

SW Melas Basin

# Context of Southwestern Melas Basin (Valles Marineris)

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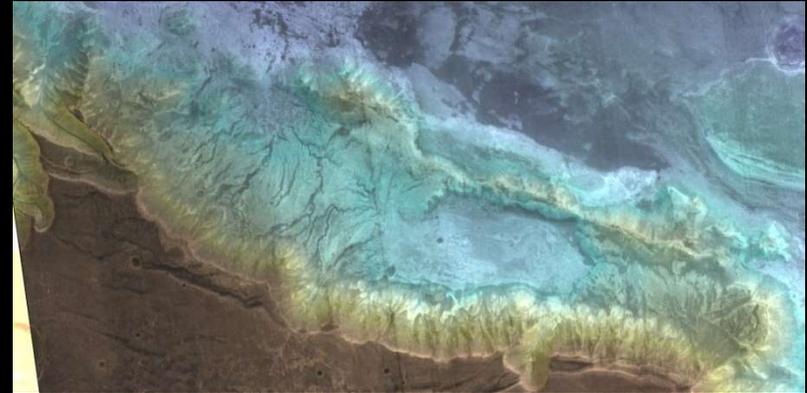
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<sup>3</sup> Planetary Science Institute, Tucson, AZ

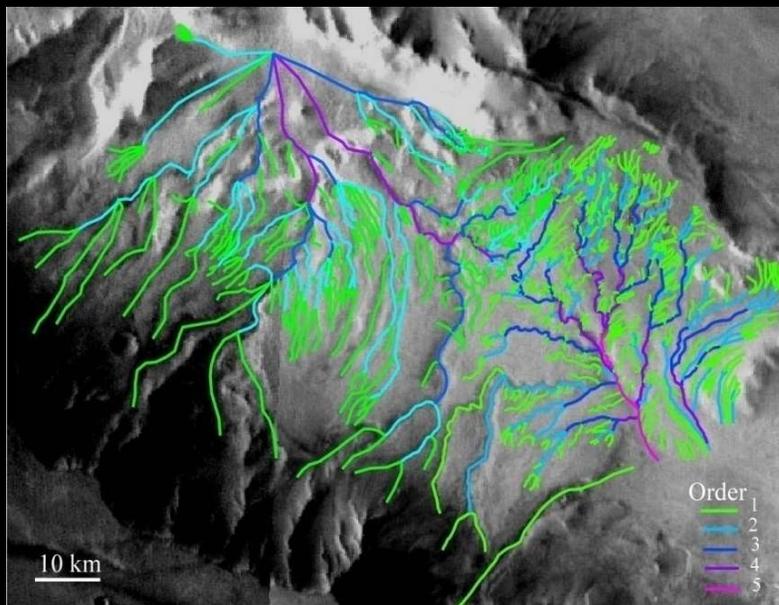
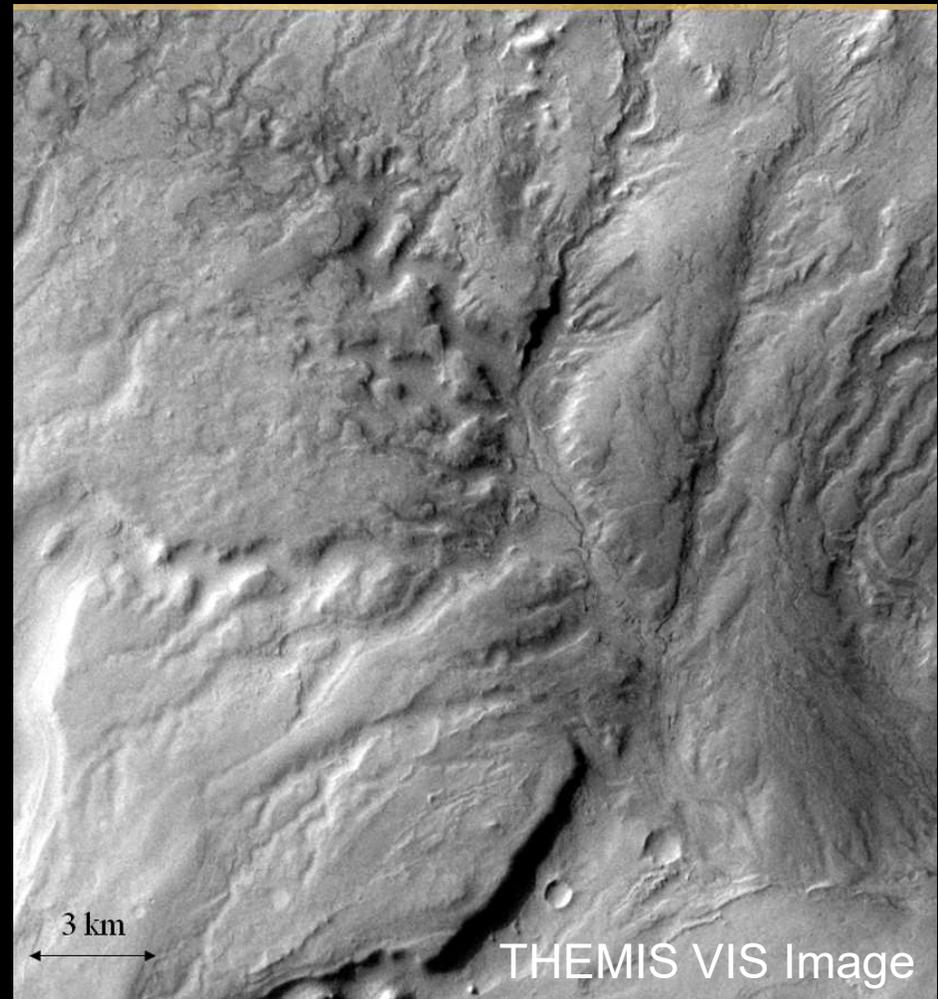
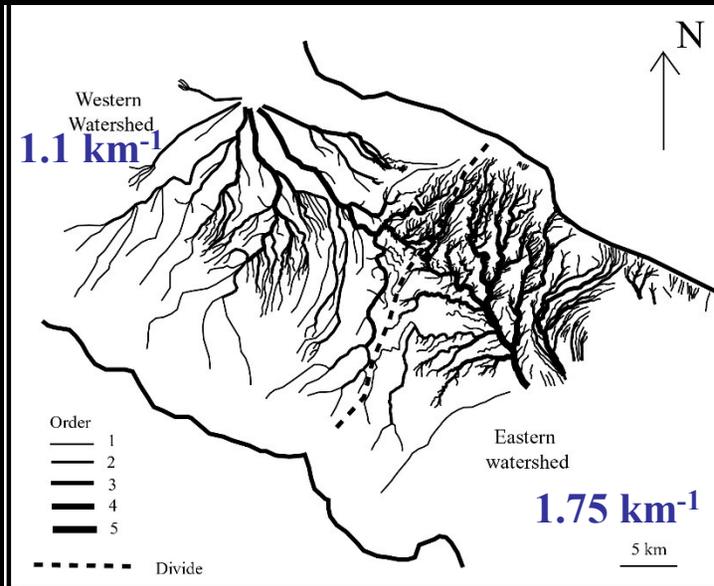
<sup>4</sup> USGS



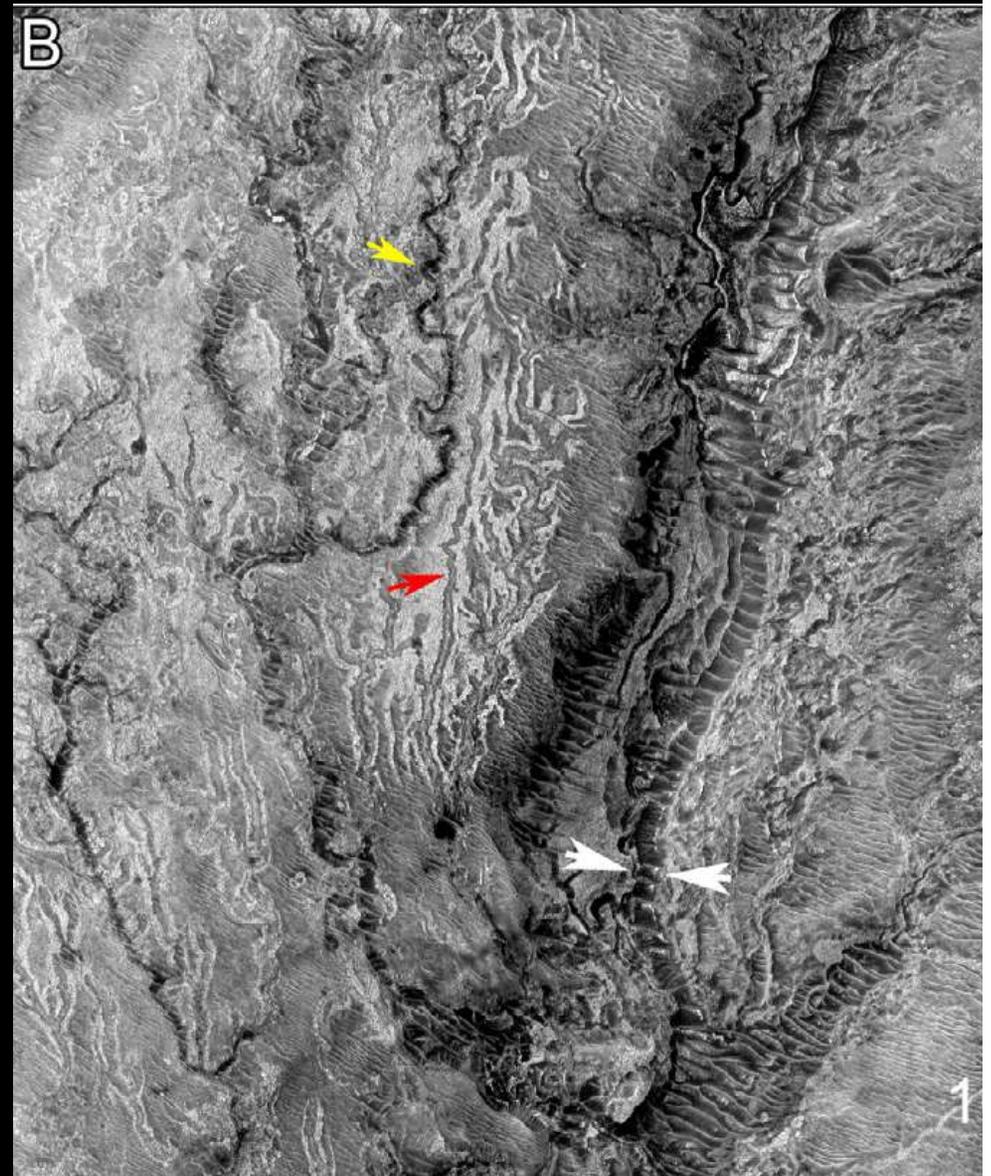
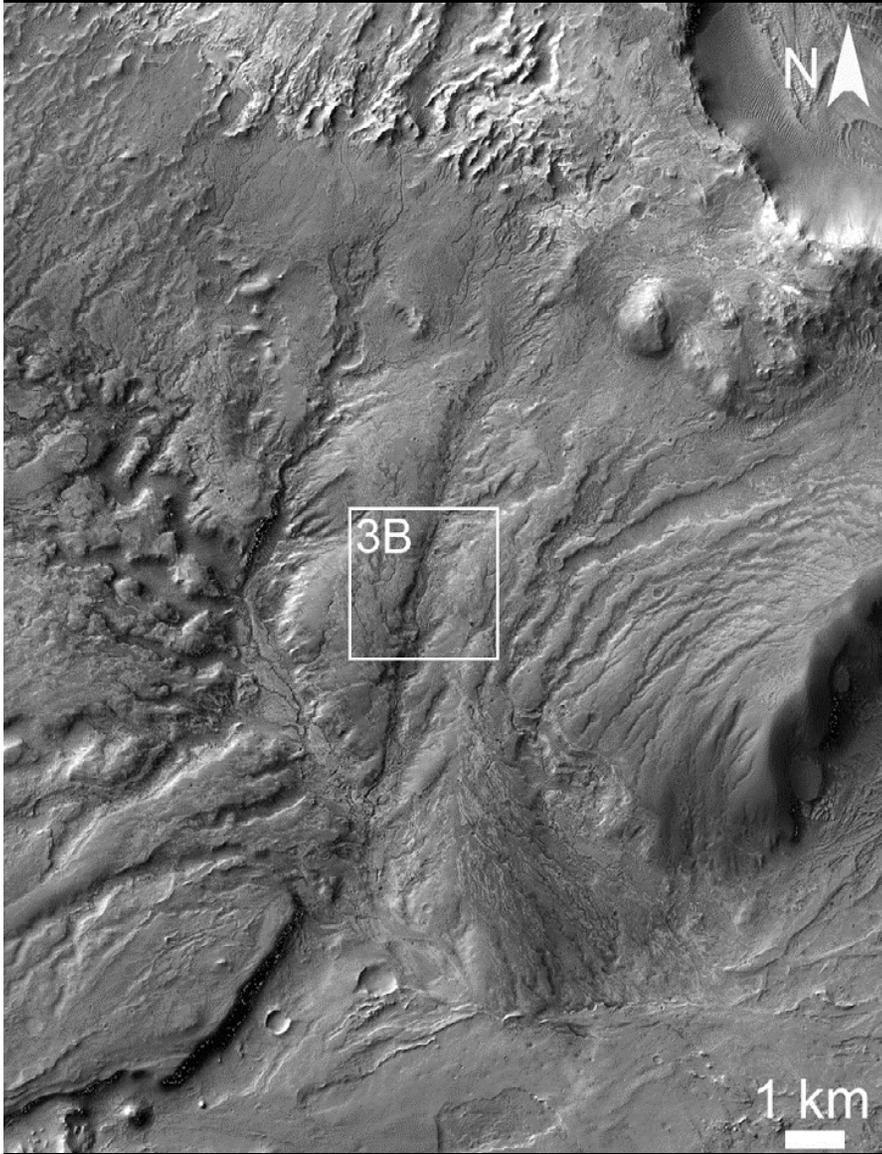
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# Evidence for surface runoff



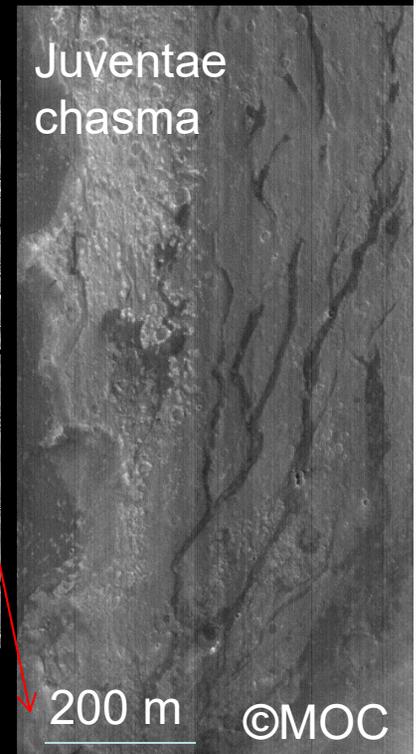
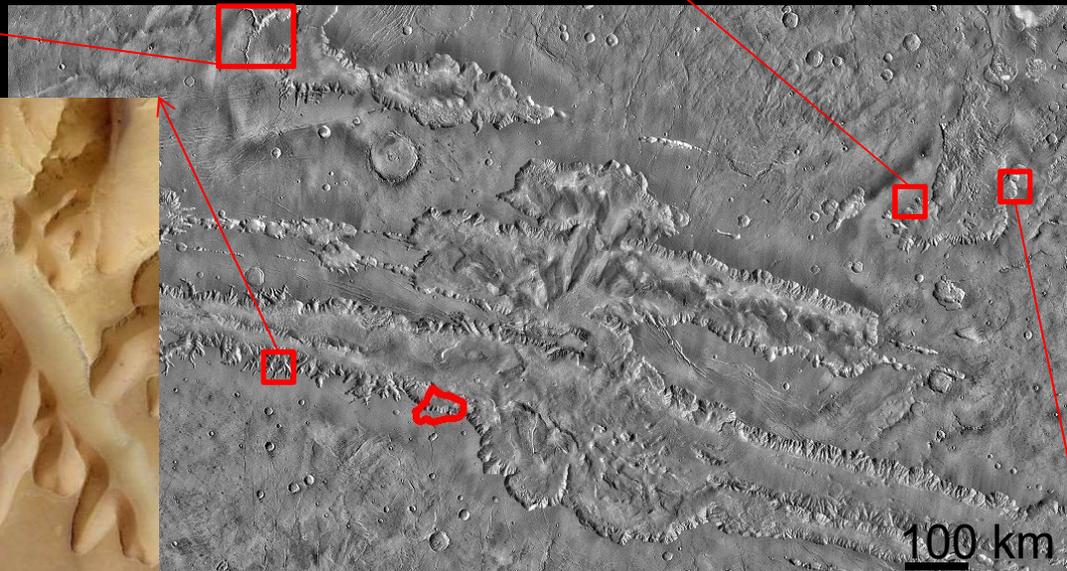
# Evidences for several generations of valleys



