

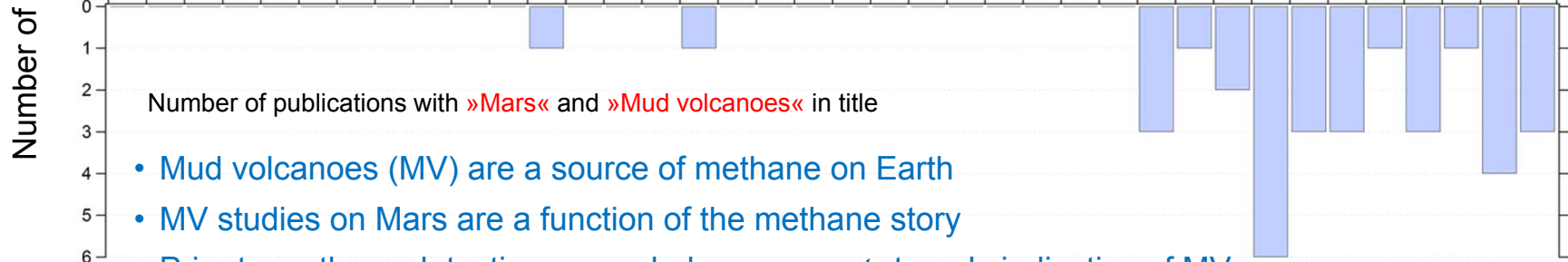
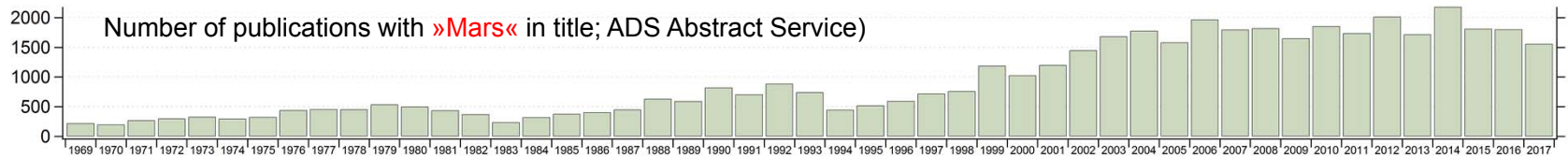
# Possible subsurface sediment mobilisation in Chryse Planitia, Mars

Ilse van de Burgt<sup>1</sup>, Ernst Hauber<sup>1</sup>, Petr Brož<sup>2</sup>, O. Čadek<sup>3</sup>

