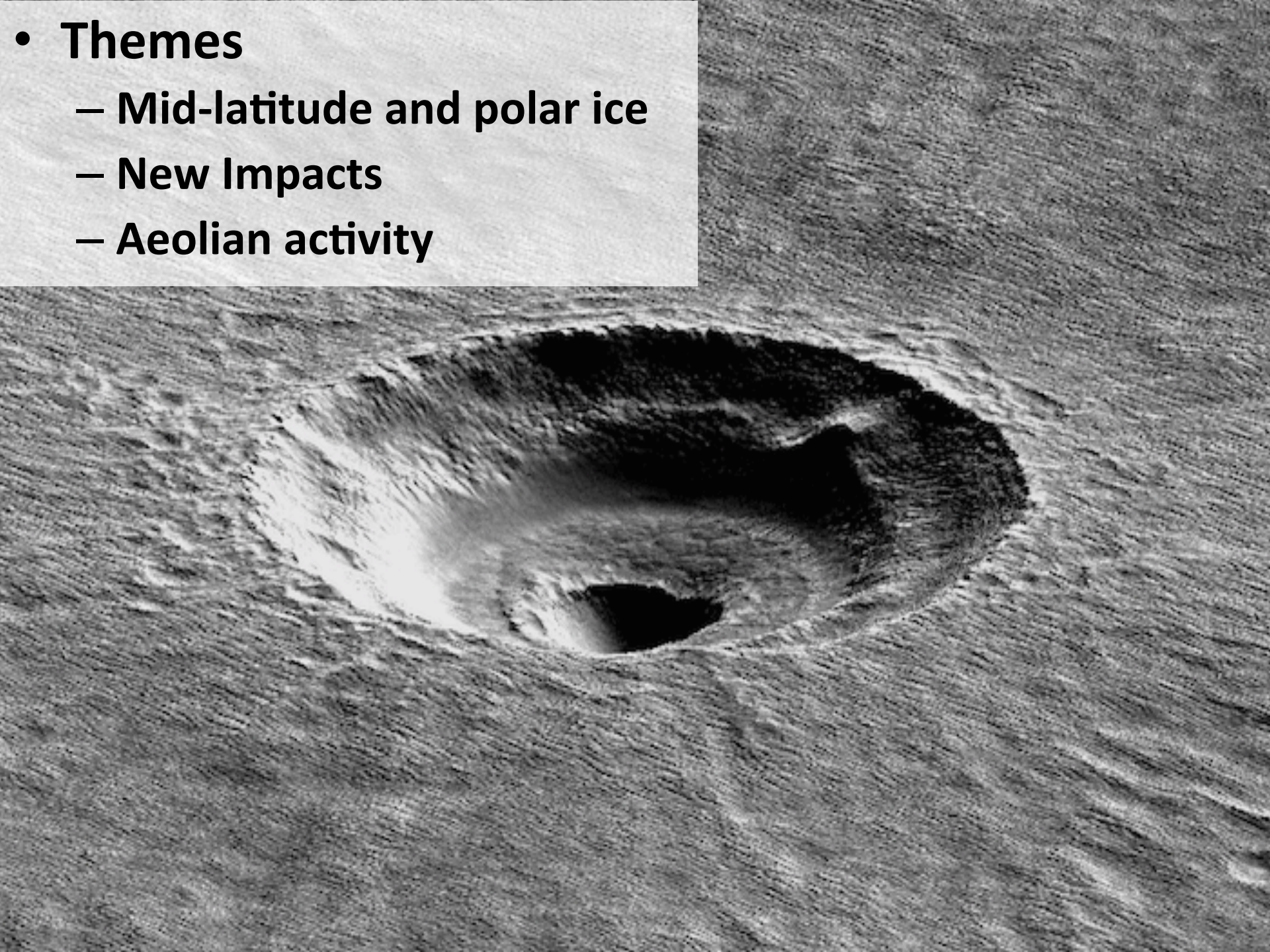
Locations of bedforms analyzed for changes (MOLA map):



Black triangles = movement detected
White triangles = no movement detected
Transverse Aeolian Ridges (TARs) not included

Data contributed by:
N. T. Bridges,
P. E. Geissler, S. Silvestro,
M. Chojnacki, M. E. Banks

◆ Locations of active bedforms indicate where winds above threshold occur.



- **Themes**
  - **Mid-latitude and polar ice**
  - **New Impacts**
  - **Aeolian activity**

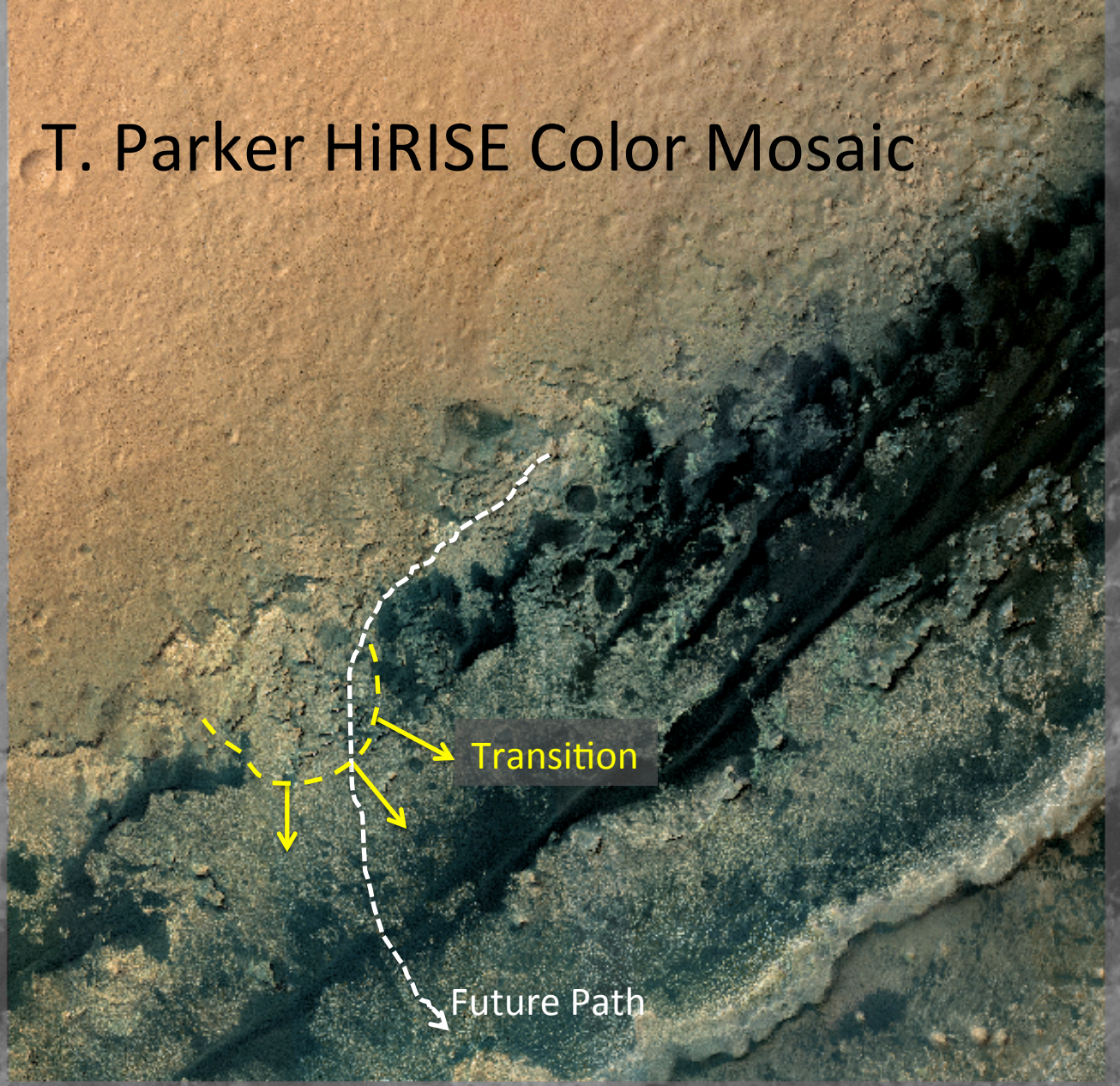
Spares

High resolution mapping of lower Mt. Sharp: Finding rover scale targets of interest and providing geologic context for Curiosity