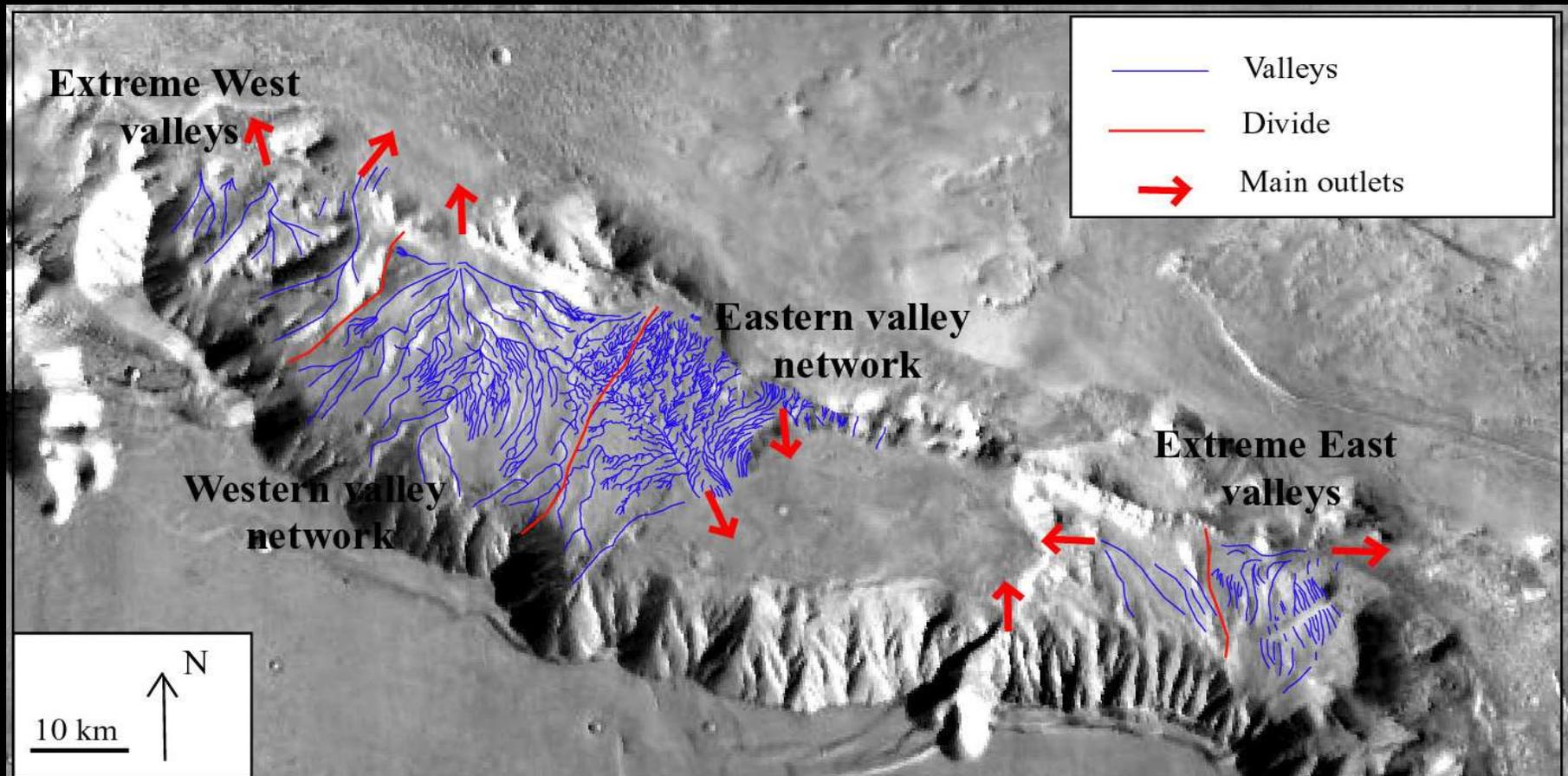
Williams and Weitz, 2014

Range of valley depth : several meters to 150 meters

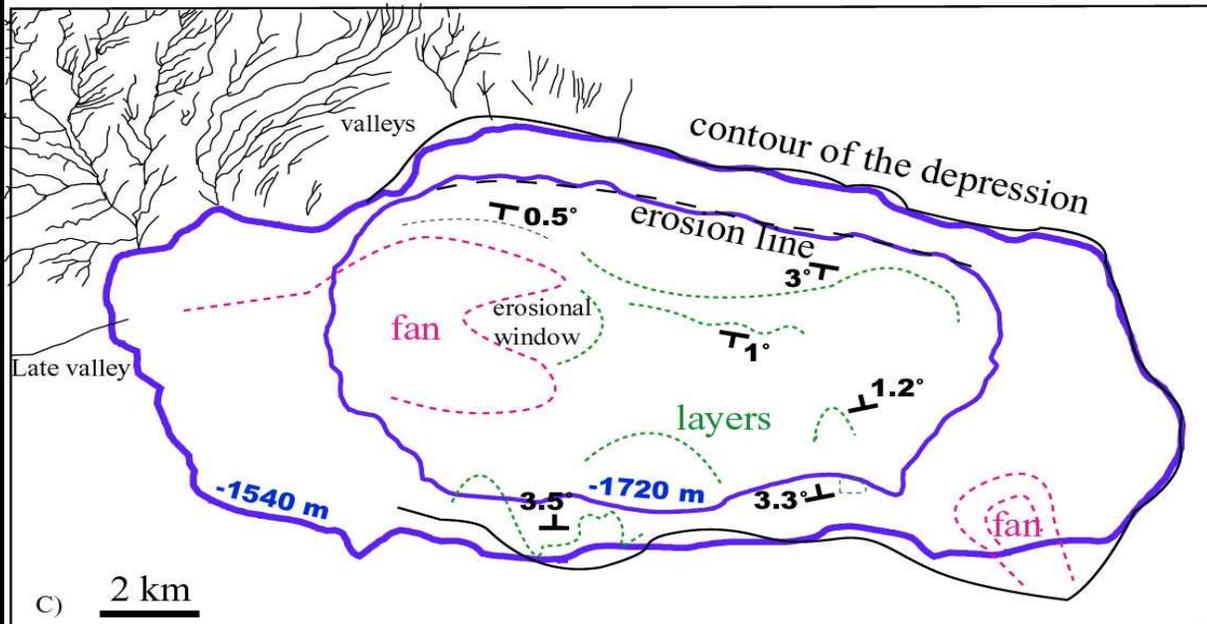
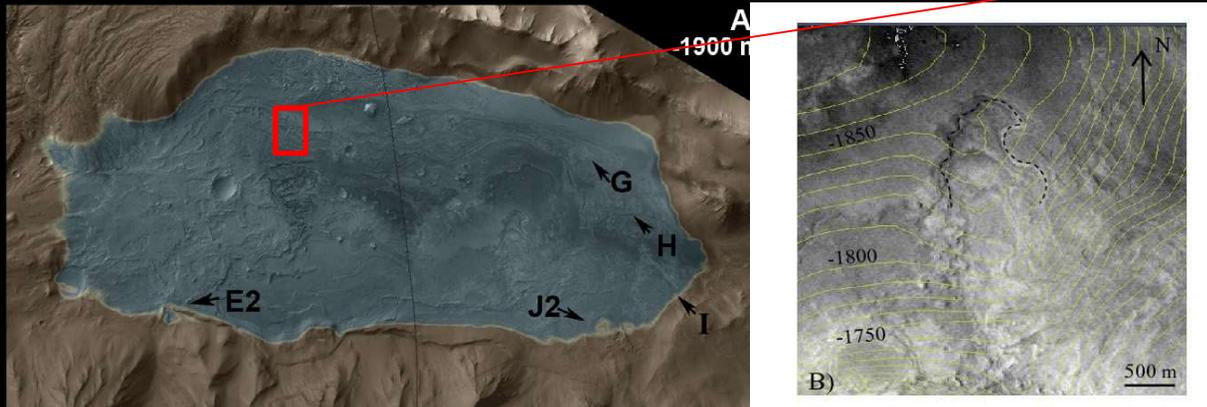
# Is Melas an isolated drainage basin ? No!



# Melas valley system and outlets

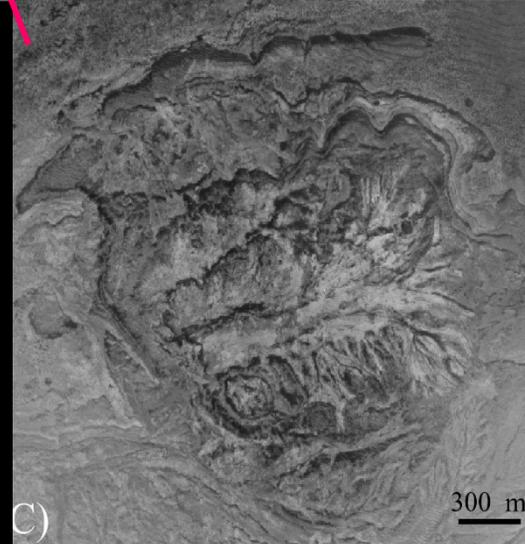
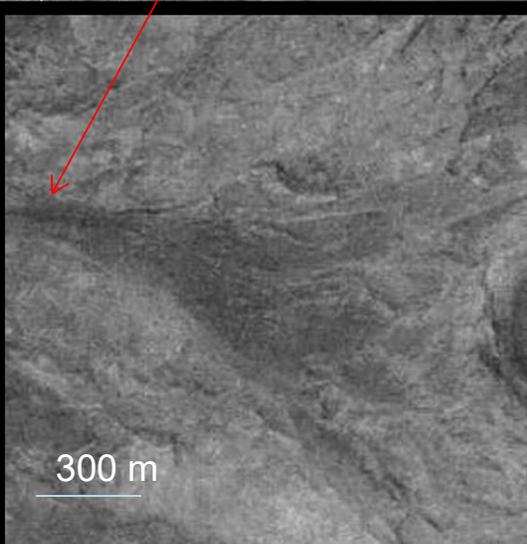
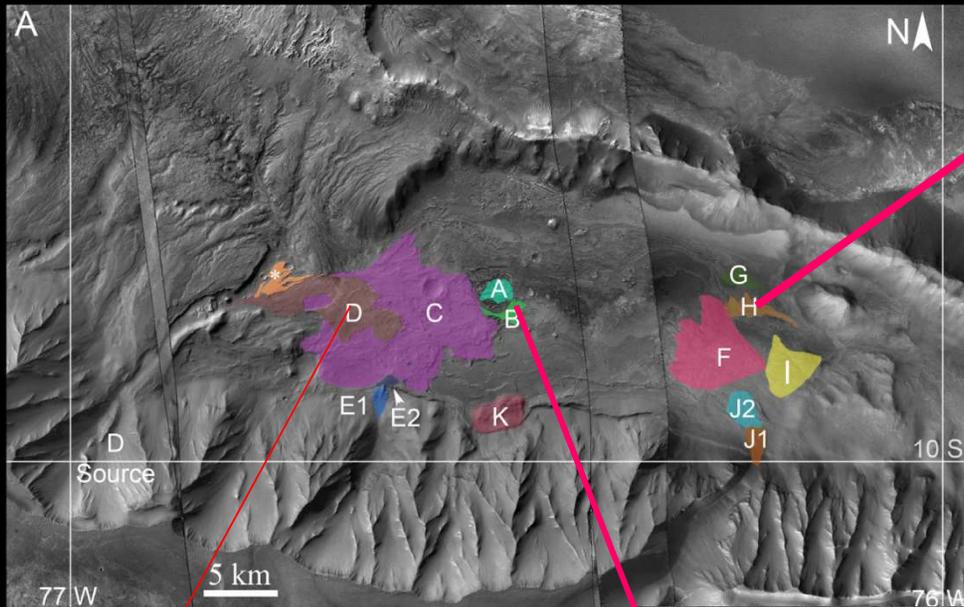