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# Background and Motivation

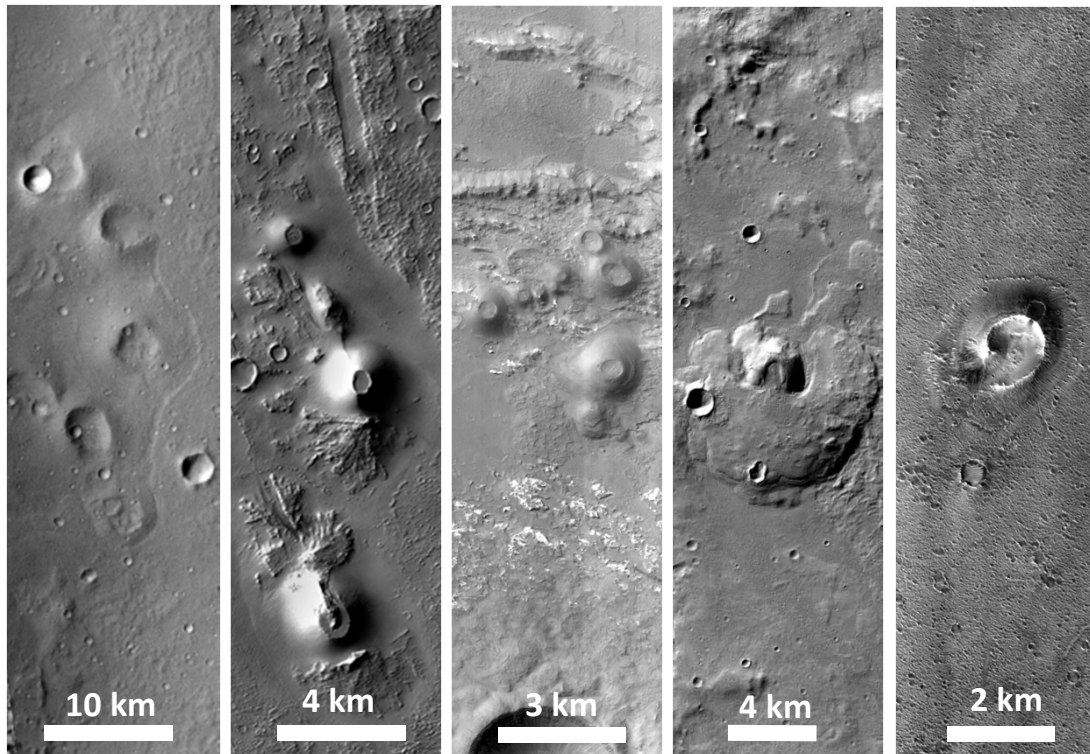


- Mud volcanoes (MV) are a source of methane on Earth
- MV studies on Mars are a function of the methane story
- Prior to methane detections, morphology was *not* strongly indicative of MV

# Mud volcanism (*aka Sedimentary Volcanism*)

- a) The discharge of at least a three-phase system (gas, water, and sediment - and occasionally oil).
- b) Gas and saline water related to a diagenetic or catagenetic hydrocarbon production system (accordingly gas is dominated by methane and subordinately C<sub>2</sub>+ hydrocarbons).
- c) The involvement of sedimentary rocks with a gravitative instability resulting from rapid sedimentation, leading to the formation of mobile shales, diapirs or diatremes.
- d) The (common) presence of breccia within the discharged material.