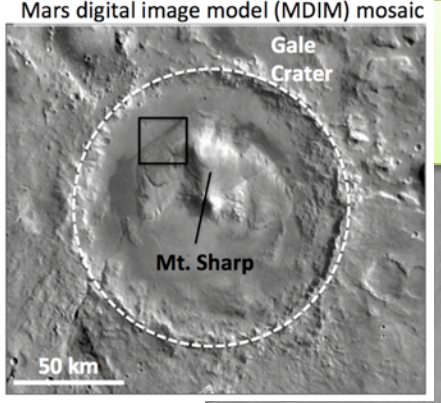
Abigail Fraeman (Caltech), Bethany Ehlmann (Caltech/JPL), Christopher Edwards (USGS Flagstaff)

HiRISE Team Meeting Presentation

1-7 Sept. 2015


T. Parker HiRISE Color Mosaic
Transition
Future Path

Lower Mt. Sharp Overview



Location #1

Curiosity traverse

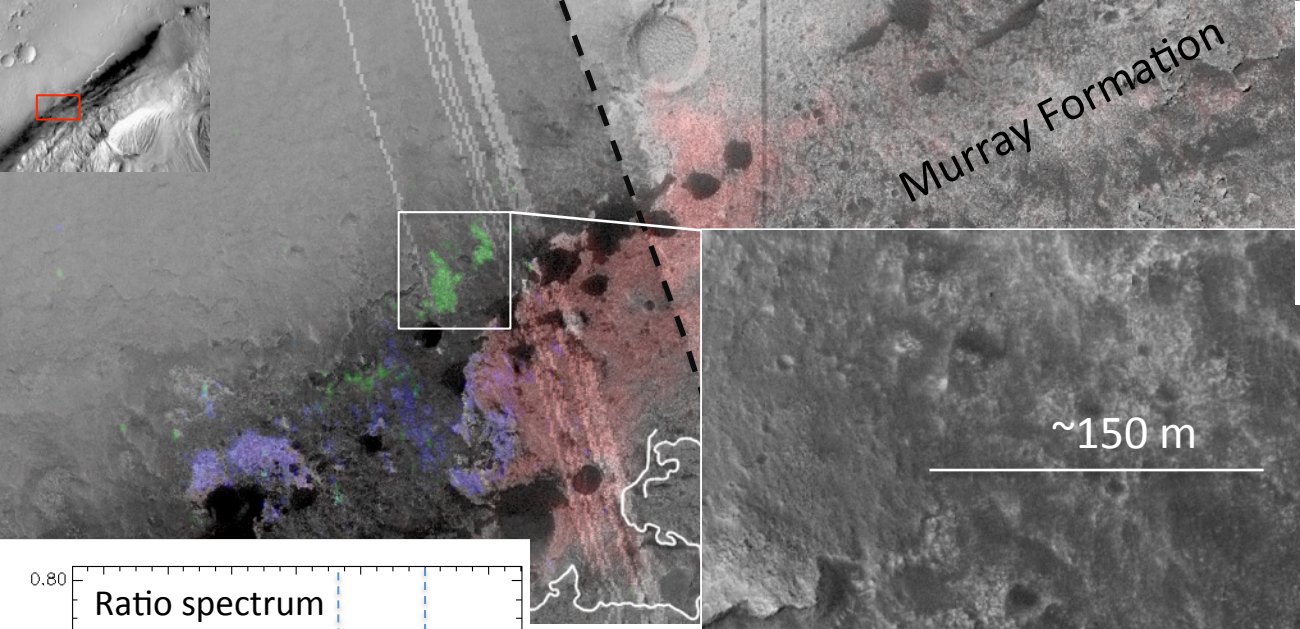
Murray Formation

Location #2

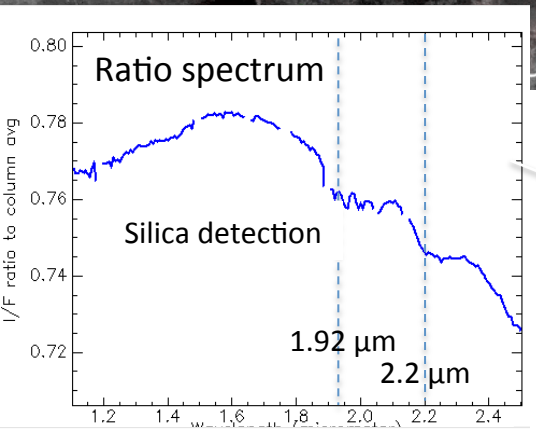
Curiosity future traverse

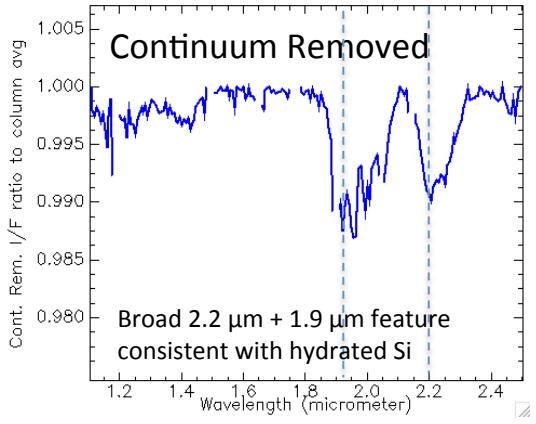
CTX Mosaic

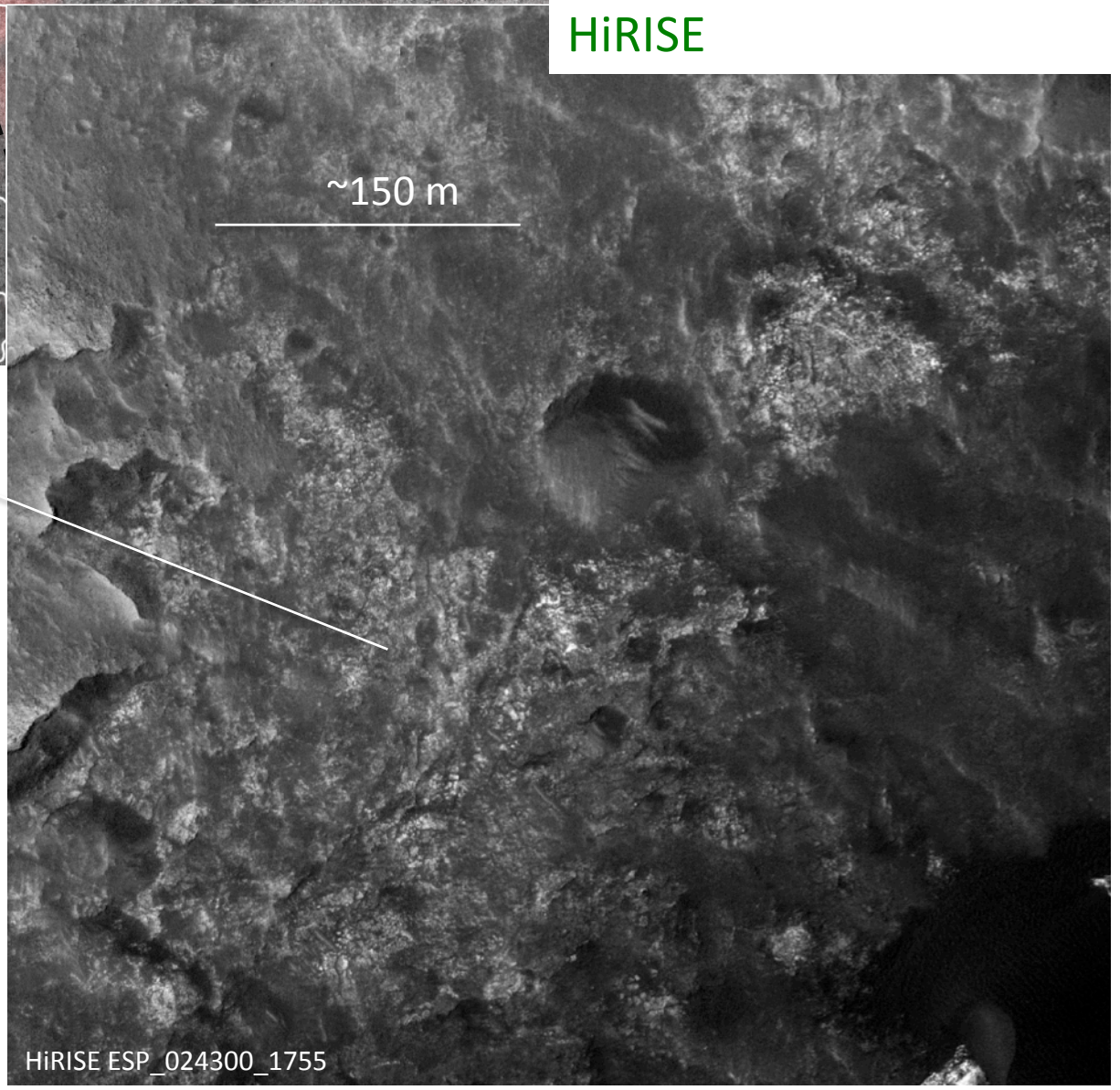
Loc 1 & 2: Clear evidence for overprinting by secondary diagenesis