# Basin Volume : 157 km<sup>3</sup>

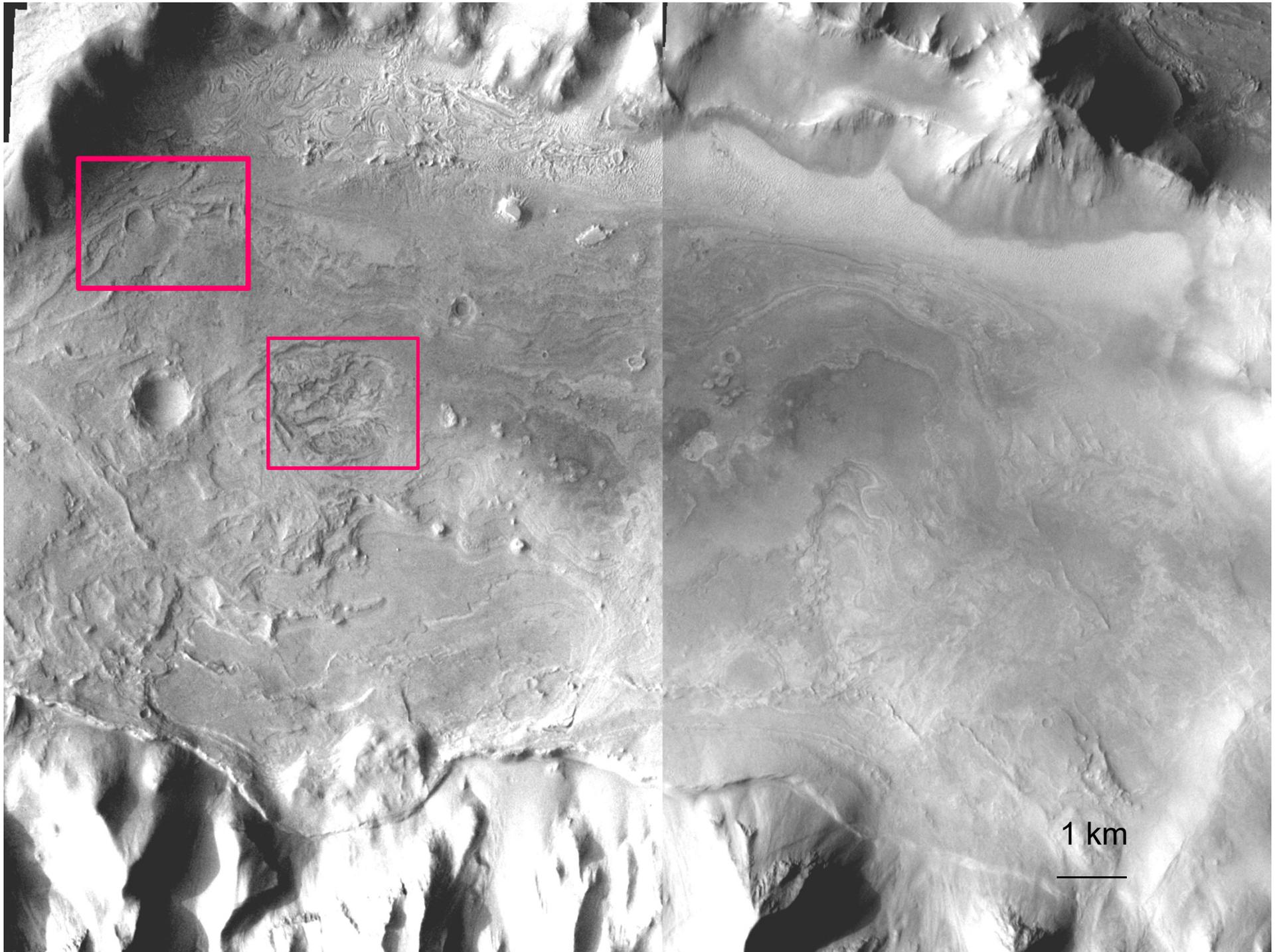


Quantin et al., 2005; Williams and Weitz, 2014

# Evidences for multiple sedimentary activity (11 fans have been identified)

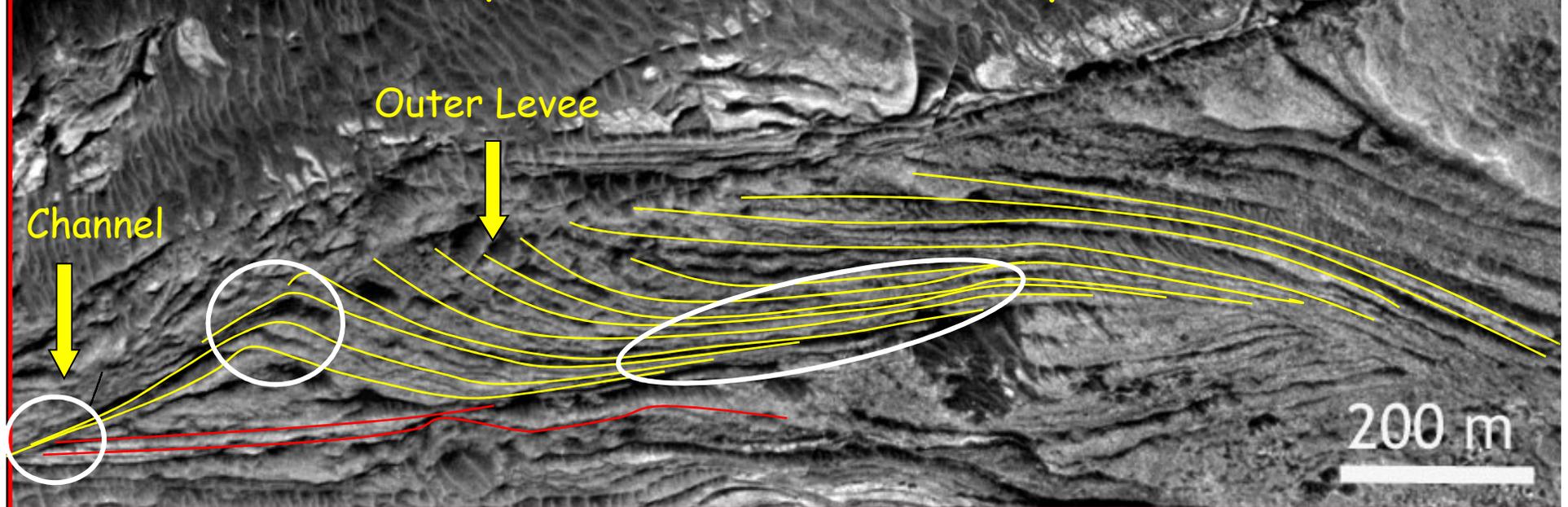


Quantin et al., 2005  
Metz et al., 2009  
Williams and Weitz, 2014

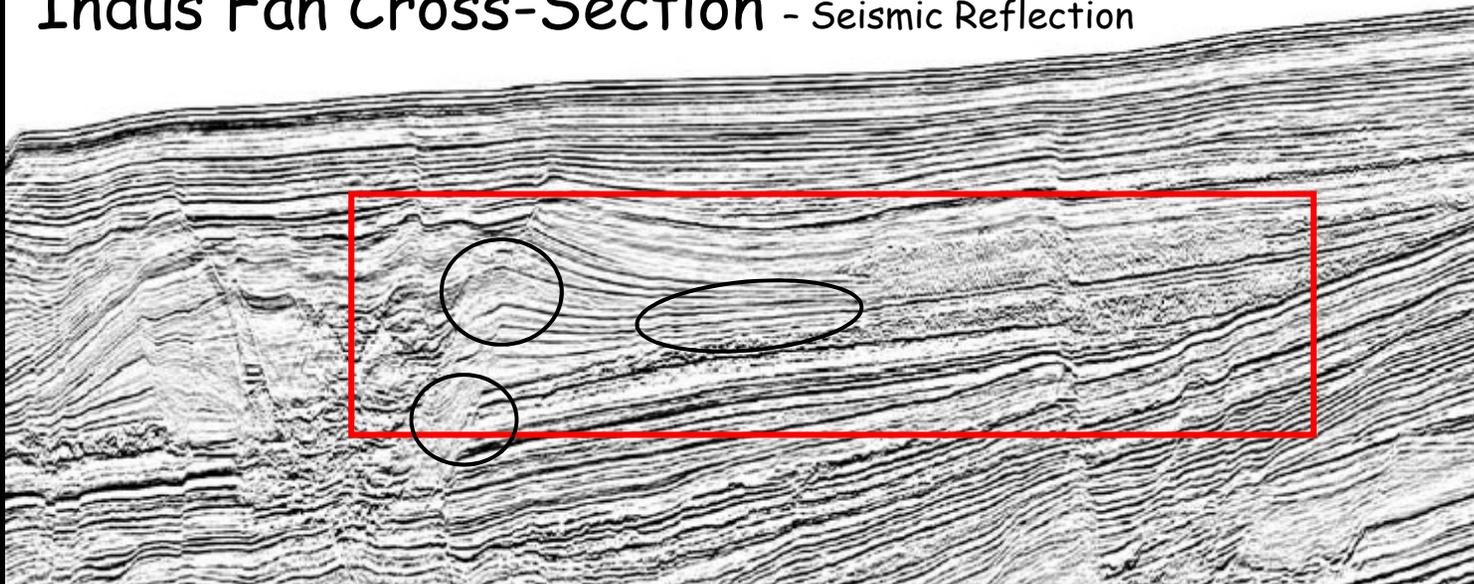


Dromart et al., 2007

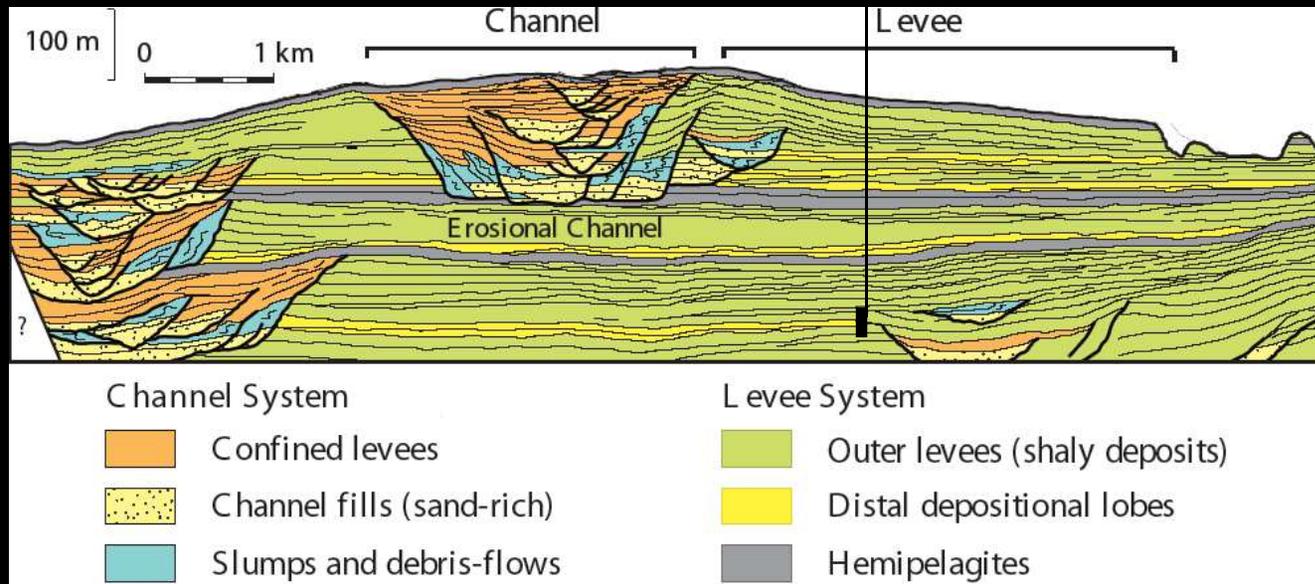
## A Subaqueous Channel-Levee System



## Indus Fan Cross-Section - Seismic Reflection



Deptuck et al.,  
2002

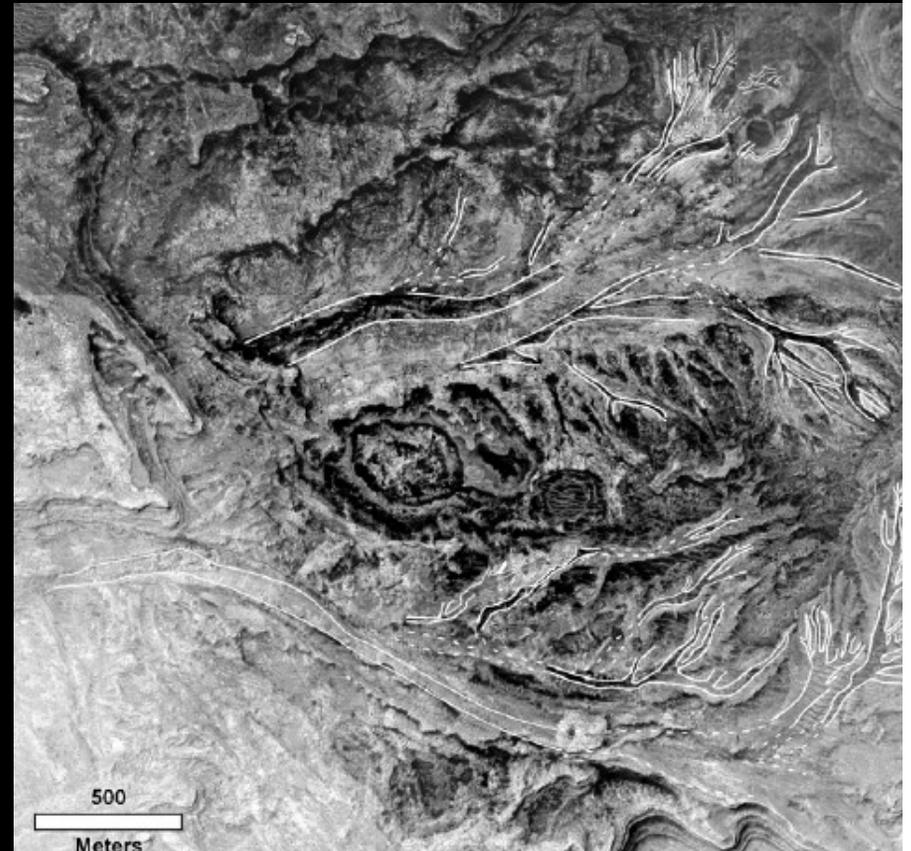
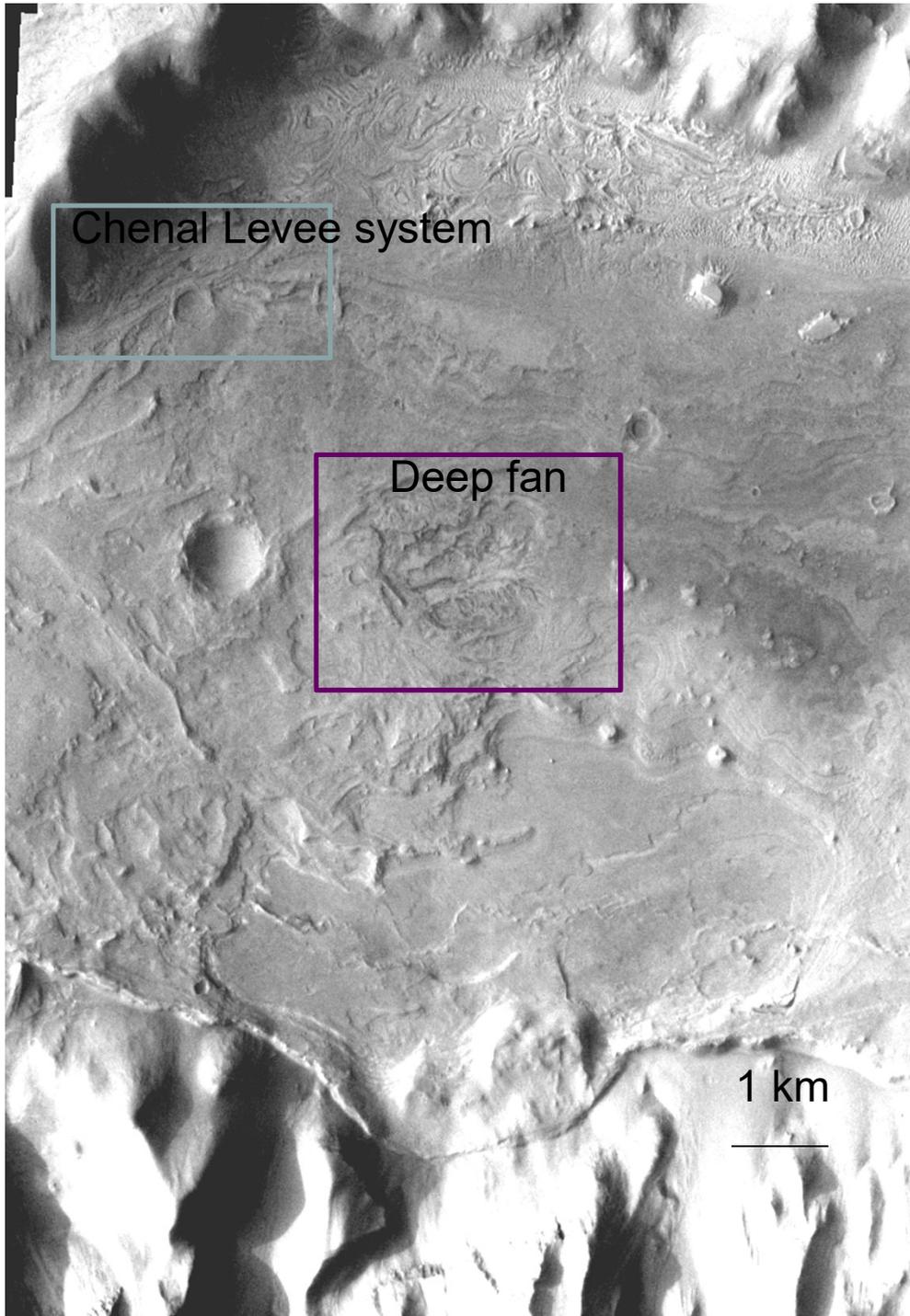


## Grain-Size Partitioning

This process is responsible for grain sorting :

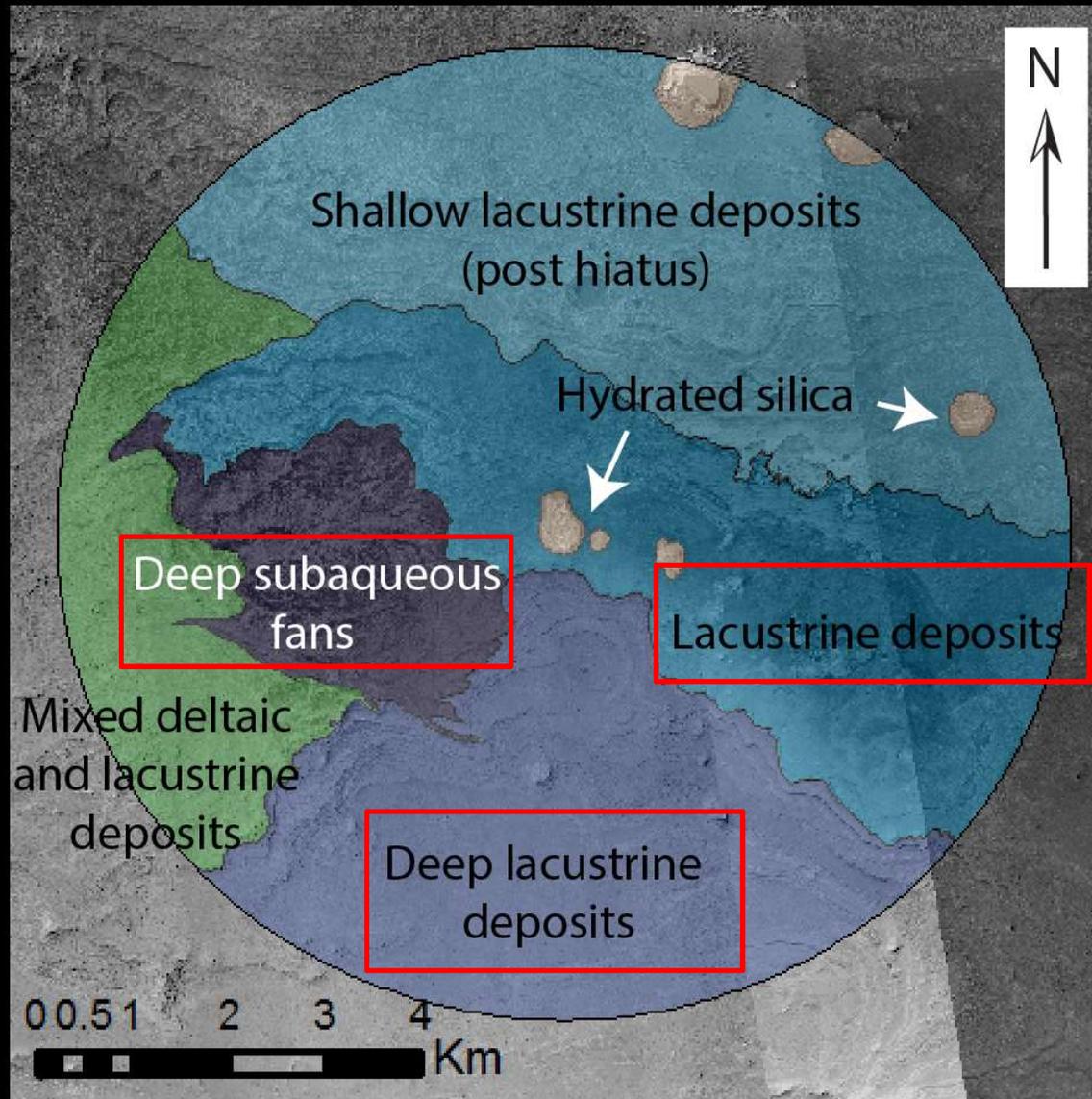
- Coarse-fraction confined to the channel fill
- Fine fraction, including clay minerals and organics spread out across the levees
- Fine fraction accumulates deeper in the basin in deep fans