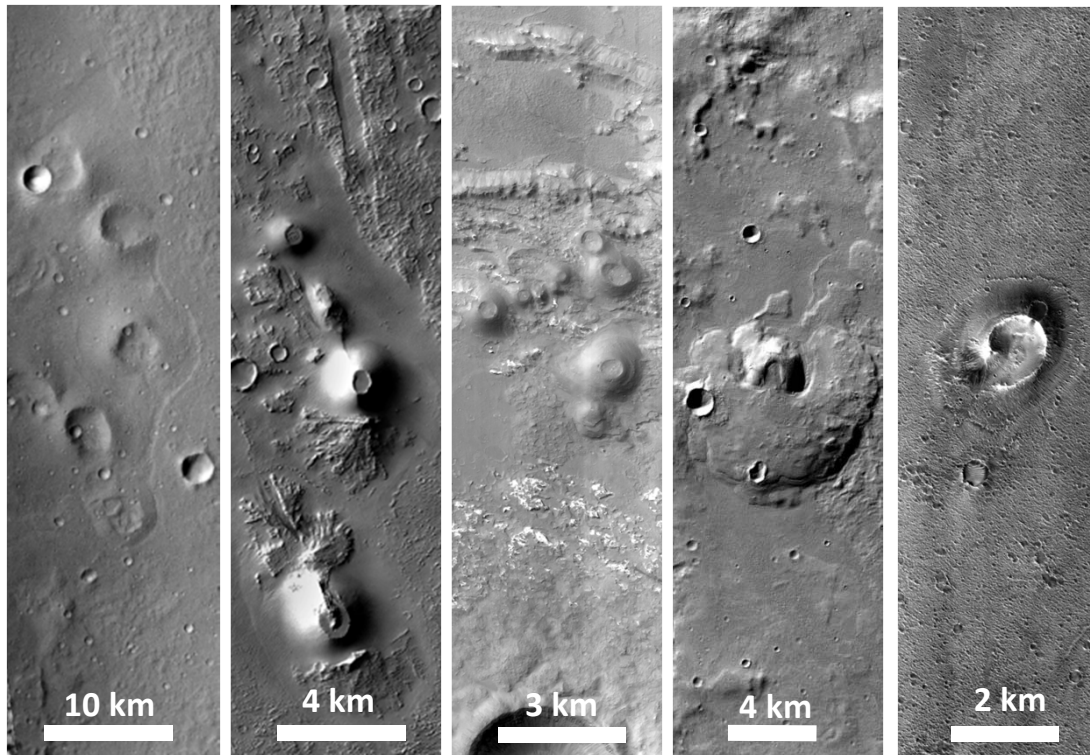
# Small volcanoes on Mars



HiRISE and CTX images

- Brož and Hauber, Icarus (2012)
- Brož and Hauber, JGR (2013)
- Brož, Čadek, Hauber, Rossi, EPSL (2014)
- Brož, Čadek, Hauber, Rossi, JGR (2015)
- Brož, Hauber, Platz, Balme, EPSL (2015)
- Brož, Hauber, Michael, Wray, EPSL (2017)

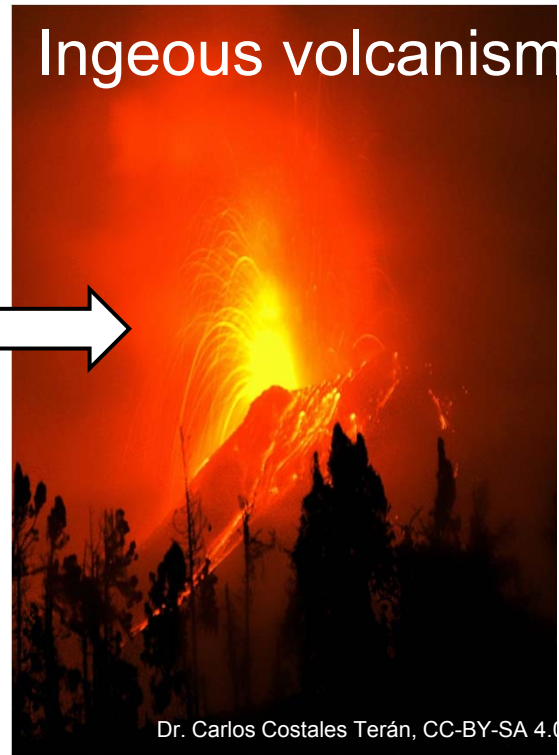
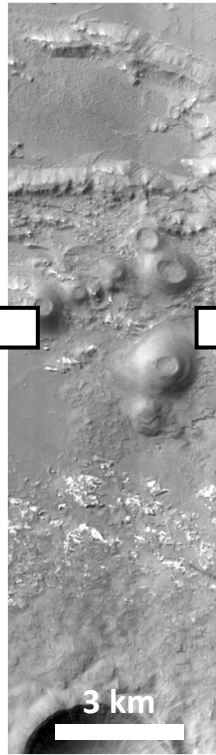
# Small volcanoes on Mars