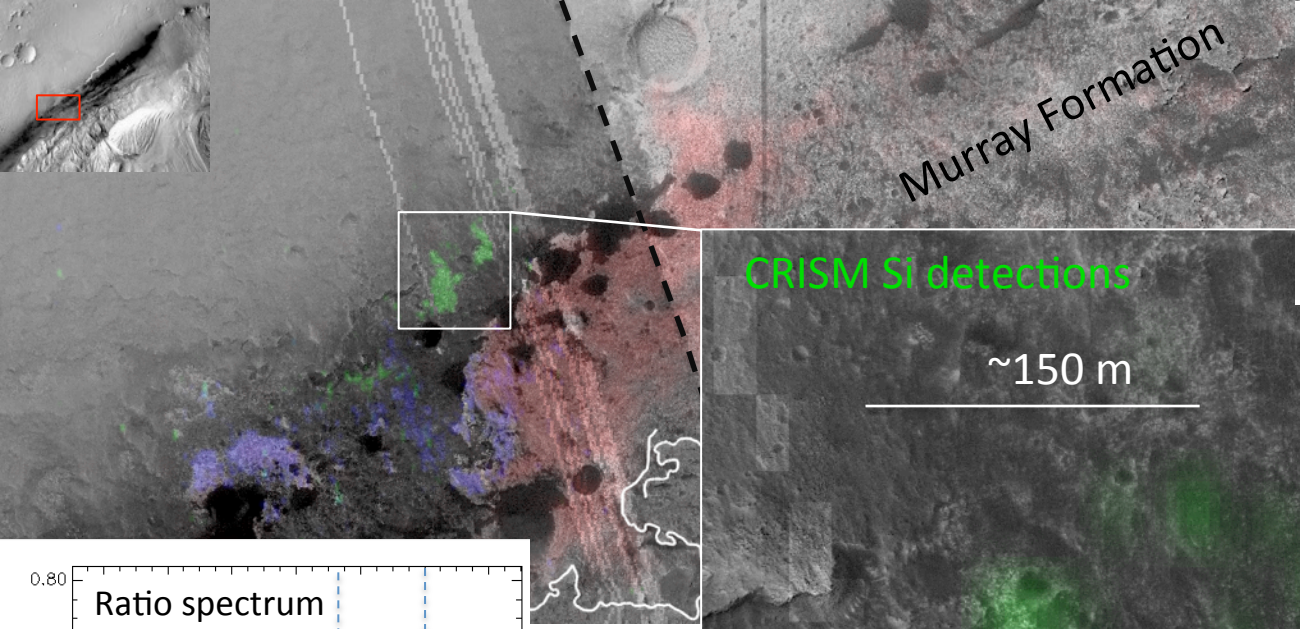


Silica deposit having clear association with light toned material in HiRISE





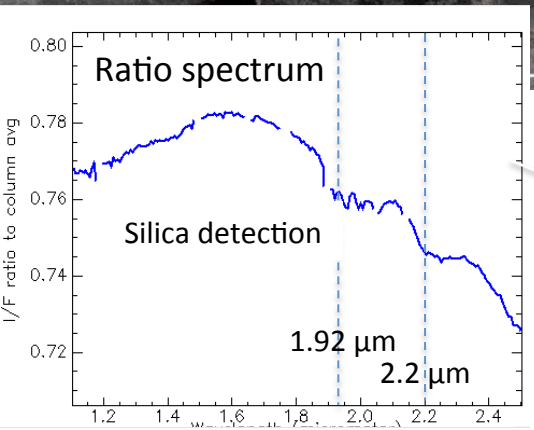


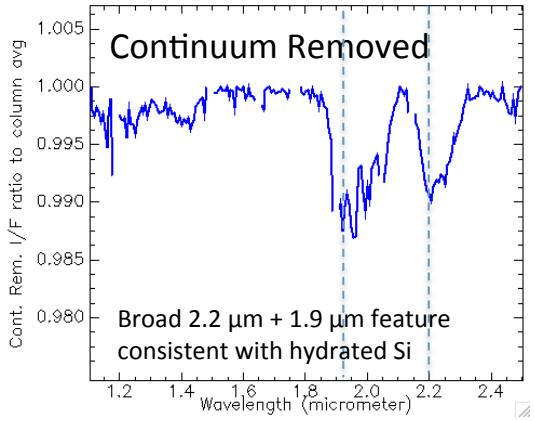


Silica deposit having clear association with light toned material in HiRISE

CRISM Si detections

~150 m





HiRISE ESP_024300_1755

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Ancient Martian Lakestands and Fluvial Processes in Iani Chaos: Geology of Light-Toned Layered Deposits and their Relationship to Ares Vallis Outflow Channels