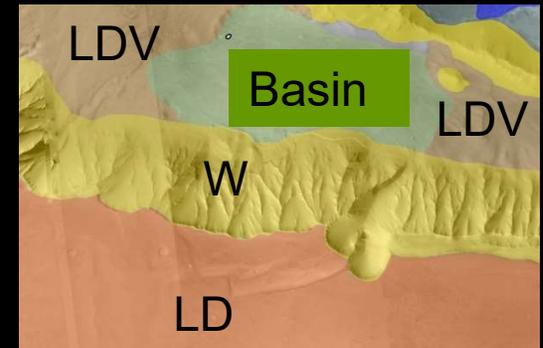
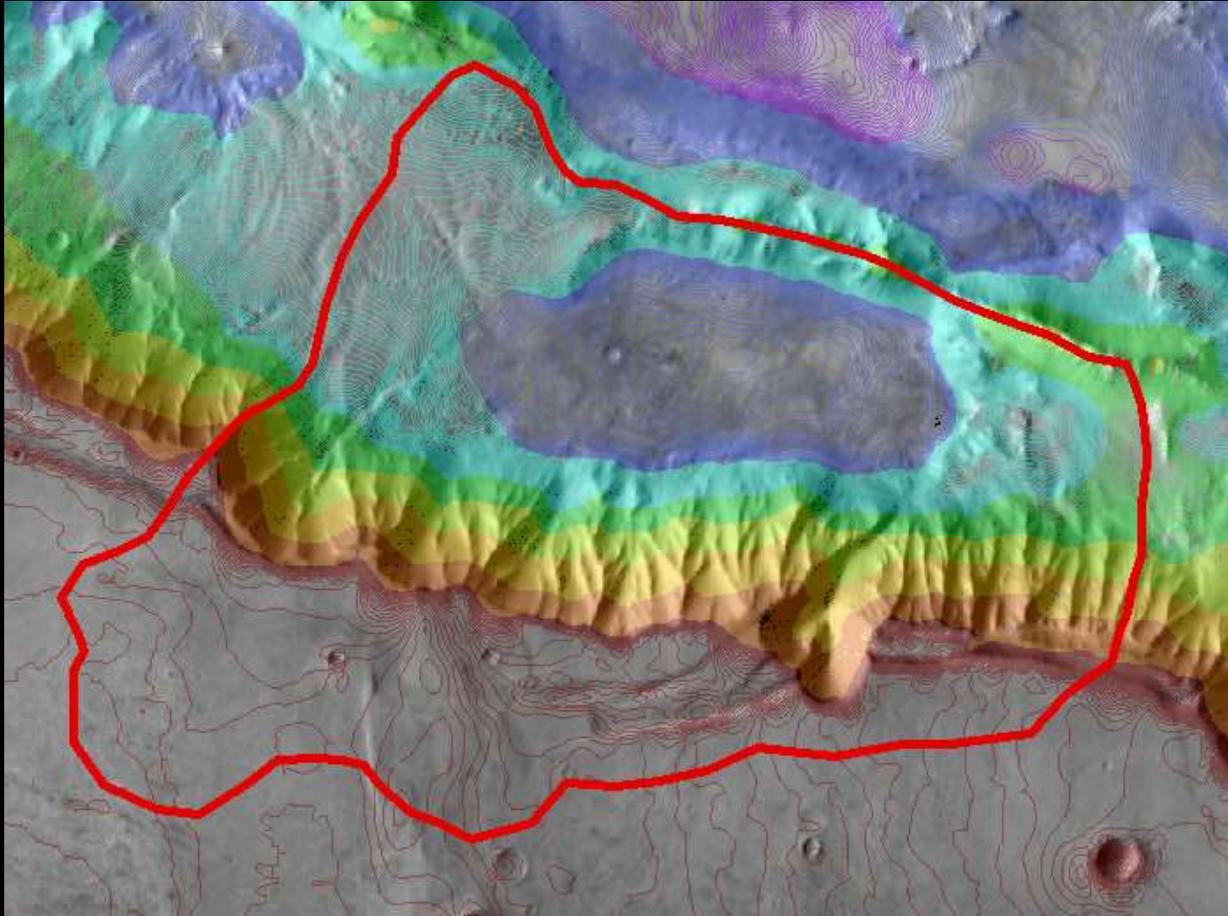


Dromart et al., 2007  
Metz et al., 2009  
Williams and Weitz, 2014

Highest potential for concentration of fine fraction inside the ellipse



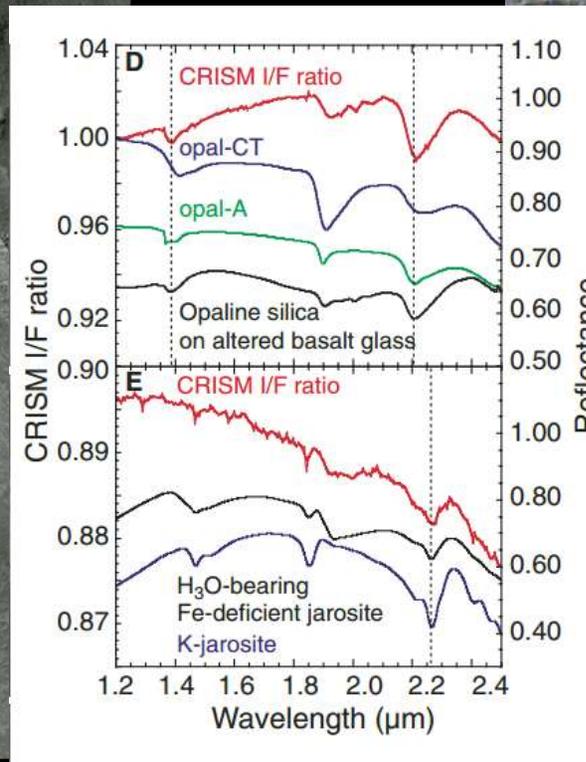
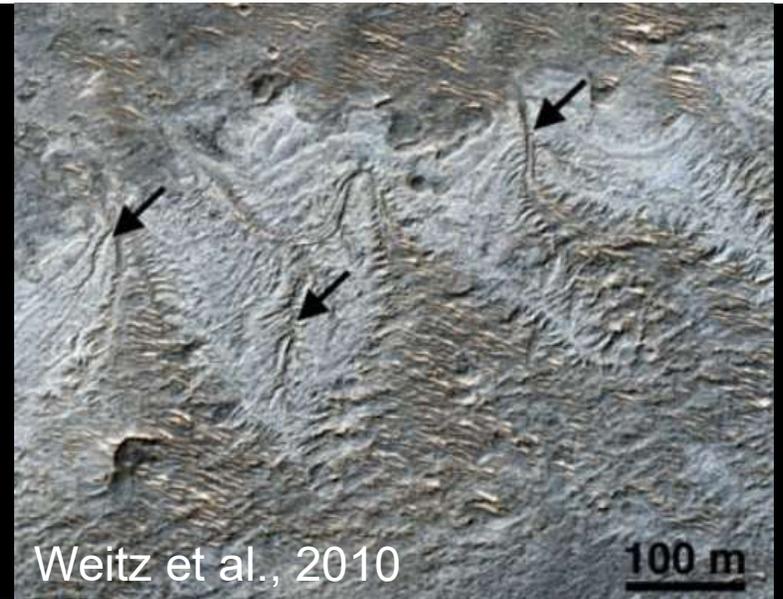
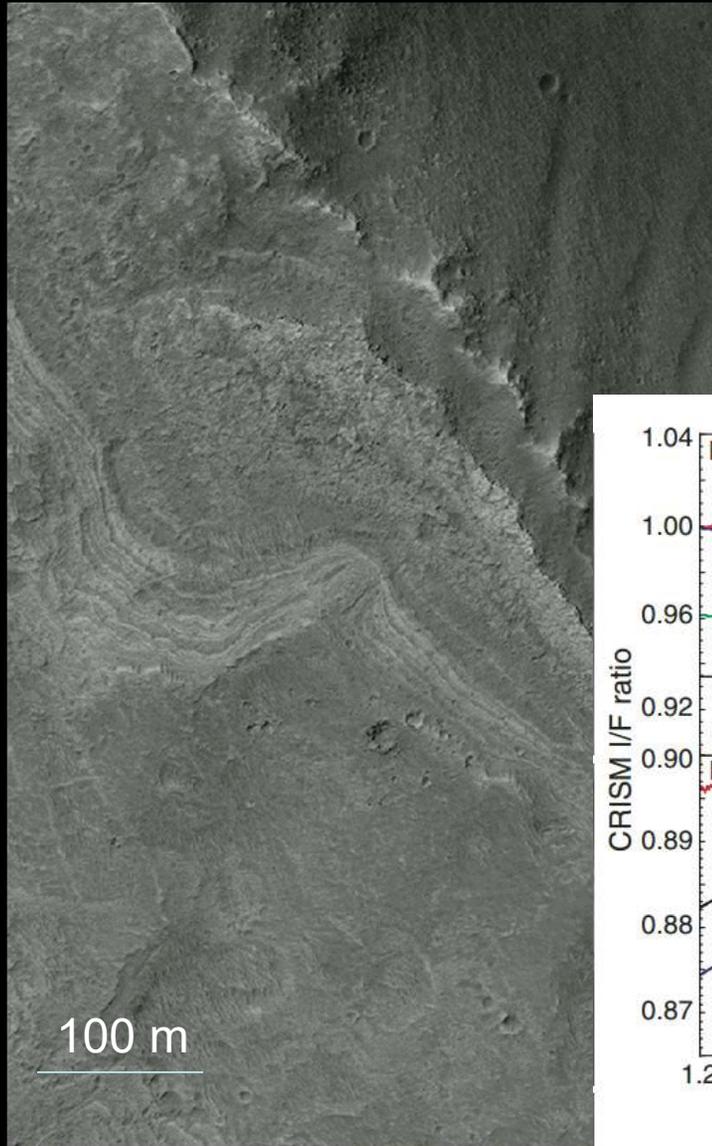
The watershed:  $3 \cdot 10^3 \text{ km}^2$



- Layer deposits of the plateau (LD)
- Valles Marineris Wallslopes (W)
- Layered deposits dissected by valleys (LDV)

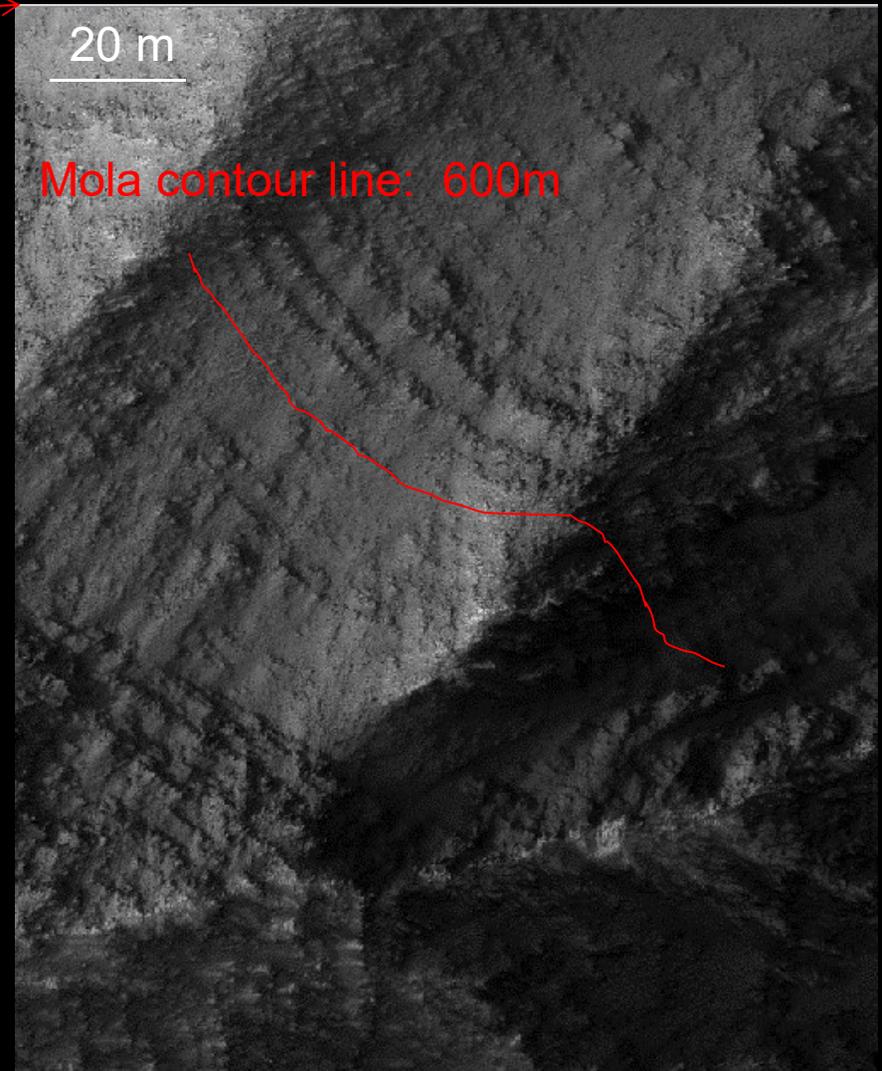
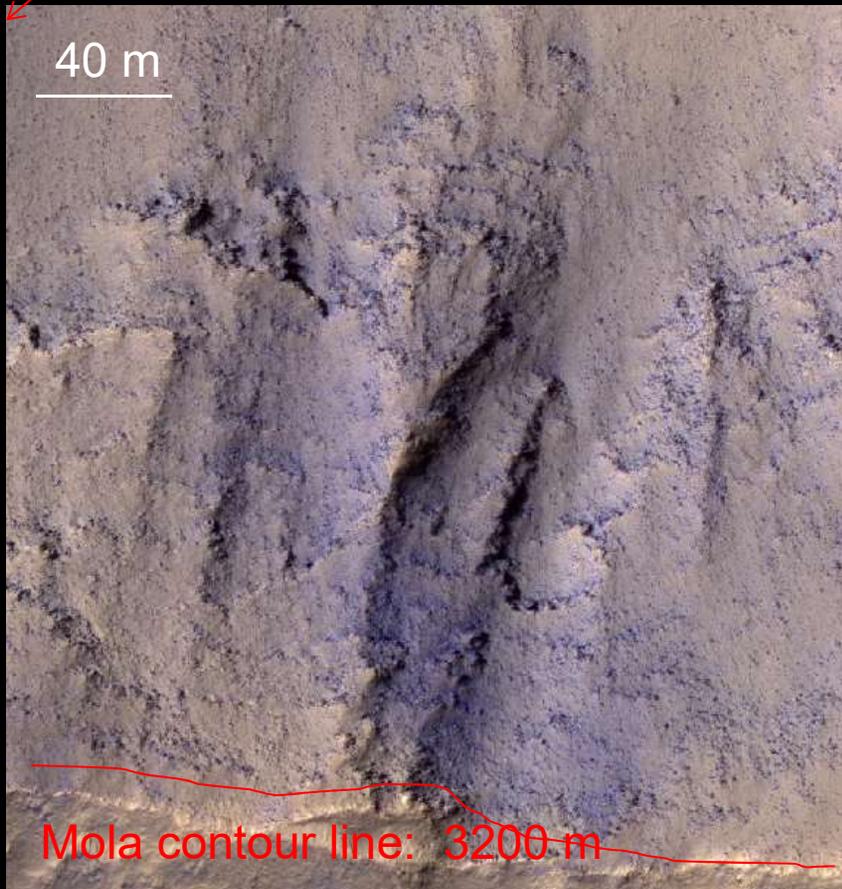
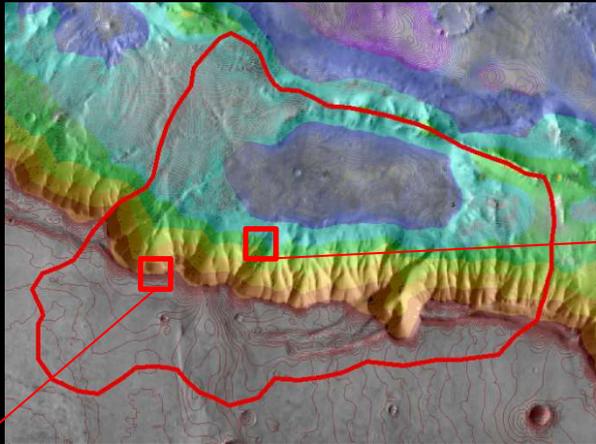
Weitz et al., 2015