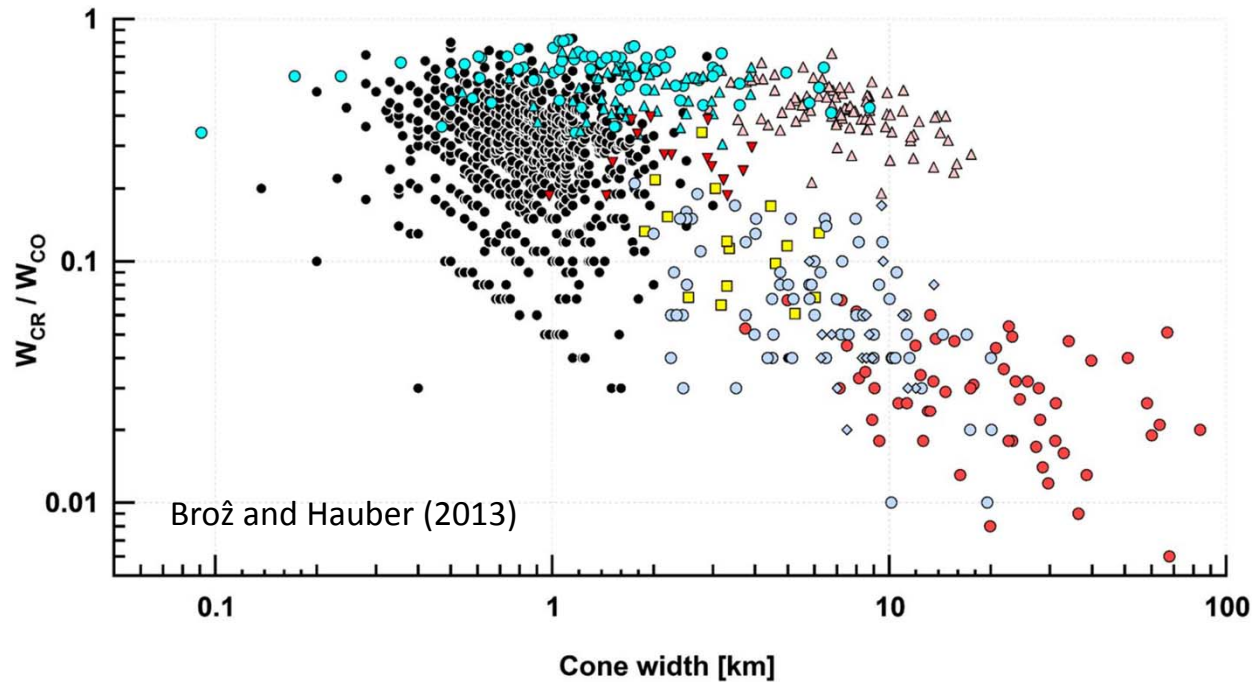
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- Brož, Hauber, Platz, Balme, EPSL (2015)
- Brož, Hauber, Michael, Wray, EPSL (2017)

# Morphology is ambiguous



# Morphometry may help, but...



- |                         |                               |                              |
|-------------------------|-------------------------------|------------------------------|
| △ NAC Cones (Mars)      | ● Cinder/Scoria Cones (Earth) | ■ Mud Volcanoes (Azerbaijan) |
| ▼ Ulysses Colles (Mars) | ○ Low Shields (Earth)         | ● Maars (Earth)              |
| ● Low Shields (Mars)    | ◇ Icelandic Shields (Earth)   | ▲ Tuff Rings (Earth)         |

Icarus  
Volume 186, Issue 1, January 2007, Pages 41-59

Evidence for and implications of sedimentary diapirism and mud volcanism in the southern Utopia highlands and boundary plain, Mars

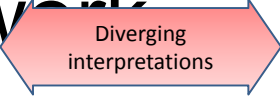
James A. Skinner Jr. , Kenneth L. Tanaka

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Southern rim of Utopia Basin



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P. Brož , E. Hauber

First published: 22 August 2013 Full publication history

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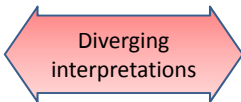
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Morphologic evidence of subsurface sediment mobilization and mud volcanism in Candor and Coprates Chasmata, Valles Marineris, Mars

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Valles Marineris



Earth and Planetary Science Letters 473 (2017) 122-130

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Amazonian volcanism inside Valles Marineris on Mars

Petr Brož<sup>a,\*</sup>, Ernst Hauber<sup>b</sup>, James J. Wray<sup>c</sup>, Gregory Michael<sup>d</sup>

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Icarus 268 (2016) 56-75

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Small edifice features in Chryse Planitia, Mars: Assessment of a mud volcano hypothesis