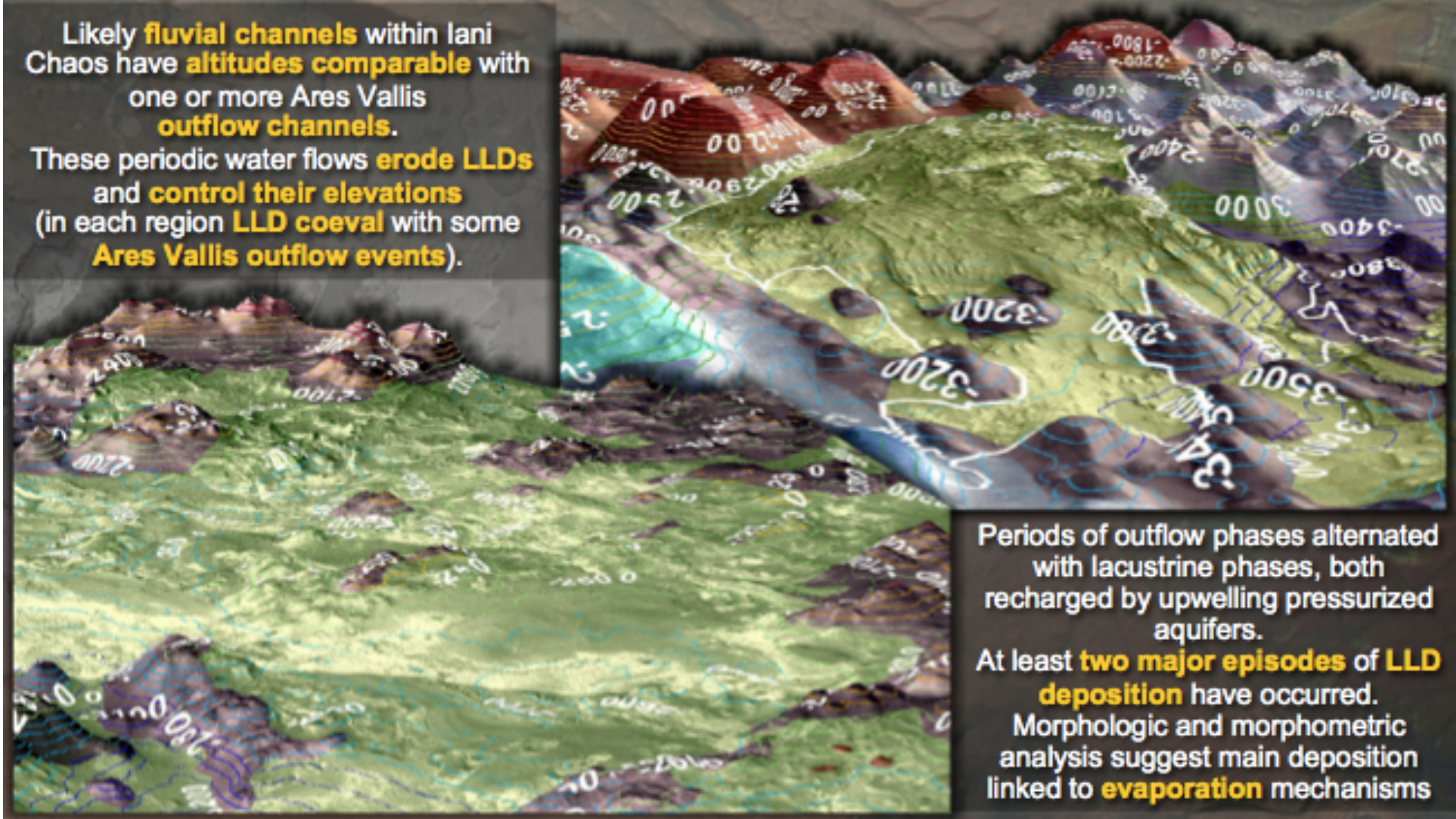
HiRISE - CaSSIS
Joint Team Meeting

Iceland
September 1-7, 2015

Email: luca.guallini@space.unibe.ch

CONCLUSIONS
Main Key-Results

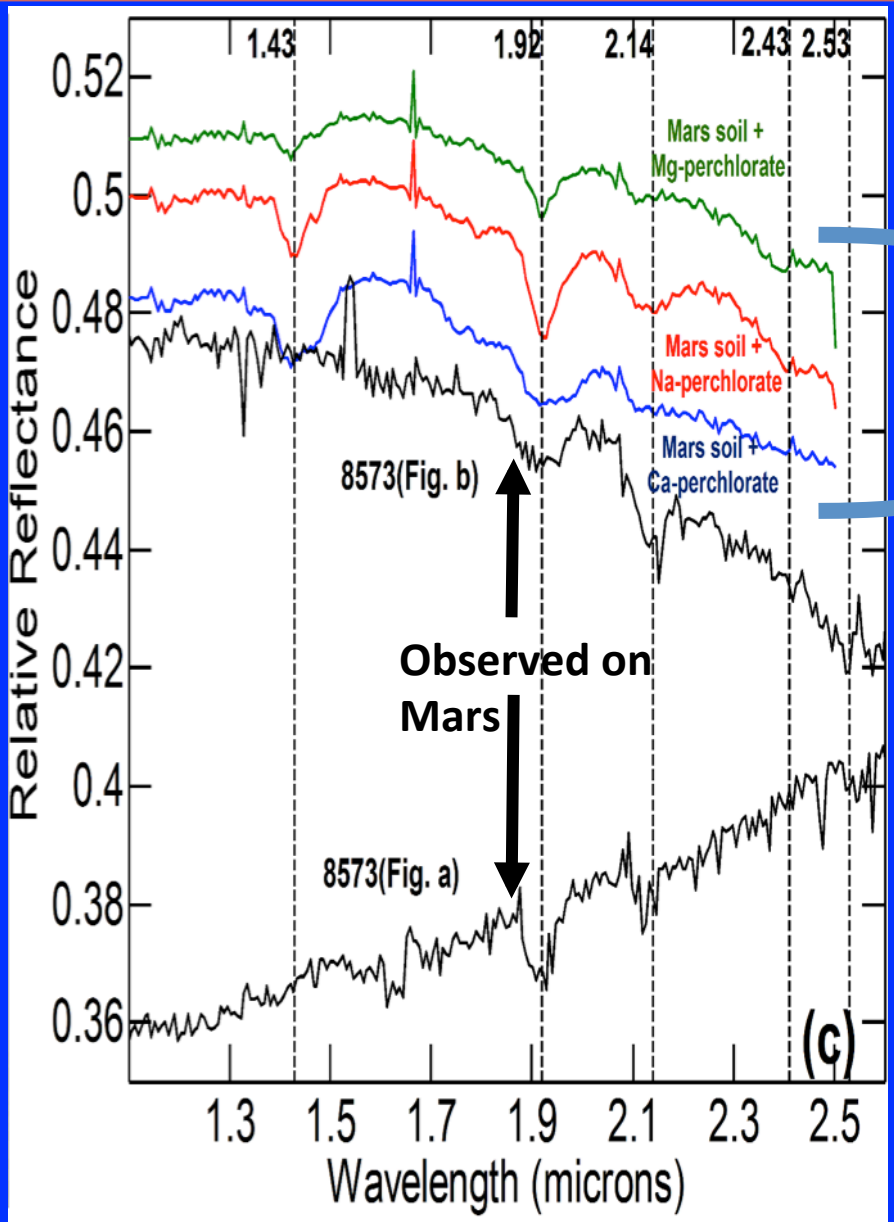
Likely **fluvial channels** within Iani Chaos have **altitudes comparable** with one or more Ares Vallis **outflow channels**.
These periodic water flows **erode LLDs** and **control their elevations** (in each region **LLD coeval** with some **Ares Vallis outflow events**).