# Melas plateau layered deposits

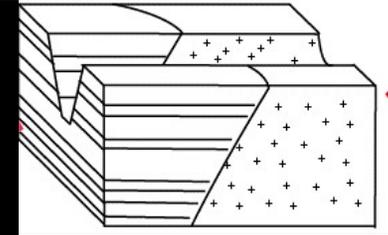


Jarosite+Opaline silica (Miliken et al., 2008)

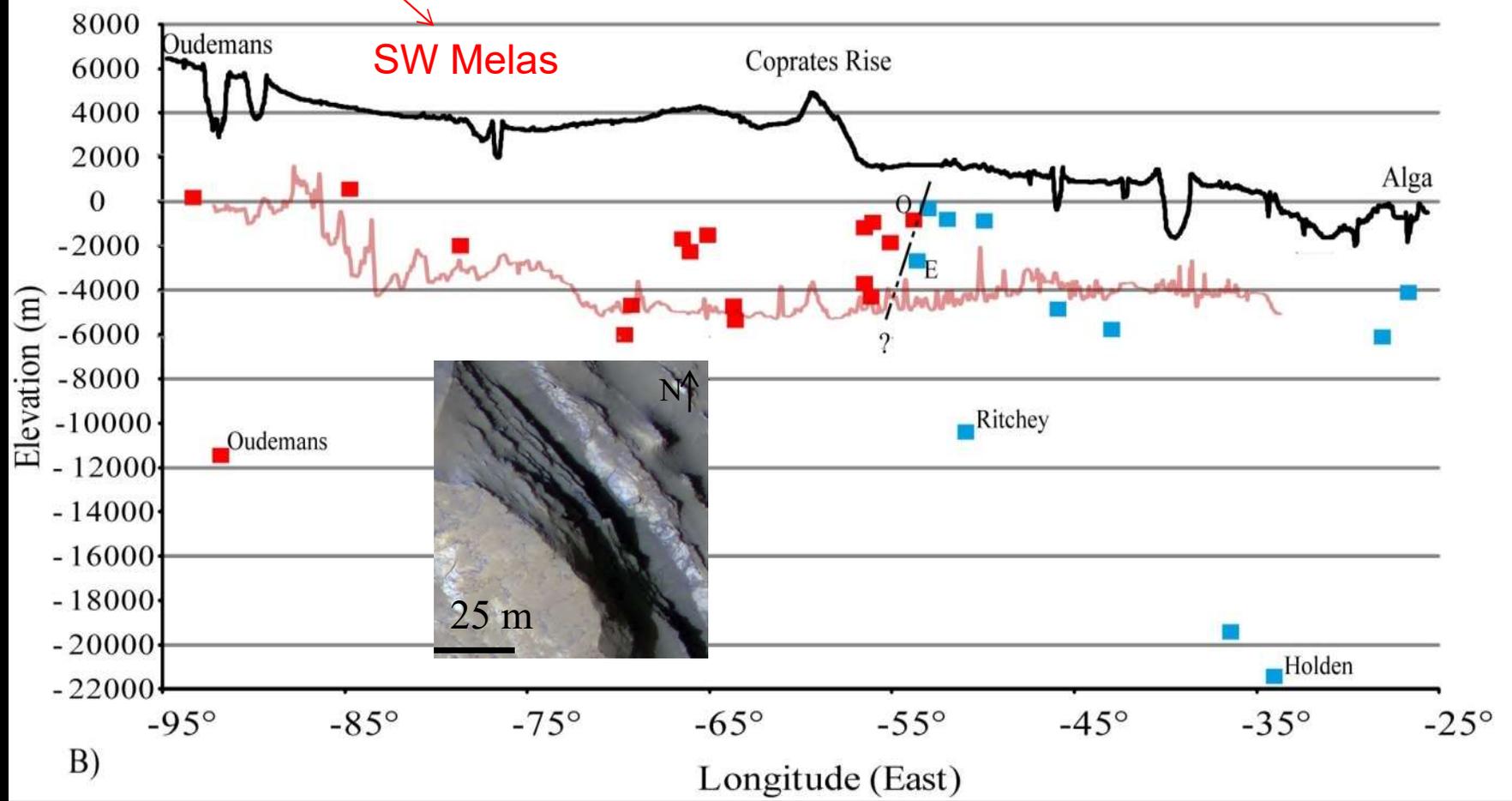
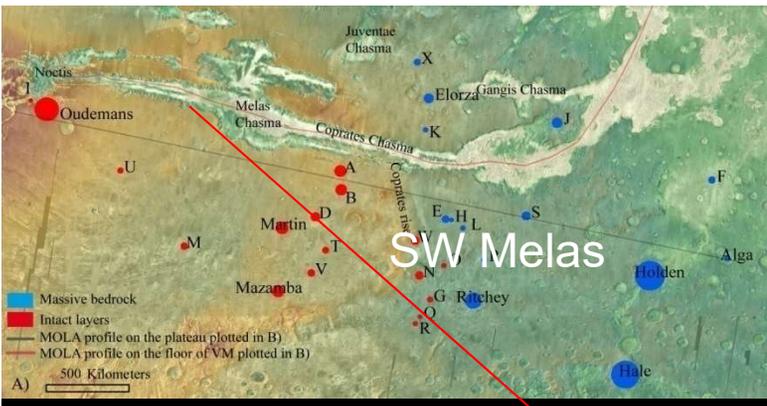
# Sampling the wallslope : insight into Tharsis volcanic activity



# Valles Marineris Crustal cross section

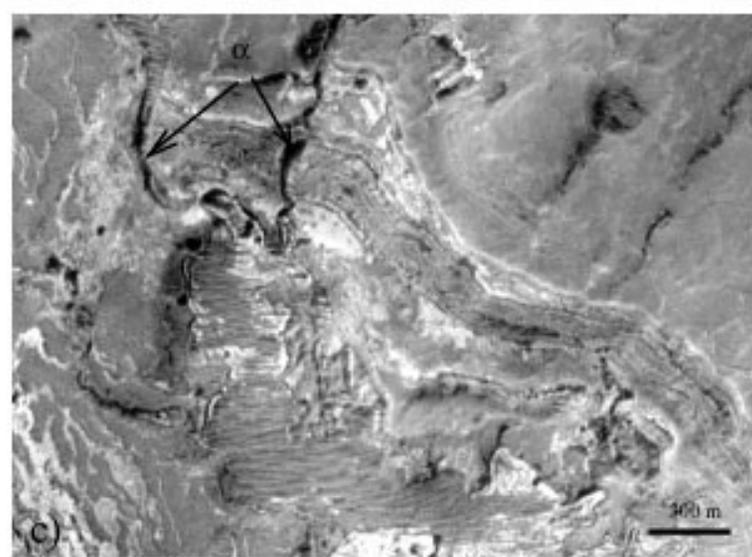
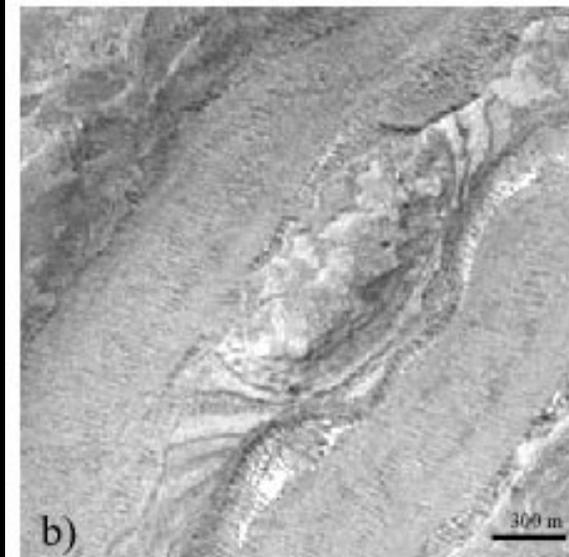
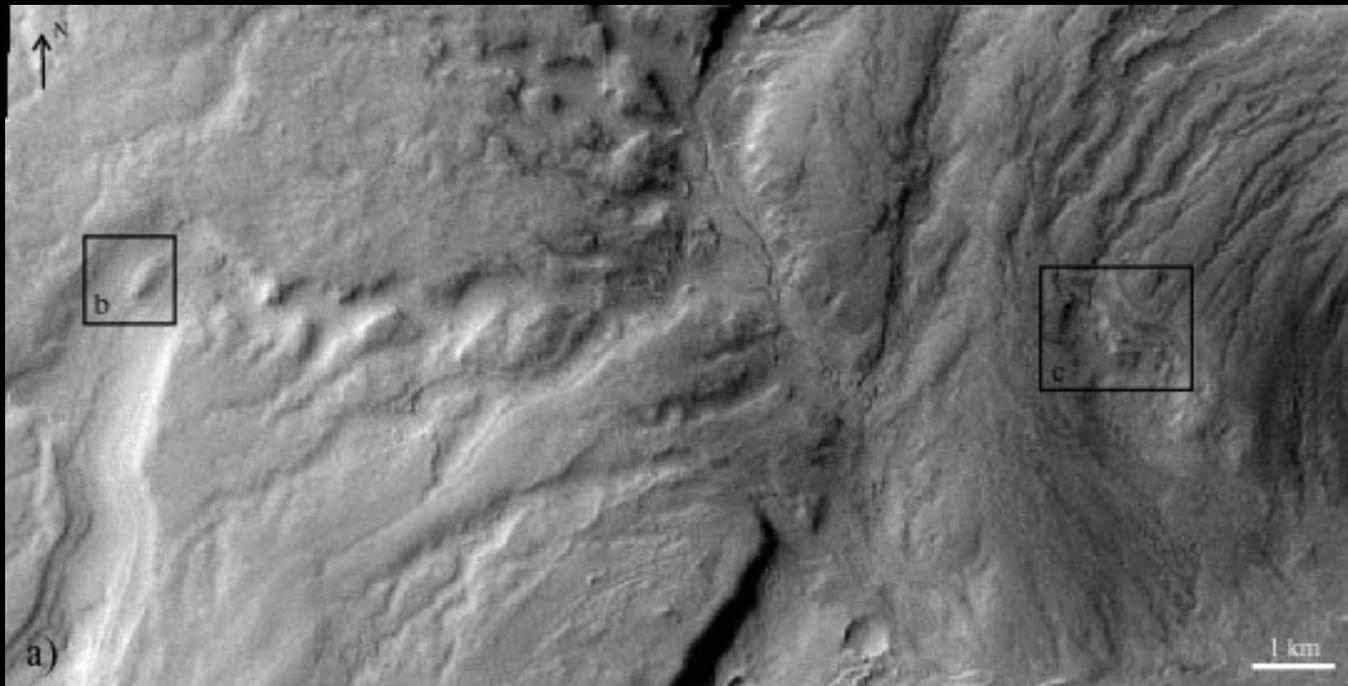


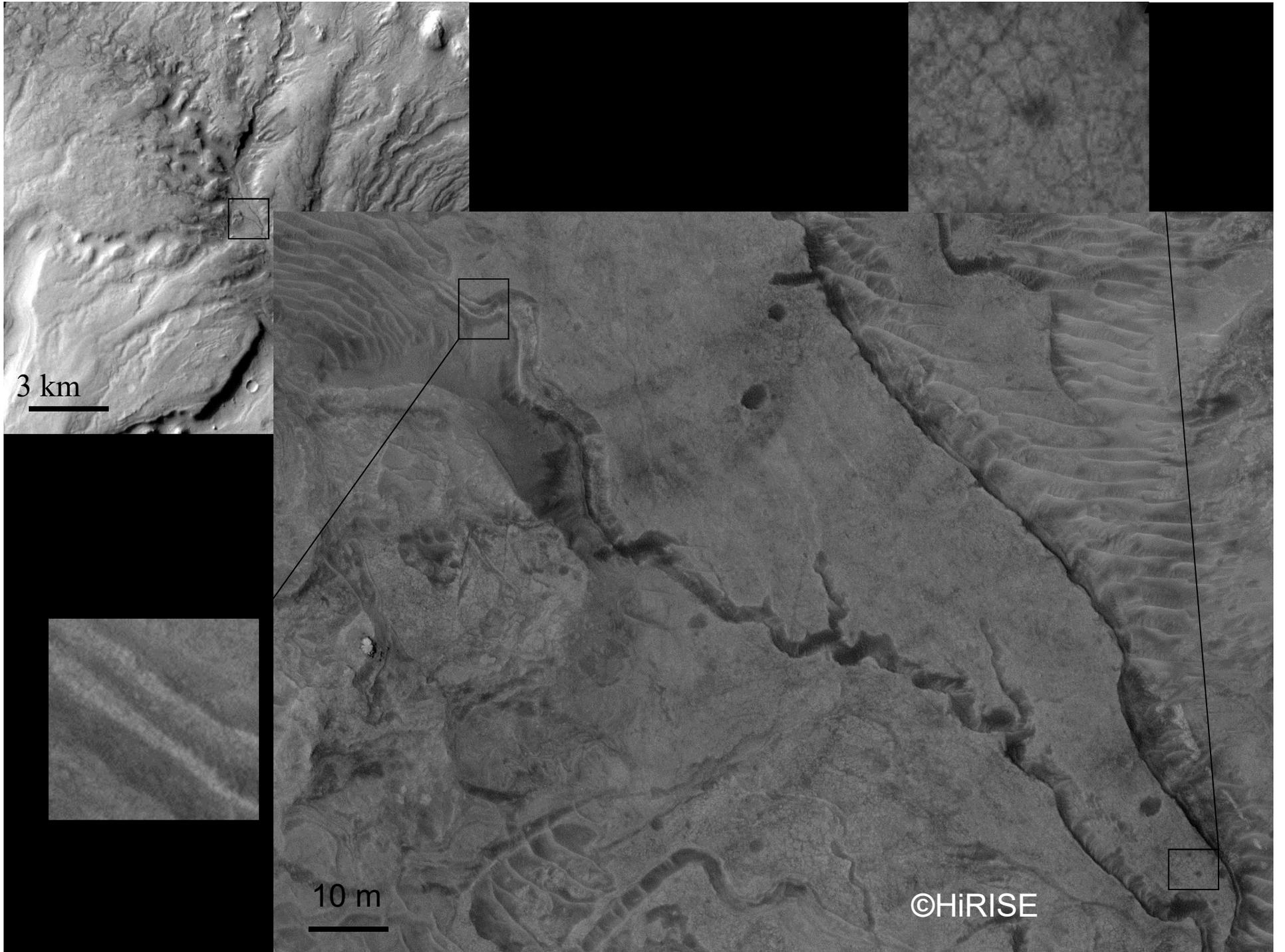
Basaltic lava flow stack from Tharsis volcanic activity