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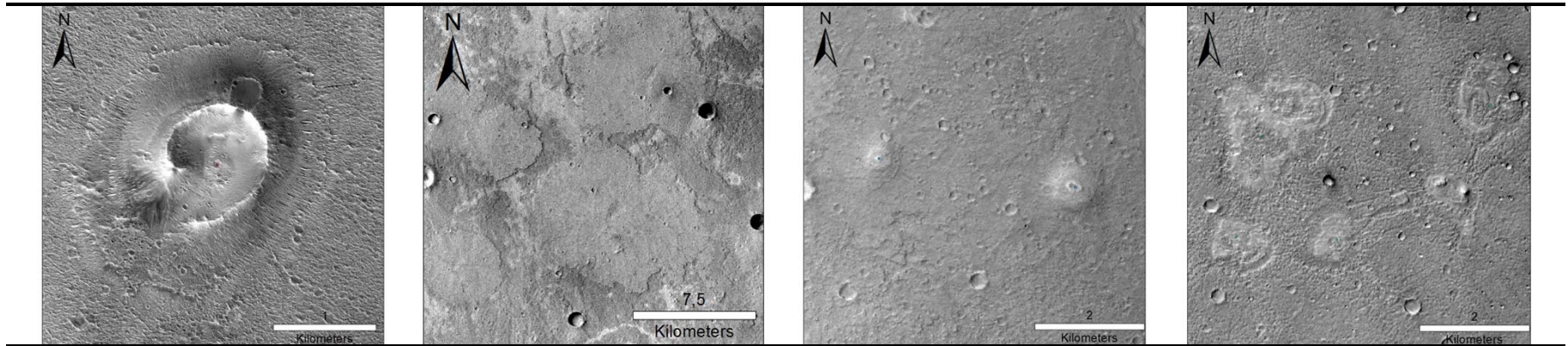
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Chryse Planitia

  
(this study)