Periods of outflow phases alternated with lacustrine phases, both recharged by upwelling pressurized aquifers.
At least **two major episodes** of **LLD deposition** have occurred.
Morphologic and morphometric analysis suggest main deposition linked to **evaporation** mechanisms

L. GUALLINI *et al.*
luca.guallini@space.unibe.ch

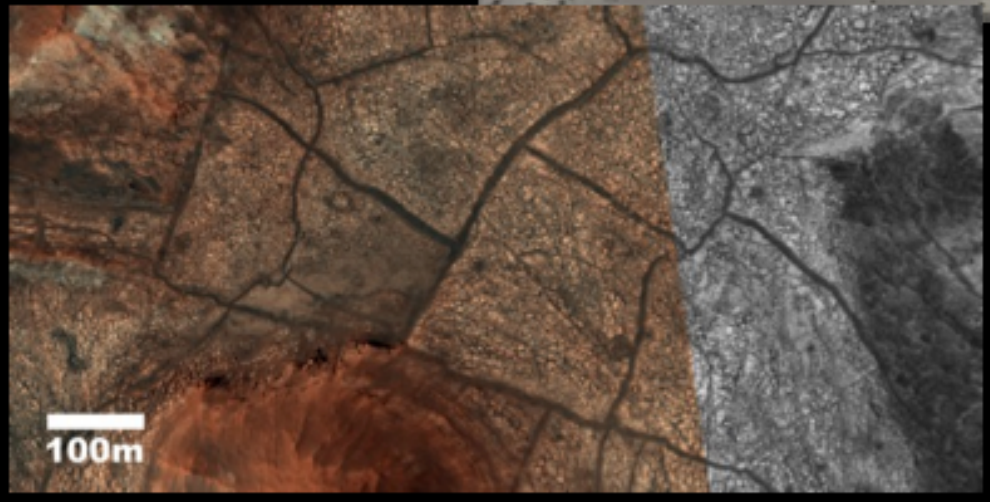
Results from Spectroscopy

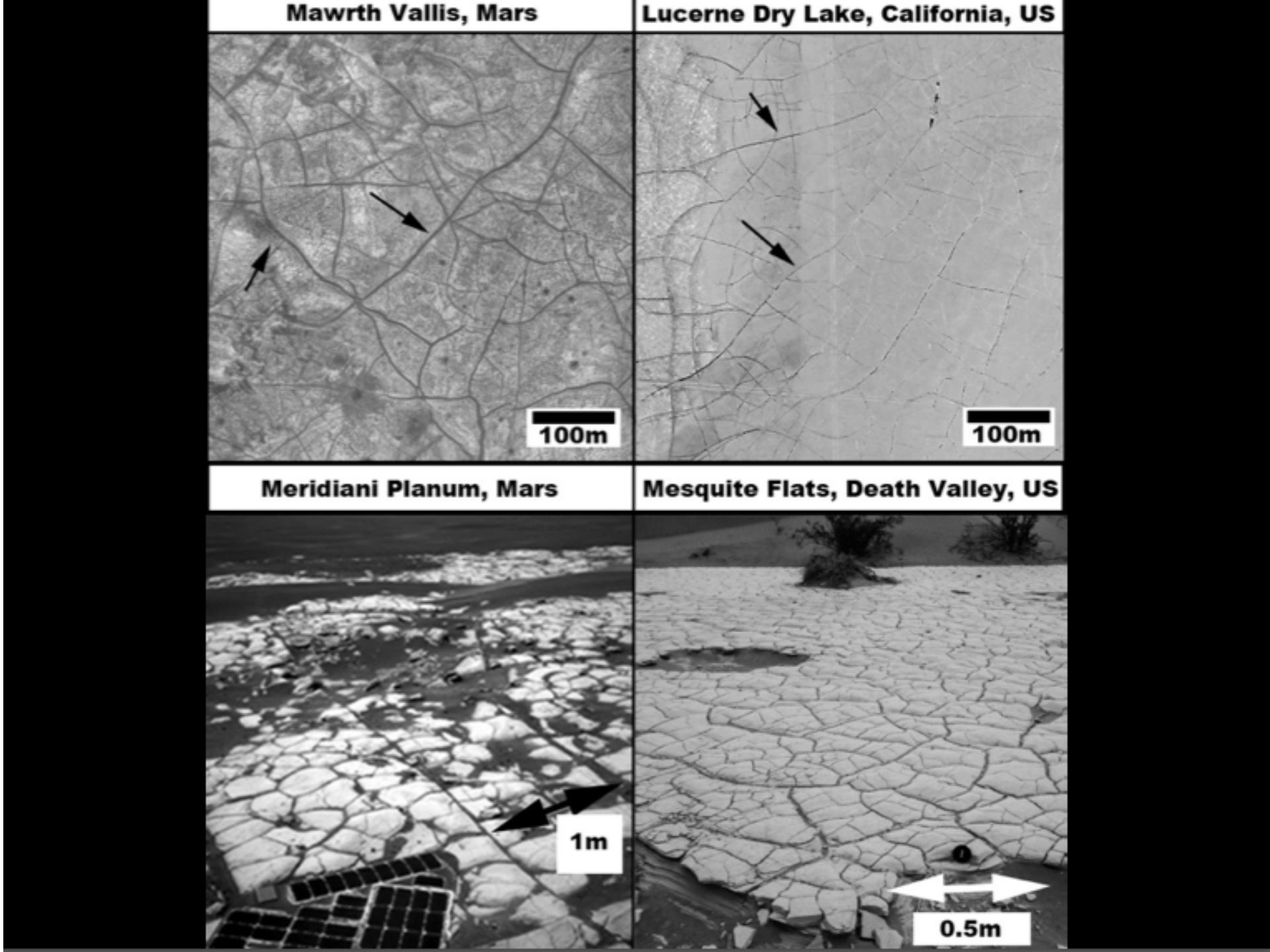


Laboratory Observations

1: Field Investigation of Dried Lakes in Western United States as an Analogue to Desiccation Fractures on Mars

Ramy El-Maarry




Mawrth Vallis, Mars
Lucerne Dry Lake, California, US
100m
100m
Meridiani Planum, Mars
Mesquite Flats, Death Valley, US
1m
0.5m

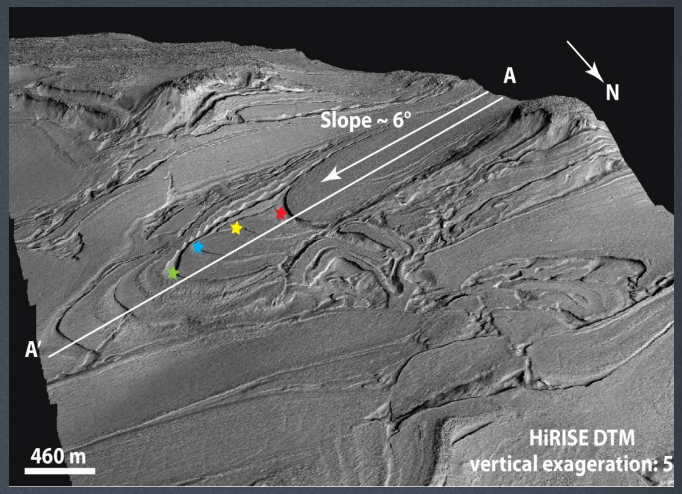
Summary

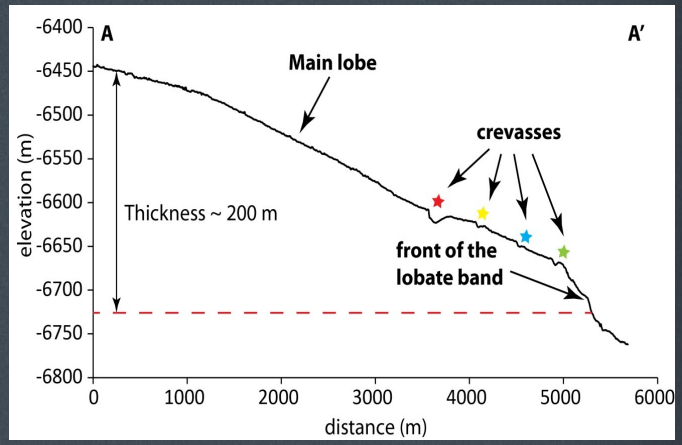
- Dried lakes contain clays mainly illite/muscovite, and smectite.
- Large desiccation fractures require fine soil matrix and groundwater activity.