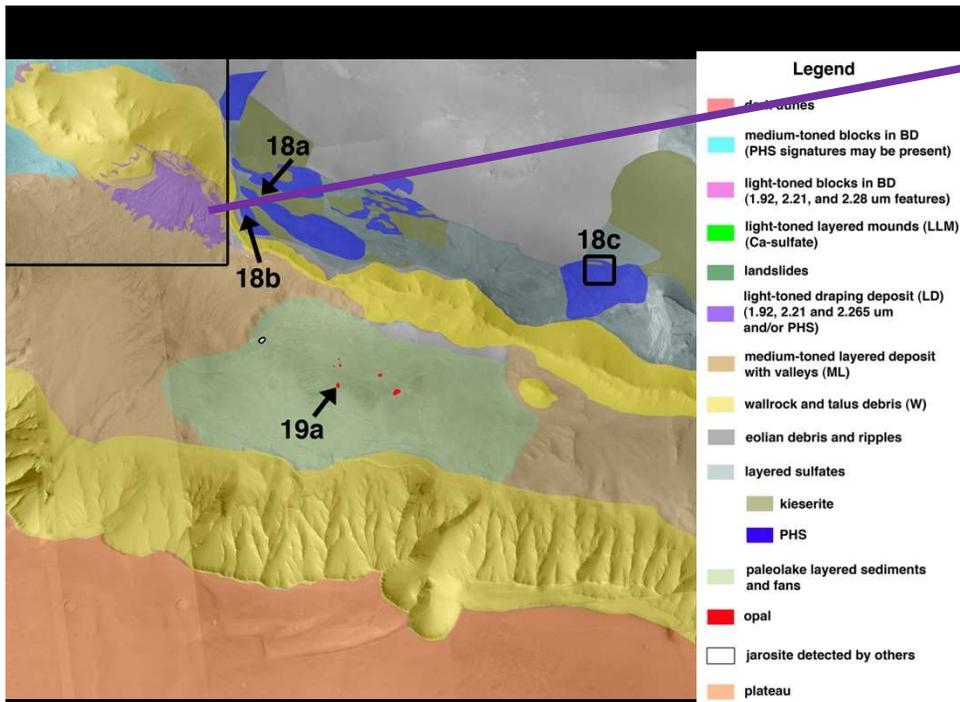


Quantin et al., 2012; Flahaut et al., 2012, Viviano-Beck et al., 2017

# Material eroded by dense Valley Networks : Layered deposits

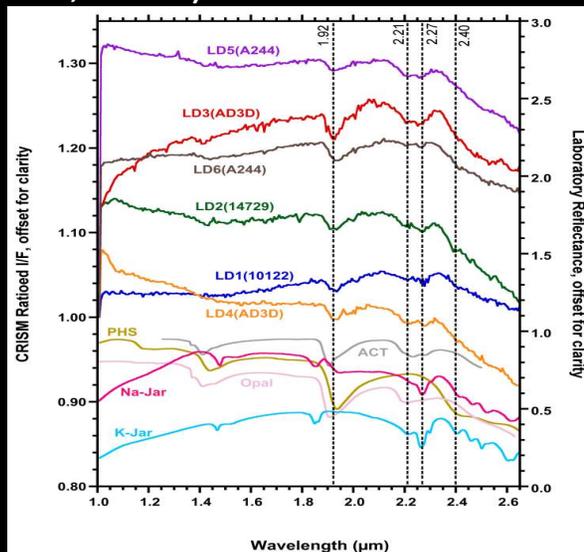






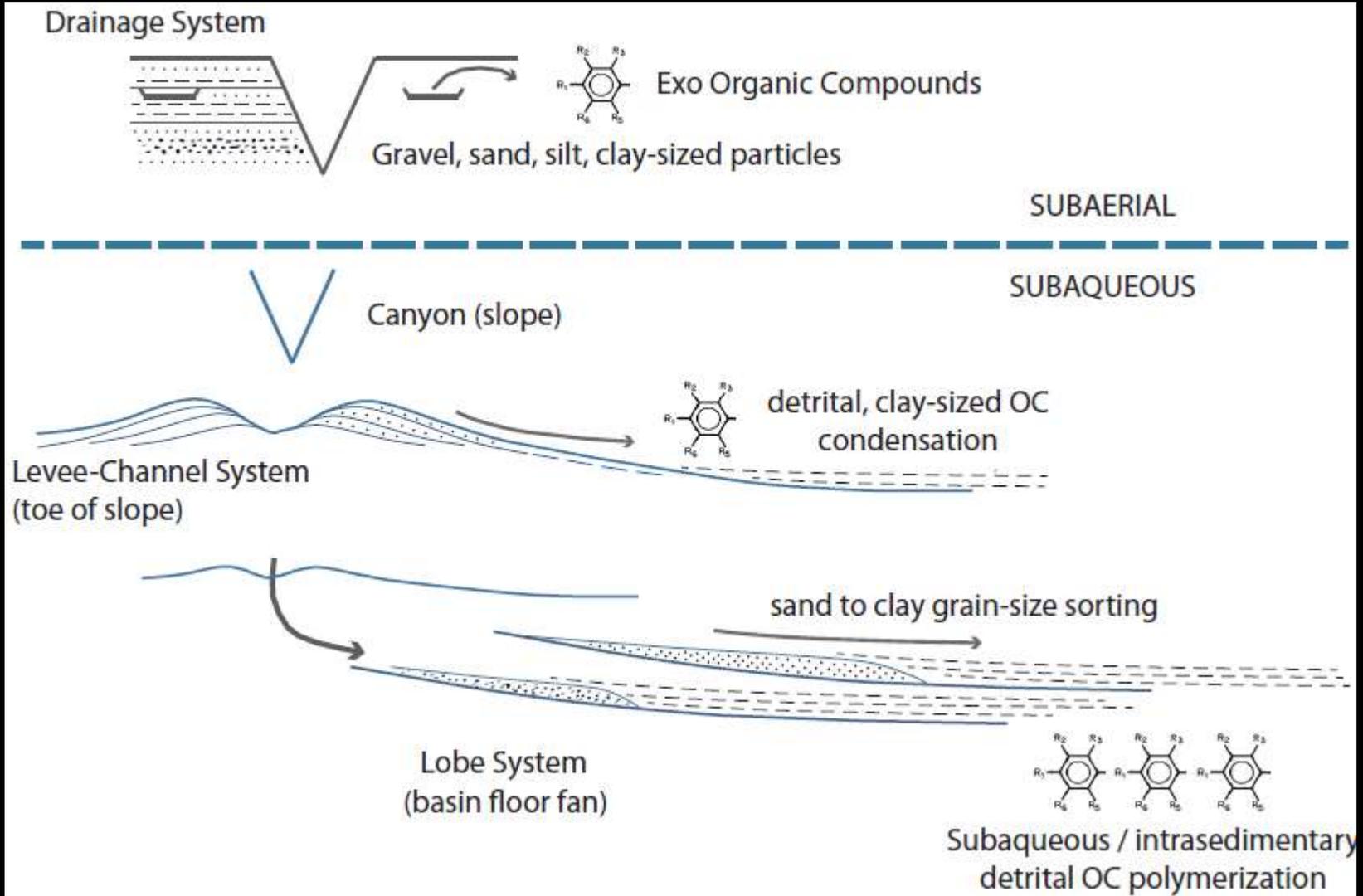
HiRISE

Mixtures of Jarosite, clay precursors, leached clays, silica, and/or polyhydrated sulfates. (Weitz et al., 2015)

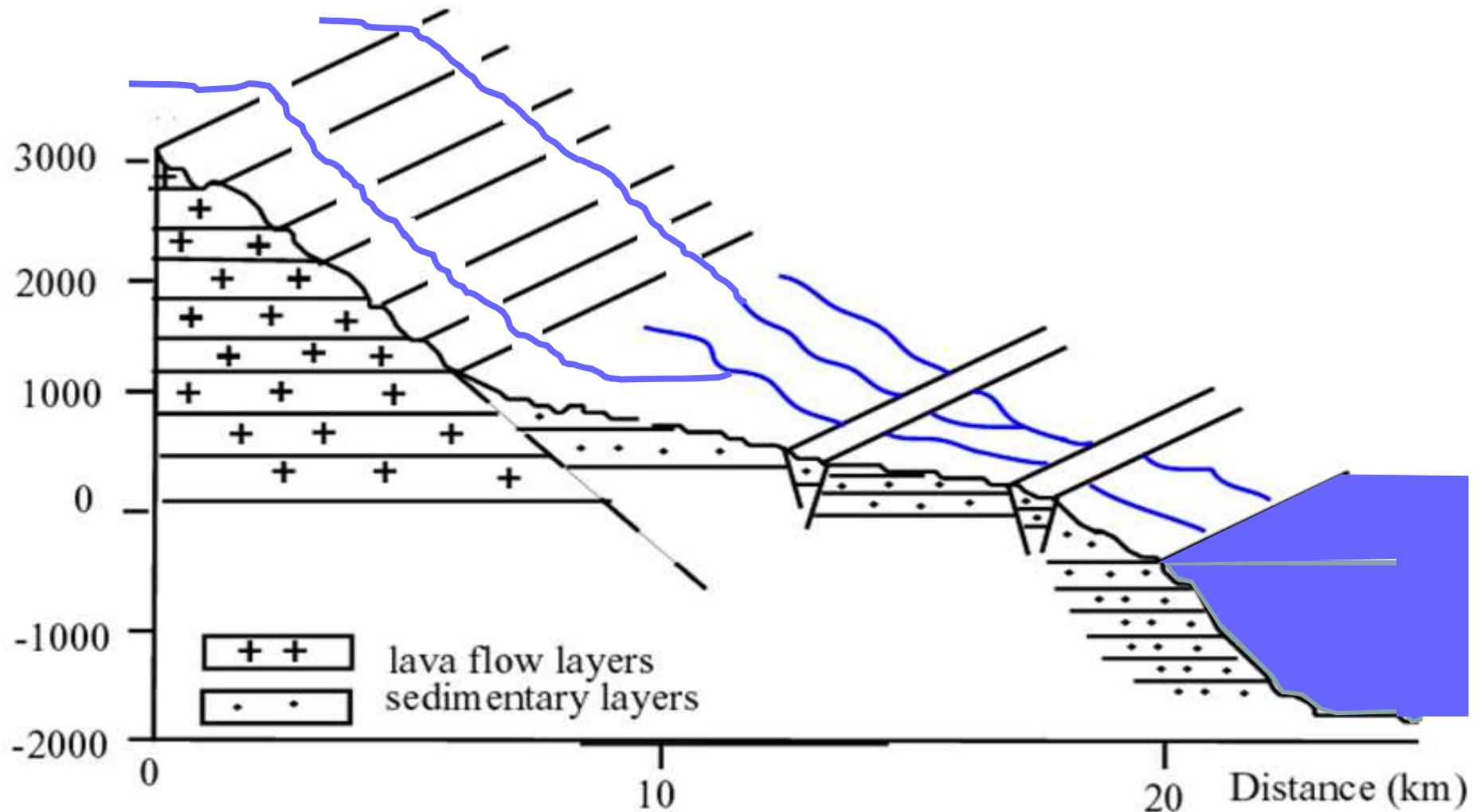


# Melas SW basin as sediments in the catchment area

Why it is an advantage for organic concentration ?



# Summary Cross section

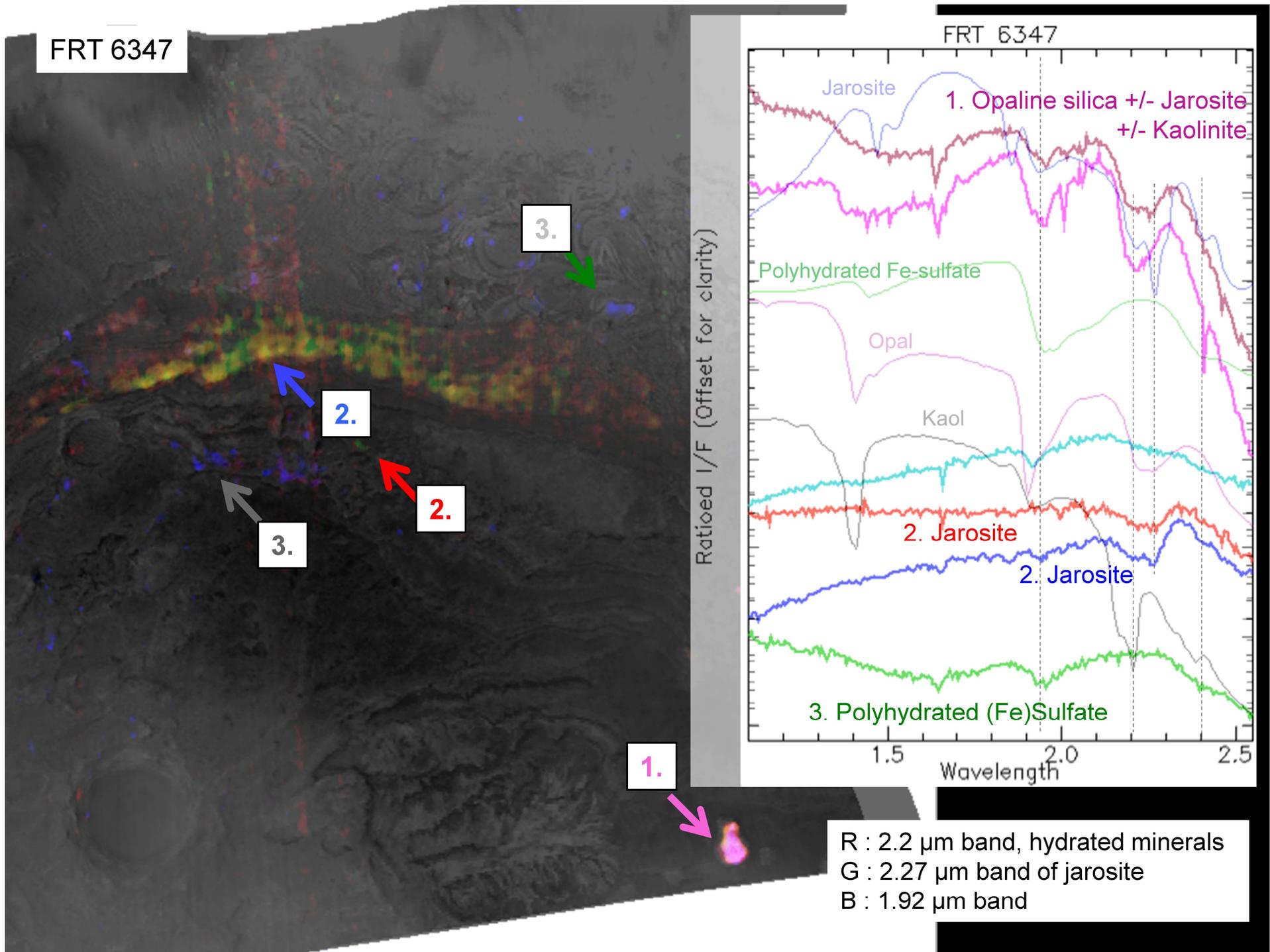


Full and short "source to sink" system

# CRISM survey



FRT 6347



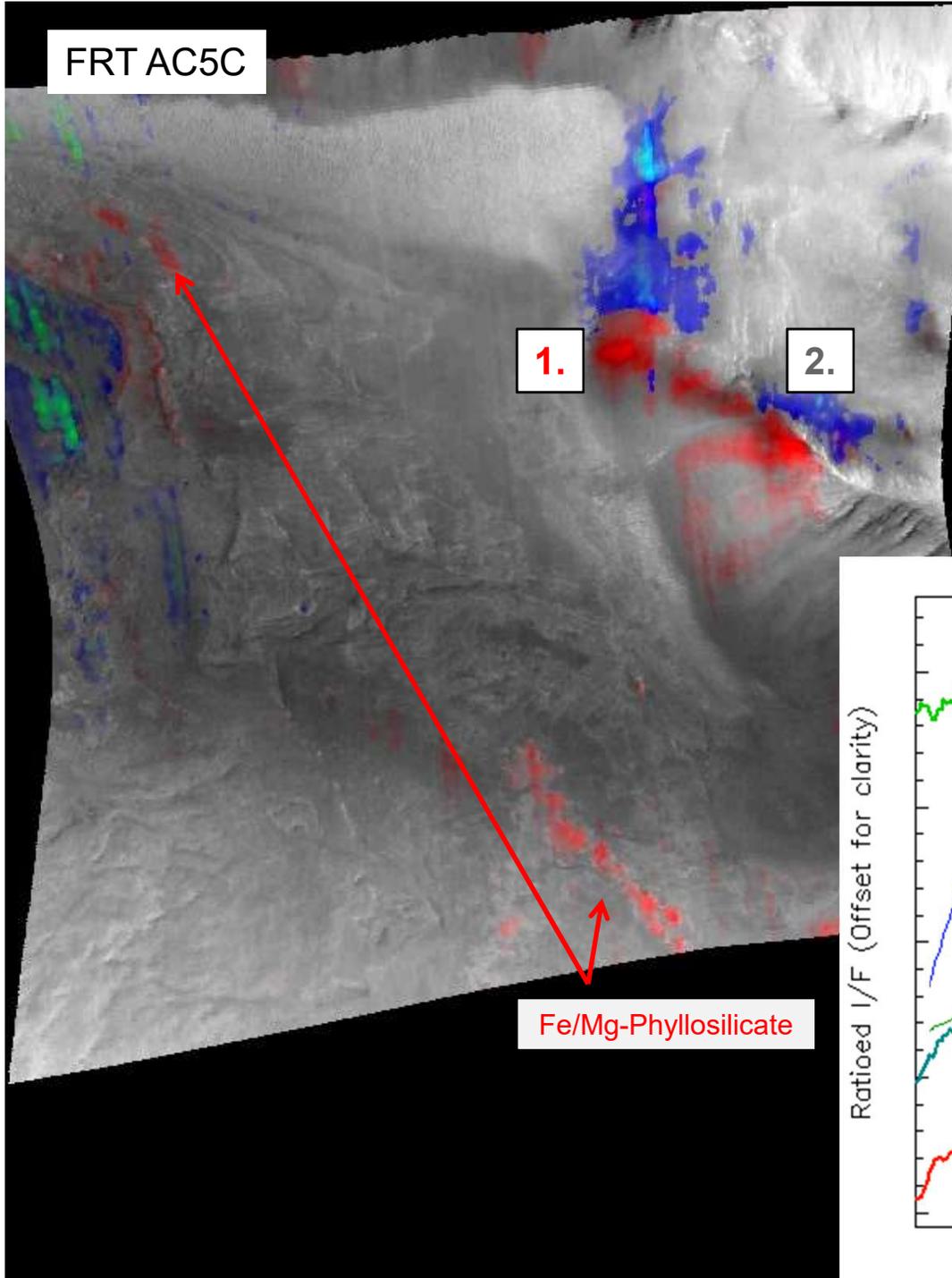
FRT 6347

Ratioed I/F (Offset for clarity)