Full study currently in review in JGR…

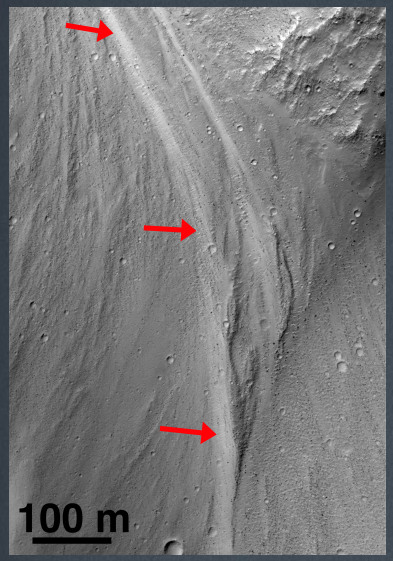
Glacial Flows in the Hellas Basin

- Geomorphologic mapping using HiRISE and CTX images and DTMs has revealed an enigmatic unit named banded terrain made up of an alternation of bands and inter-bands
- Many of these bands display signs of viscous flow with frozen structures in the slope and multiple smooth changes in direction. In other words, these are glaciers.
- The morphology of the bands seems to be controlled by the topography and the competition of the flows of the adjacent bands
- Results published in Diot, X., et al., 2014. PSS 101(0), 118–134. http://dx.doi.org/10.1016/j.pss.2014.06.013



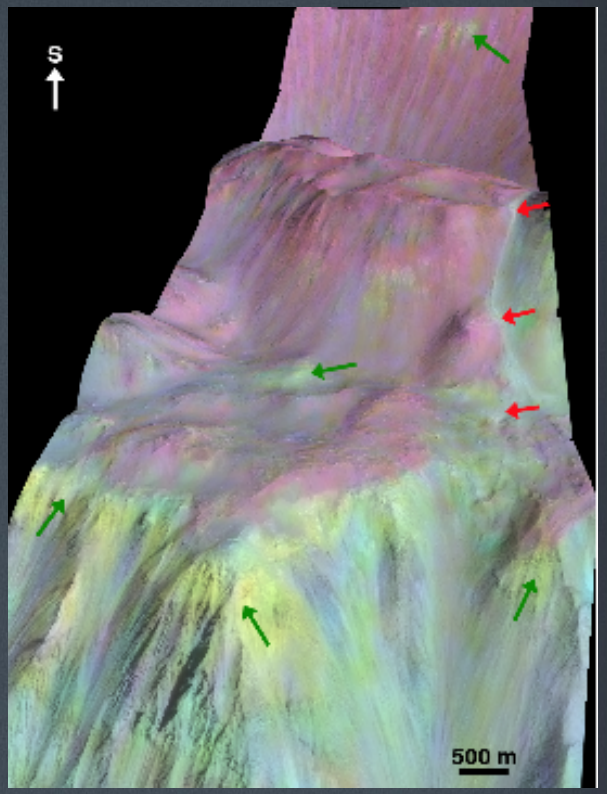


Fresh Exposures of Hydrous Fe-bearing Amorphous Silicates on Mars



Channel containing Fe-allophane/opal (red arrows). Portion of HiRISE image PSP_008141_1645.

- Discovered relatively fresh exposures of a hydrated, amorphous material along the wallrock slopes in Coprates Chasma, Mars.
- CRISM reflectance spectra extracted from the deposits exhibit broad absorptions at 1.42, 1.94, and ~2.25 μm that are most consistent with laboratory spectra of nanophase hydrated Fe-rich allophane and Fe-rich opal.

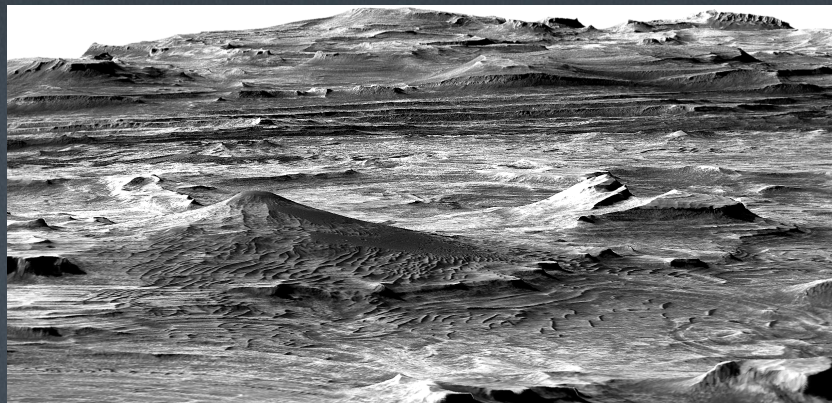


HiRISE DTM perspective view at 2X vertical exaggeration with CRISM spectral parameters overlain in color. Red arrows identify an Fe-allophane/opal deposit (whitish blue), which extends across 940 m in elevation, whereas green arrows identify exposures of smectites within the wallrock (yellow-light green).

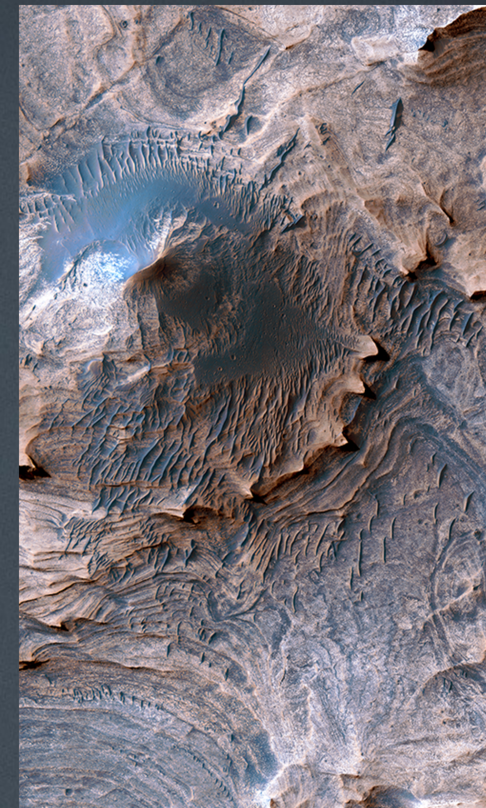
- At this time, the Fe-rich allophane/opal deposits at Coprates appear to have some of the strongest hydration signatures yet detected on Mars using CRISM data, indicating a young exposure time and minimal time for dehydration.
- The discovery of new Fe-bearing hydrated amorphous silicates by orbital spectroscopy provides additional information about the history of water and aqueous alteration on Mars, and is consistent with the detection of hydrated amorphous phases by rovers on the martian surface.
- Results published in Weitz C.M. et al. (2014) Geophysical Research Letters 41, 8744-8751.

HIRISE

Marsquakes and Water-Lain Sediments in Candor Chasma



Perspective view of the Candor Colles region of west Candor Chasma, Mars. HiRISE image PSP_001641_1735



An injectite megapipe (conical hill). Image is ~1 km across. HiRISE image PSP_001641_1735

- Unprecedented high-resolution geologic and structural mapping using HiRISE data has revealed evidence of past marsquakes and water-lain sediments in the west Candor Chasma region of Valles Marineris.
- Orientations of the sediment layers indicate that these rocks formed as sand and dust was blown in by the wind and became trapped in shallow playa lakes.
- Injectite megapipes are also observed. These features formed by underground movement of the water-lain sediments in response to ground shaking (marsquakes) from several large fault zones in the area.
- These injectites served as reservoirs for groundwater and thereby would have hosted potentially habitable environments in the Martian subsurface approximately 3 to 3.5 billion years ago.
- Results published in Okubo, C.H., 2014, Bedrock geologic and structural map through the western Candor Colles region of Mars: U.S. Geological Survey SIM 3309, scale 1:18,000, http://dx.doi.org/10.3133/sim3309.

Threshold For Sand Motion on Mars Determined With HiRISE Images

Old View: The wind strength required to move sand on Mars was highly uncertain

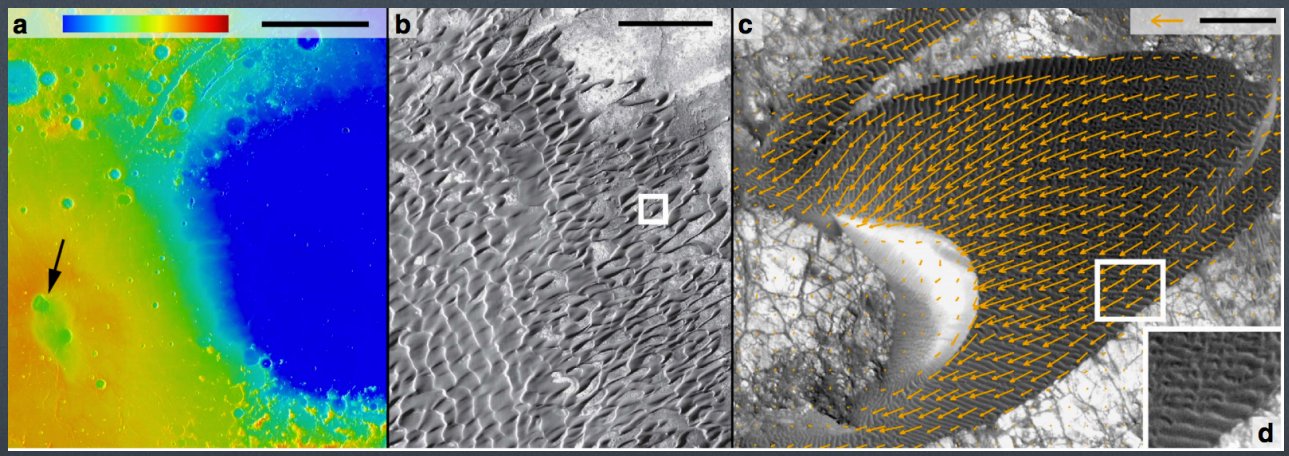
New View: HiRISE measurements show that dune sand flux, and therefore wind strength, varies seasonally. Tying these measurements to general circulation models shows that that the wind strengths needed to move the sand are about 10% of previous estimates based on wind tunnel data*.

Why: The average flux of sand is driven by both higher wind speeds from gusts needed to initiate motion, and lower speeds necessary to maintain it. At scales of several kilometers seen from HiRISE, this “effective” threshold for motion is a mixture of these two components.

Implication: This measured value provides a calibrated input into climate models where detailed observational data are lacking, allowing the accurate prediction of sand fluxes across the planet.

Future work: Continued monitoring by MRO/HiRISE will refine these estimates for Nili Patera and other regions on the planet.

Location of the study area in the Nili Patera dune field, Mars (8°N, 293°E)

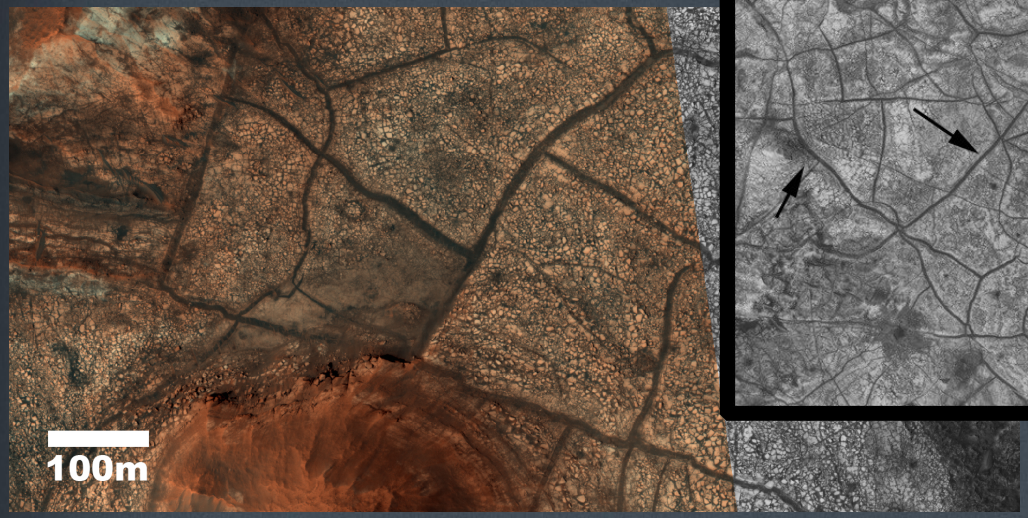


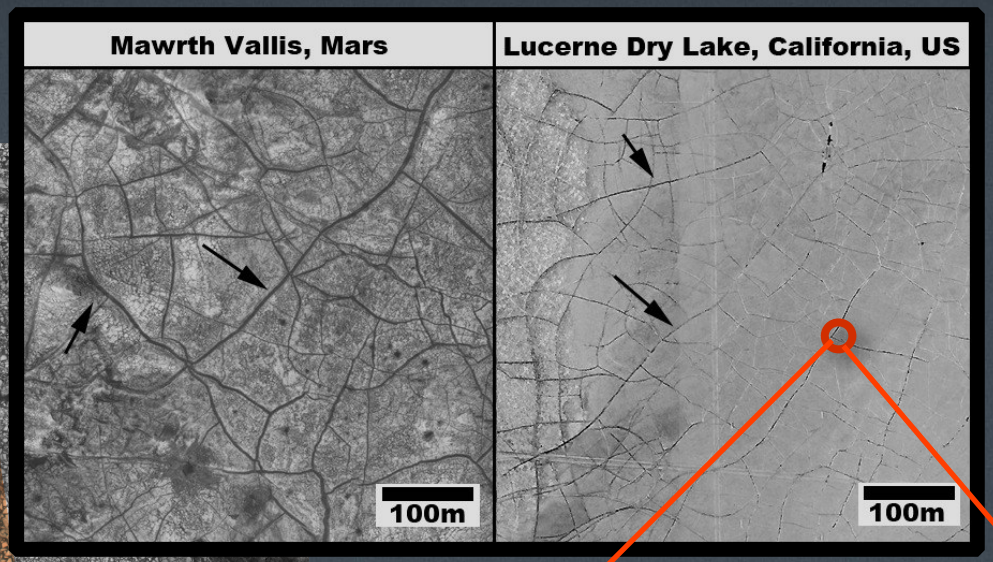
*http://www.nature.com/ncomms/2014/140930/ncomms6096/pdf/ncomms6096.pdf

HIRISE

Large “Mud Cracks” on Mars

Mawrth Vallis, Mars (HiRISE image PSP_006755_2030)





- Large polygonal surface features resembling giant mud-cracks are observed by HiRISE in many locations on Mars.
- They are located in areas that display minerals that may have formed in ancient lakes and rivers.
- When these ancient lakes dried out, they may have produced these beautiful features.