Wavelength

R : 2.2  $\mu$ m band, hydrated minerals  
G : 2.27  $\mu$ m band of jarosite  
B : 1.92  $\mu$ m band

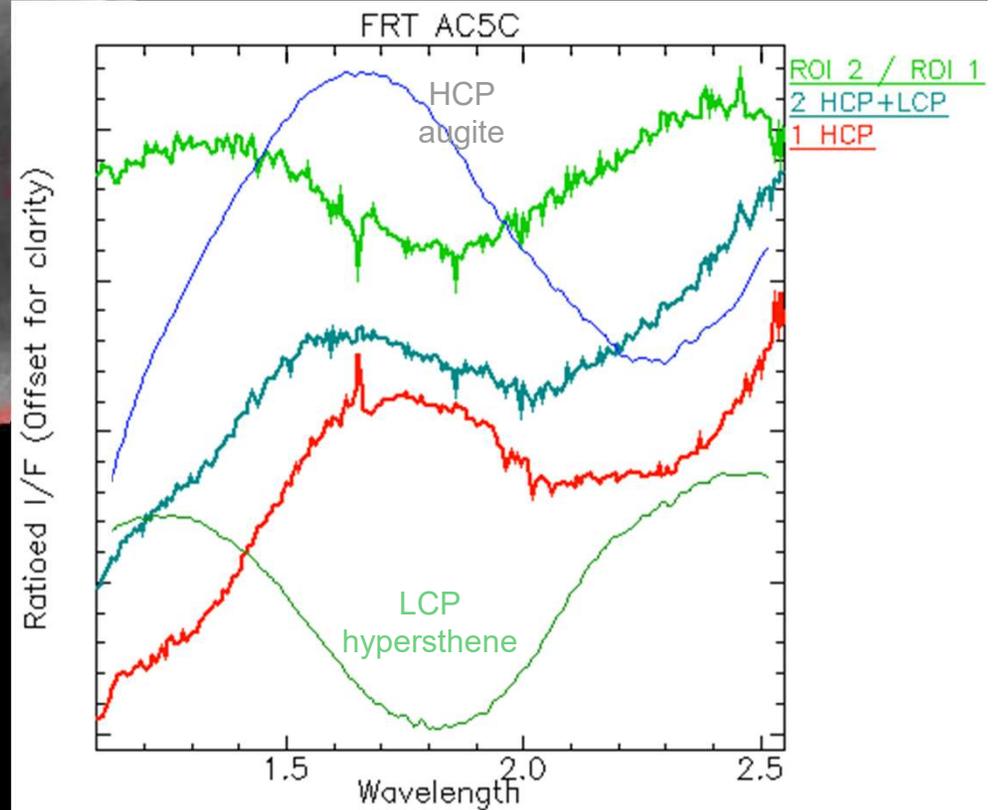
FRT AC5C



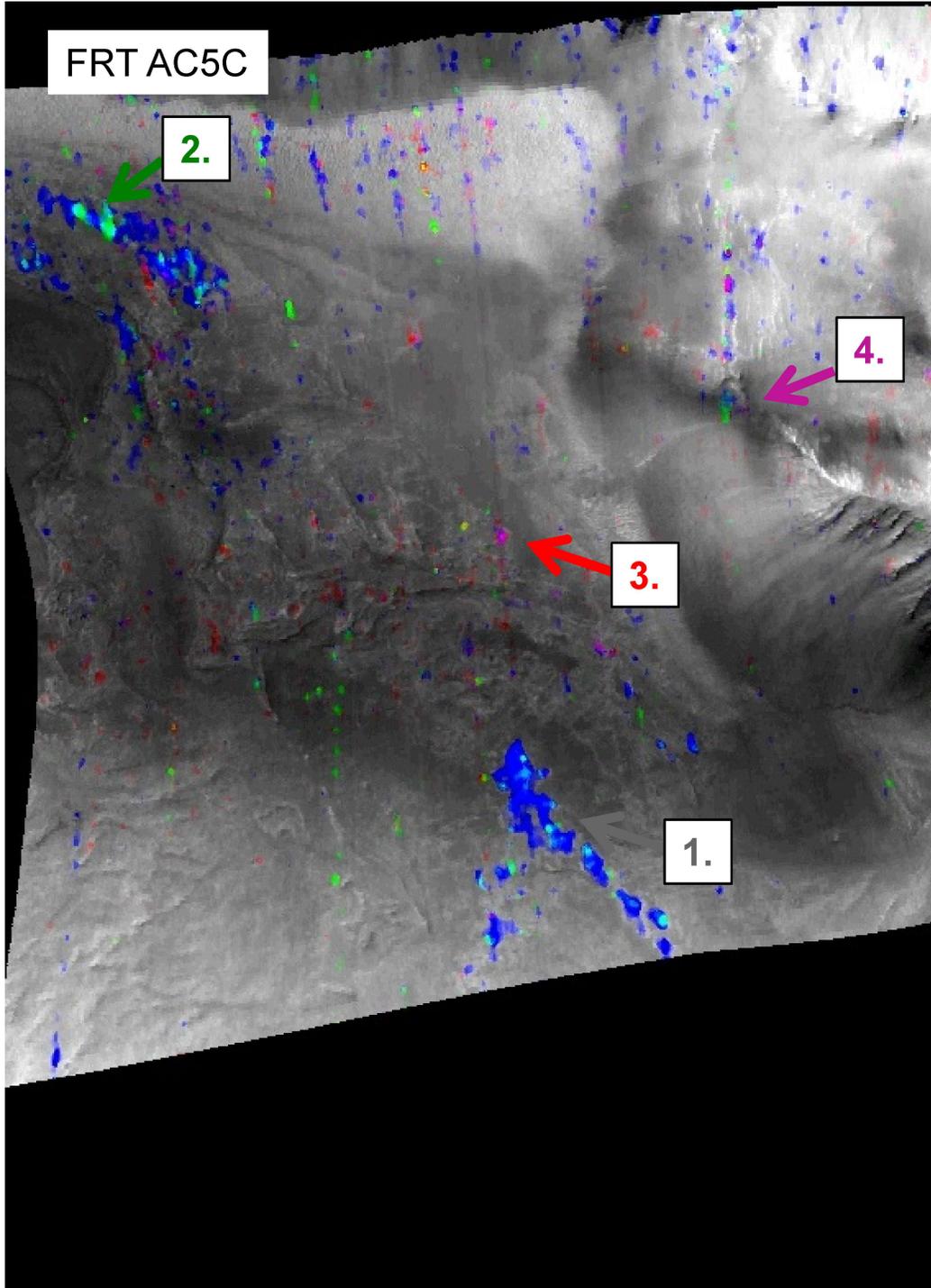
R : 1  $\mu\text{m}+$  band of Olivine, HCP or other Fe-bearing minerals (phyllos)  
G : MGM LCP  
B : MGM HCP

1. HCP bearing rocks

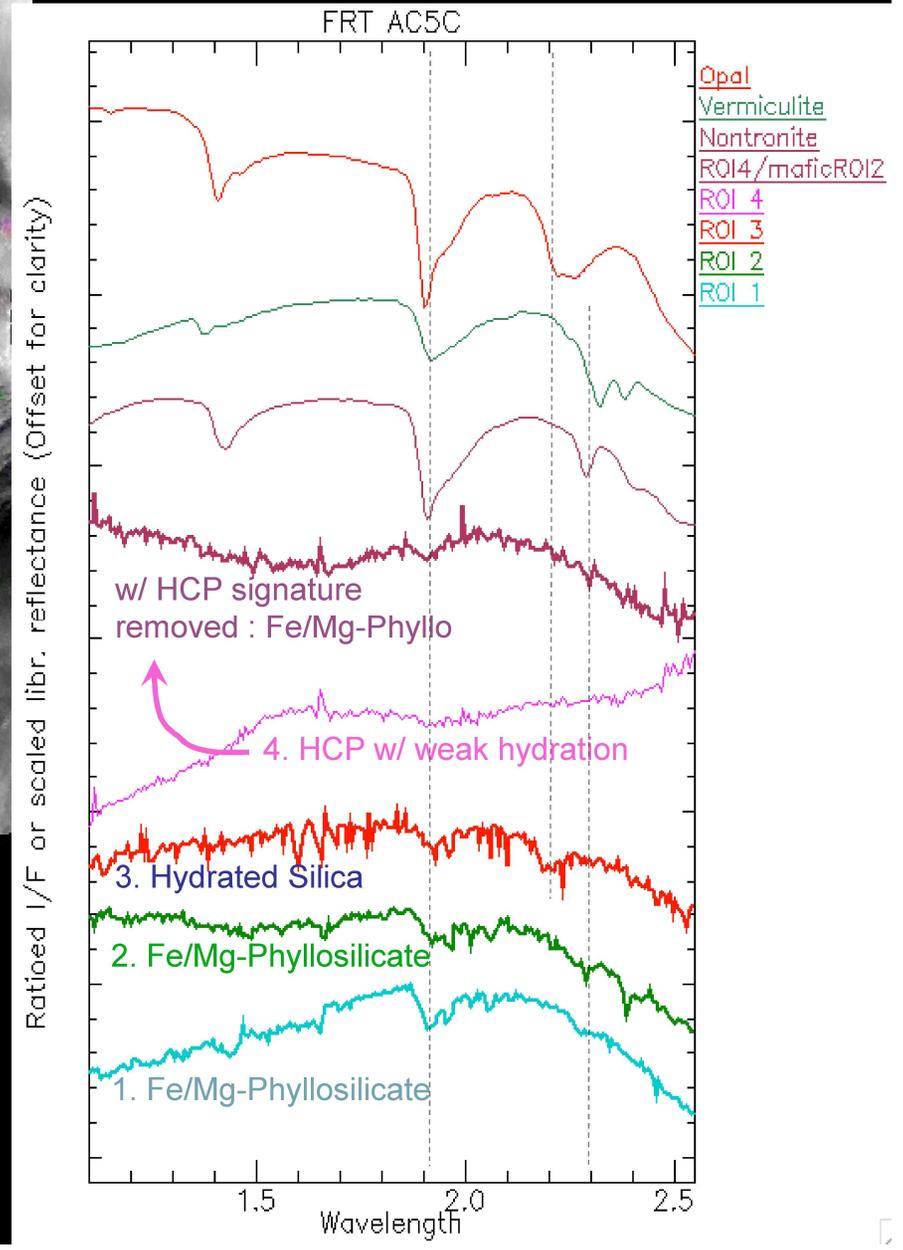
2. HCP + LCP bearing rocks

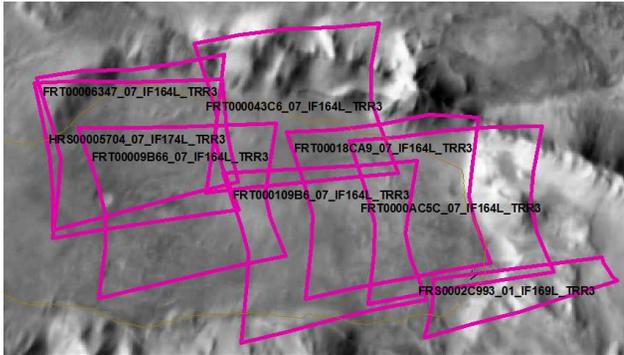


FRT AC5C



R : Si-OH index  
G : Fe/Mg-Phyllo index  
B : 1.9  $\mu\text{m}$  band

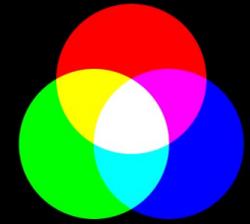




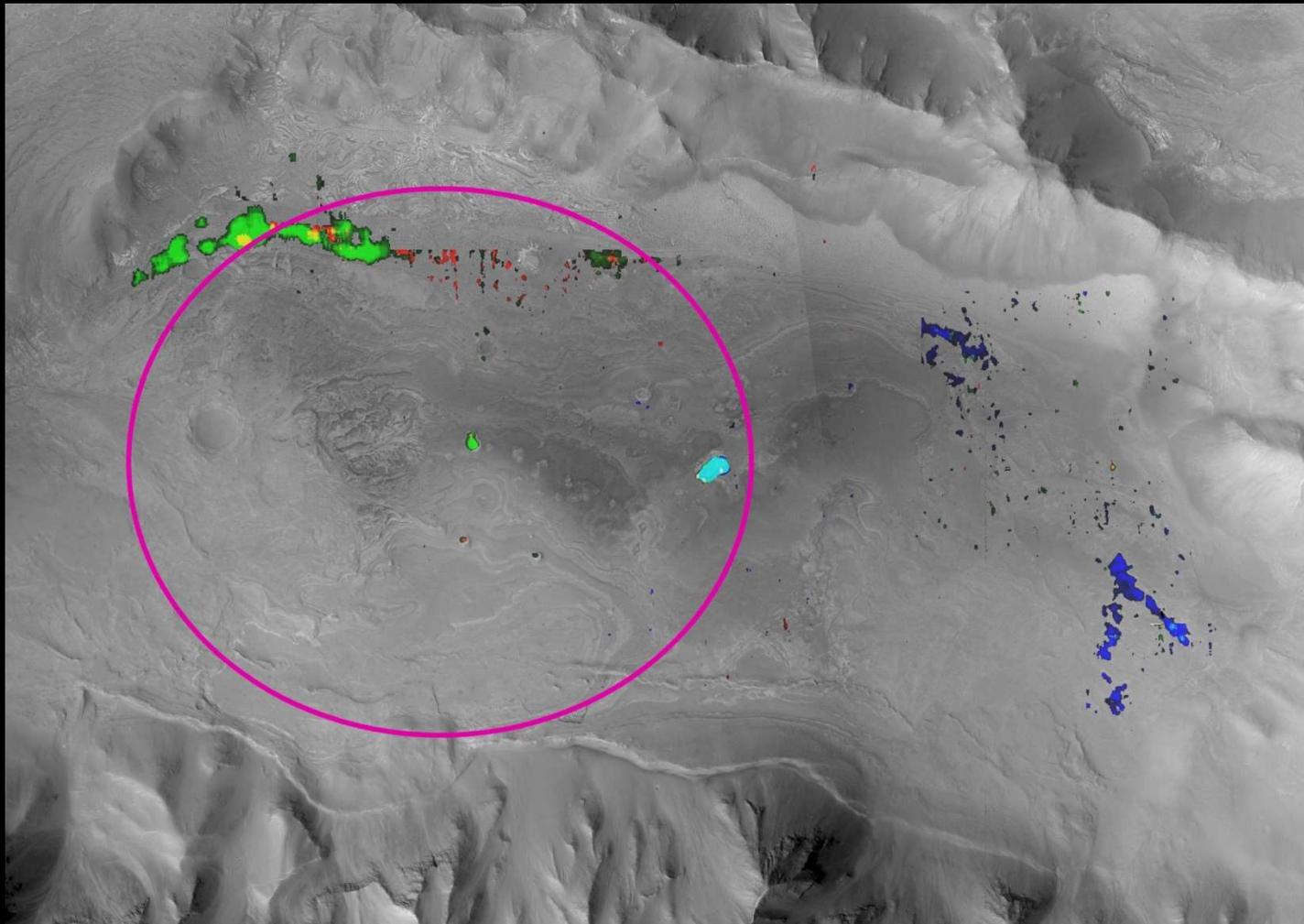
# Basin mineralogical diversity

2.26  $\mu\text{m}$  (Jarosite)