Significance

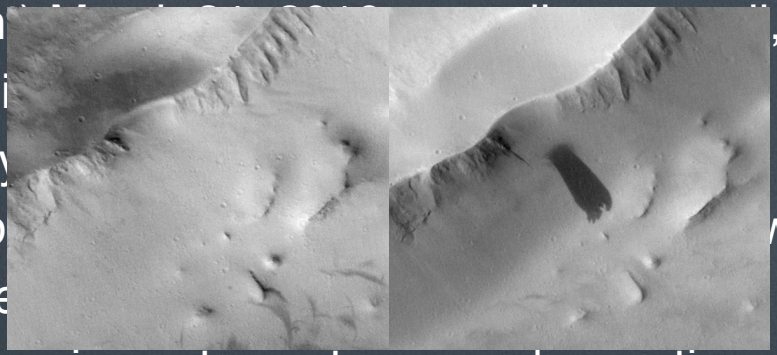
The presence of giant mud cracks can be used as an identifying tool of areas that may have harbored lakes **and possibly life** on ancient Mars.

El-Maarry et al., 2014, (Icarus)

HIRISE

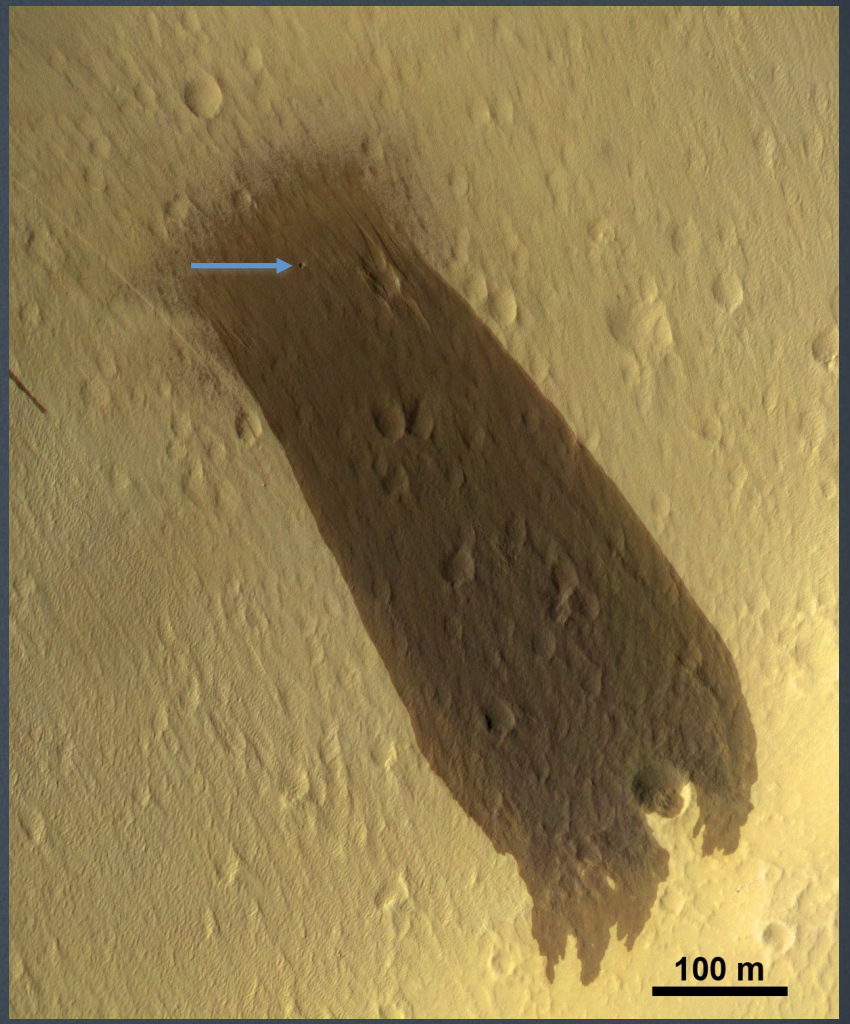
Impact-triggered dust avalanche on Mars

MRO's Context camera (CTX) acquired the image at lower left on Nov 18, 2007 and the adjacent image on Feb 14, 2010, showing a large new slope streak in the aureole (giant landslide deposits) of Olympus Mons. Slope streaks (dust avalanches) are common on Mars but this one is unusually wide and it began from an unusual extended/fuzzy source area. HiRISE acquired the follow-up image (righ , pristi fuzzy air-b w (rece that an impact event occurred sometime between the dates of the CTX images and triggered a large dust avalanche.



P13_006153_2133_XN_ 33N141W_071118

B18_016662_2087_XN_ 28N140W_100214



Mars Sand Dunes on the Move

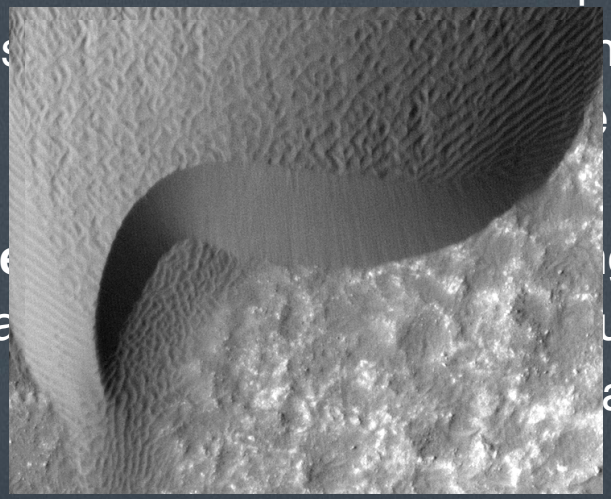
Old View: Winds strong enough to blow sand occur in just a few locations

New View: This happens in many places on the planet as shown in HiRISE camera pictures from MRO

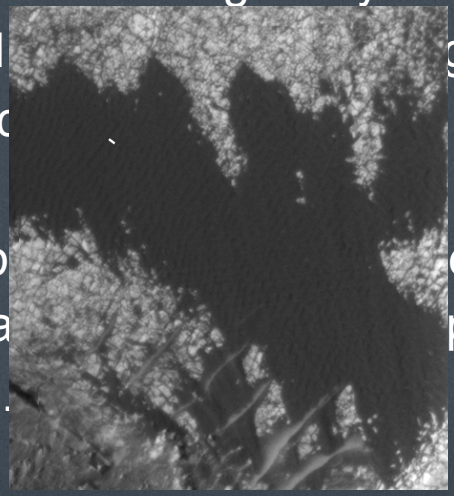
Why: Winds on Mars more gusty and carry more sand than previously thought

Implication: Current Mars winds capable of moving many dunes. Immobile dune[illegible]ned grains, are [illegible]nt c[illegible]

Future [illegible]g b[illegible]dvance our understa[illegible]urfa[illegible]processes on [illegible]ars.



Moving dune in Herschel Crater between March 3, 2007 and December 1, 2010.



Moving sand patch in Becquerel Crater between November 24, 2006 and September 5, 2010.

HIRISE