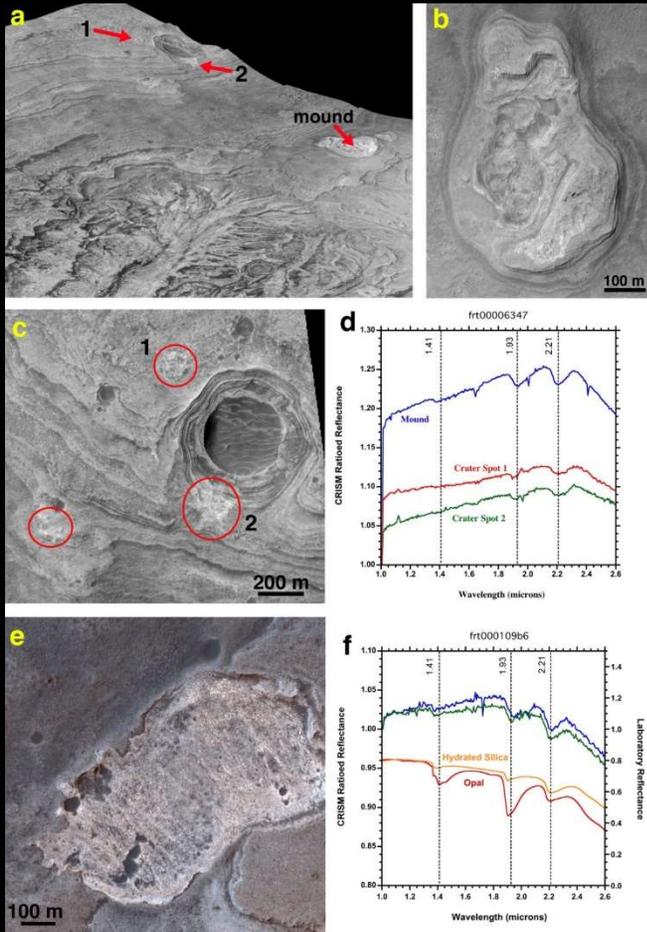
1.9+2.2  $\mu\text{m}$   
(Si-OH, Jarosite)



1.9  $\mu\text{m}$  (Hydrated minerals, clays)



# Opaline silica Buttes

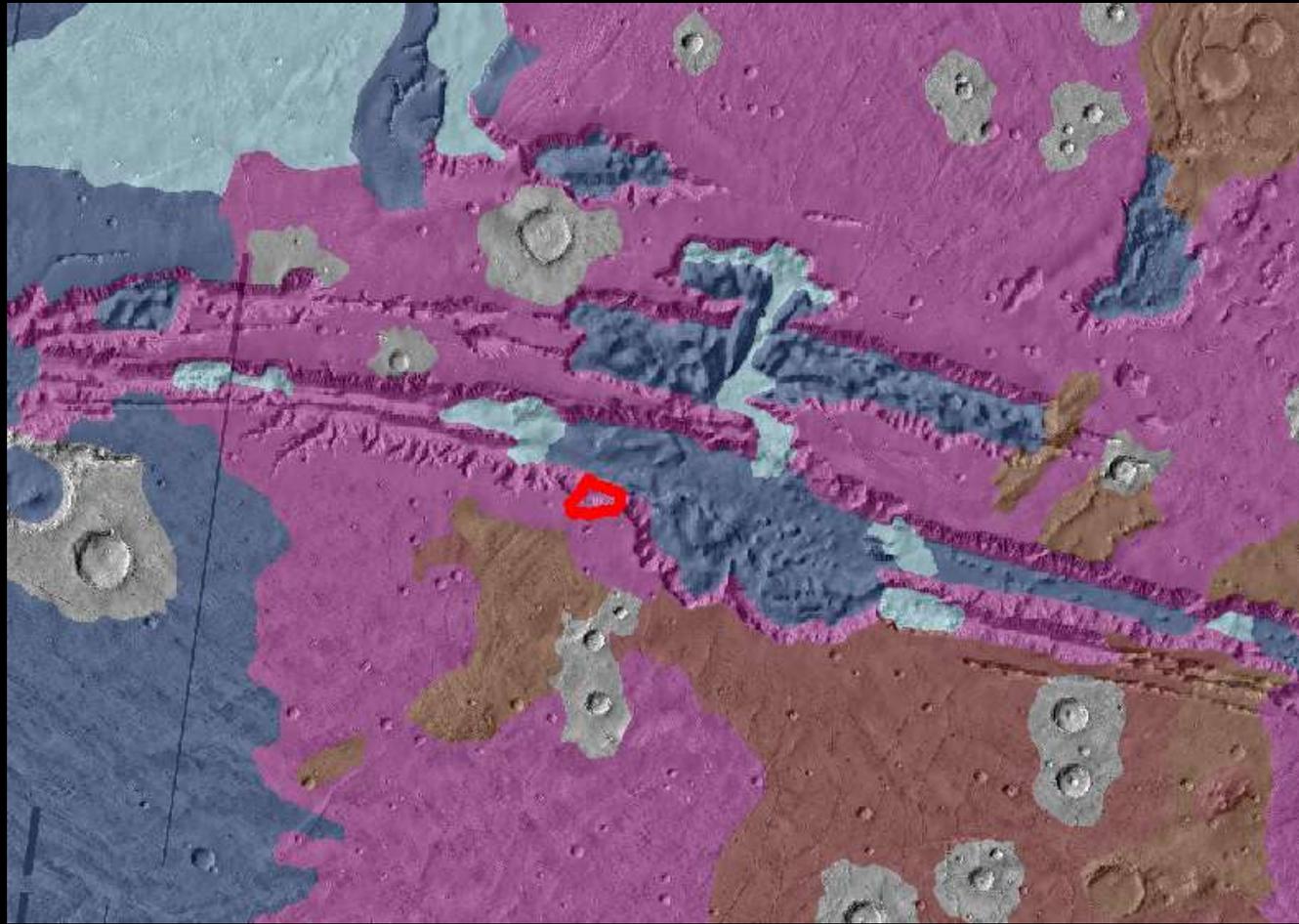


(Weitz et al., Icarus, 2014;  
Williams and Weitz,  
Icarus, 2014)



-Opaline silica : overprint/preservation of  
existing structure (like organic structure)  
Possible origin : hydrothermal buttes  
(geyserites)

# Age of the fluvio-lacustrine activity

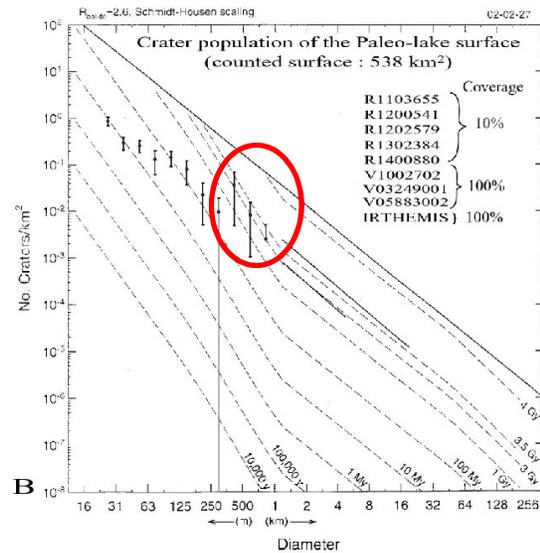


- Noachian
- Early Hesperian
- Late Hesperian
- Amazonian

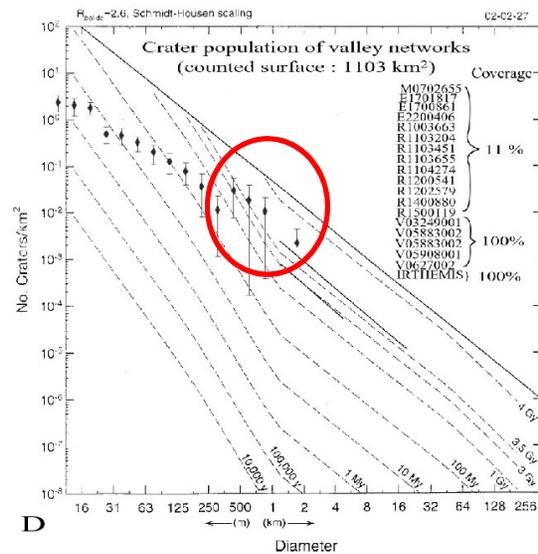
Tanaka et al., 2014

Valleys are dissecting Early Hesperian units

# Partial clue from crater counts



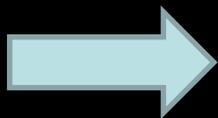
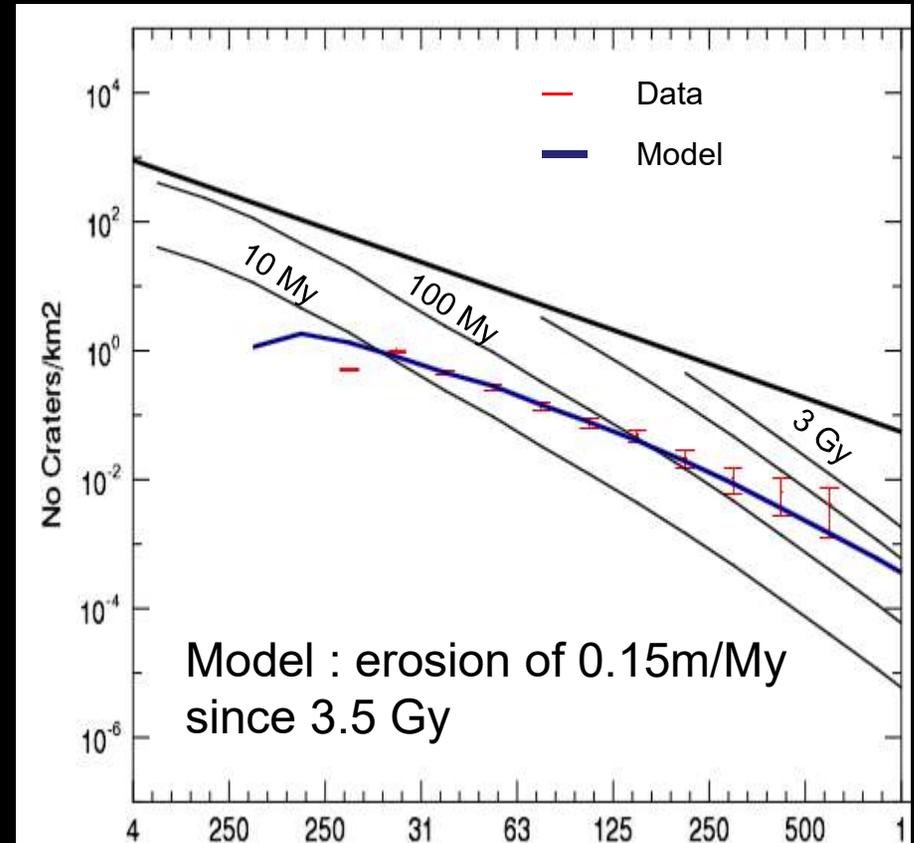
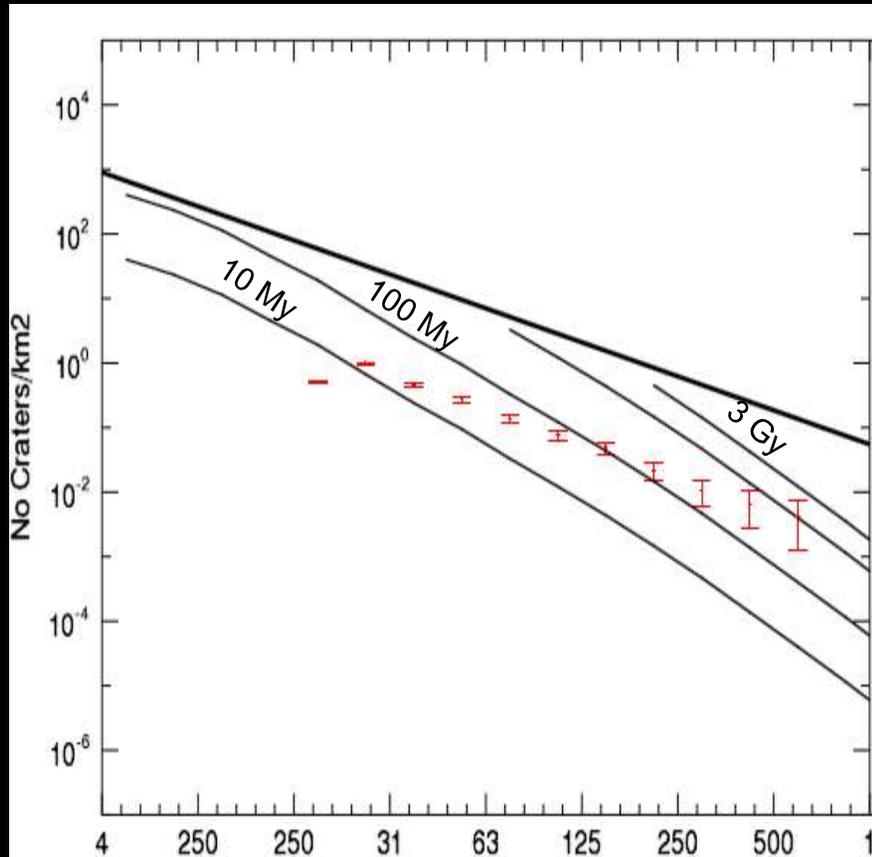
Large craters in the paleo-lake: > 3 Gy



Large craters on the valley network : >3.5 Gy

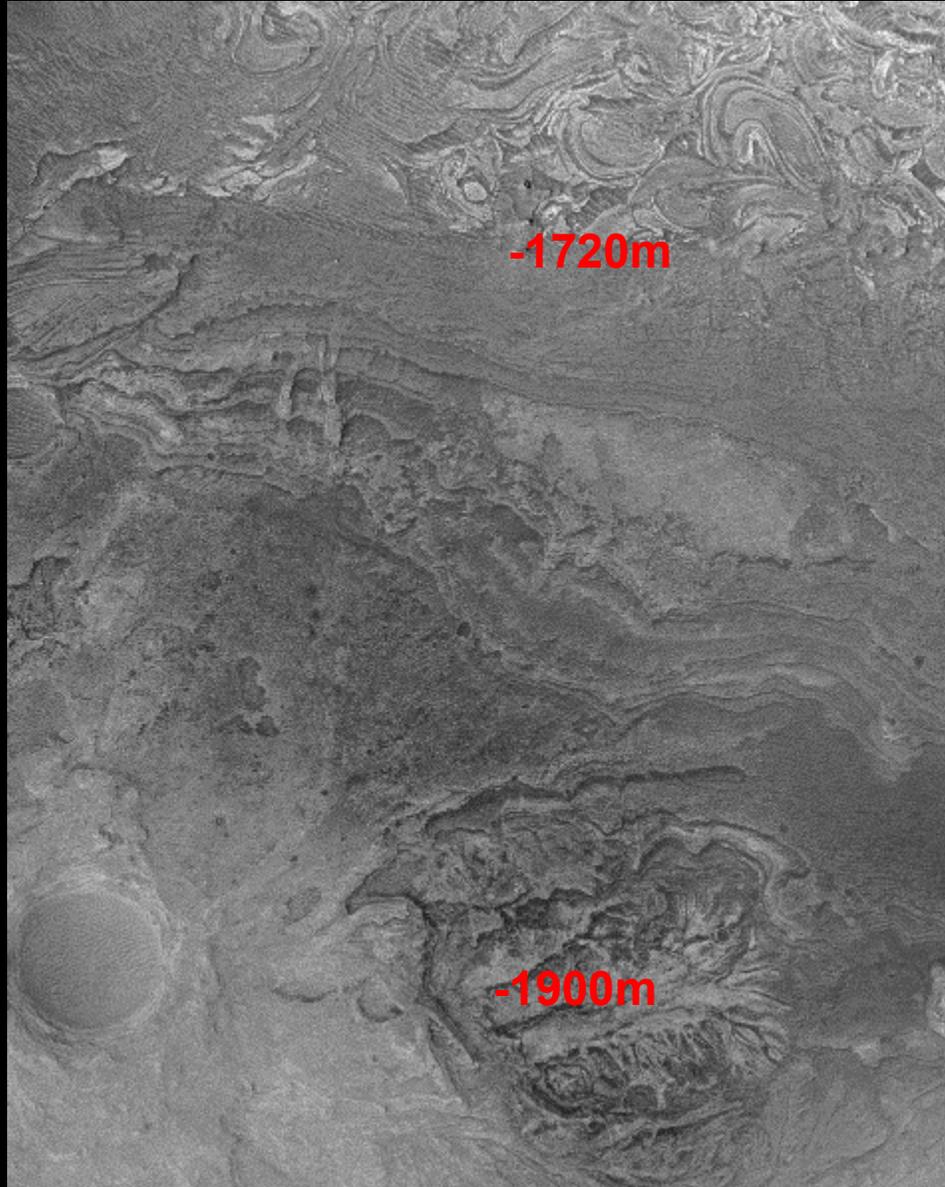
Quantin et al., 2005

# Long and continuous erosion



More than 500 m over the past 3.5 Gy have been removed

Method from Quantin et al., 2017



The lacustrine layer exposures also witness the large amount of erosion (at least 200m)

Davis et al., 2017



# Conclusions

- Complete “source to sink” system (constrained geochemistry and volume budget)
  - » Advantage for in situ analyses
  - » Advantage for returned sample isotopic analyses
- Evidence for efficient concentration processes for fine grained materials (like organic)
- Hydrated minerals diversity including hydrated silica, jarosite, and clays
- Long lived exhumation history (at least 200m have been removed)