# Morphological classes



cones

pies

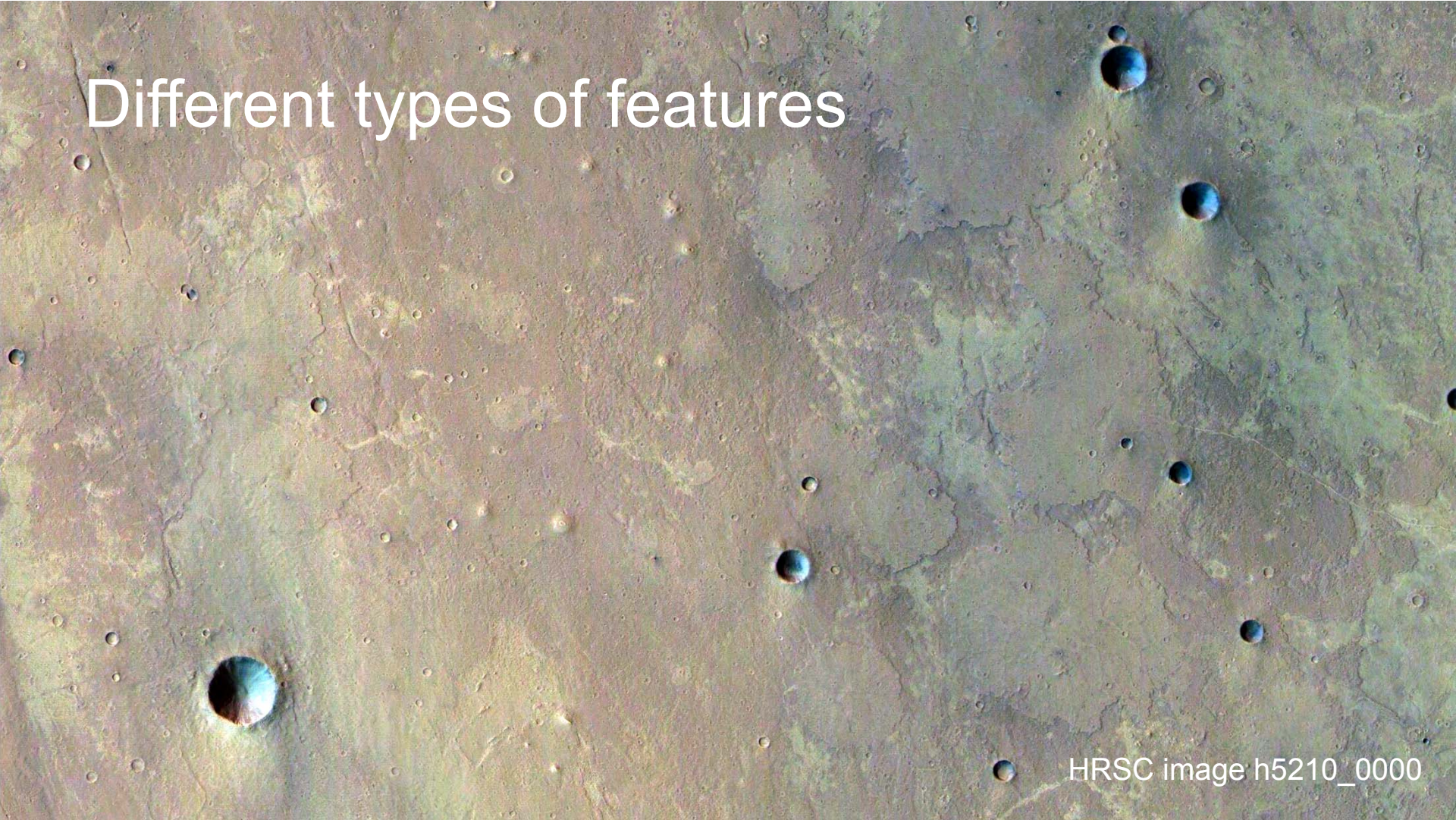
domes

irregular patches

already used by Komatsu et al. (2016)

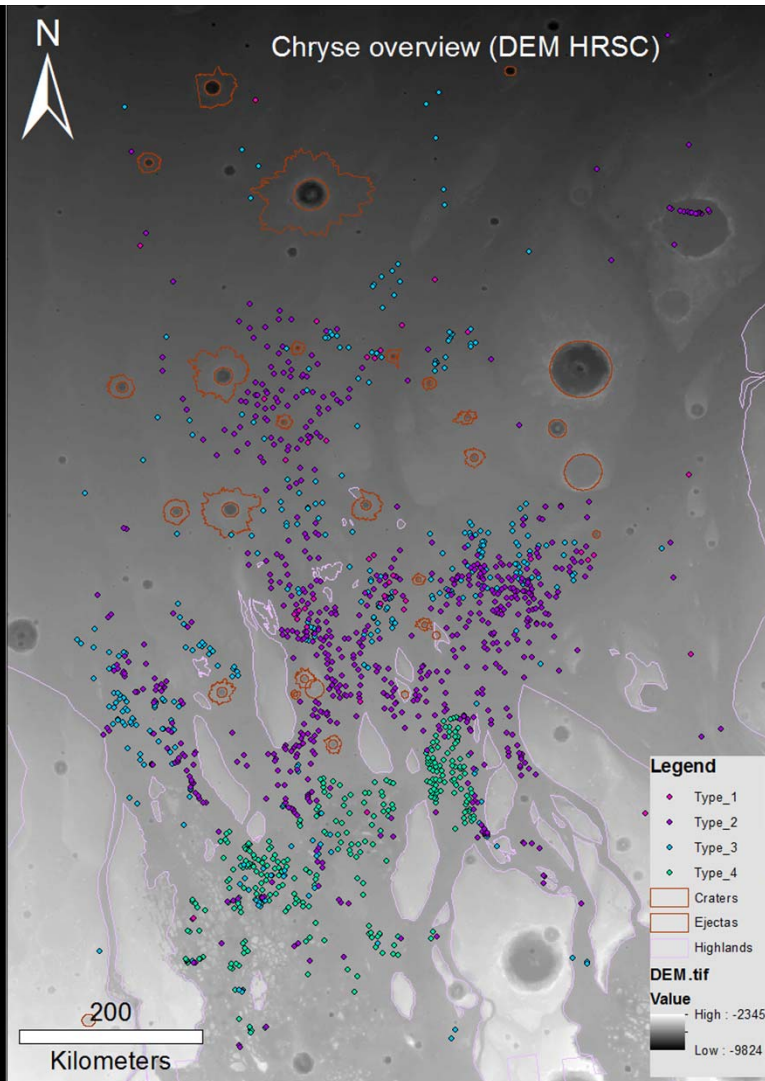
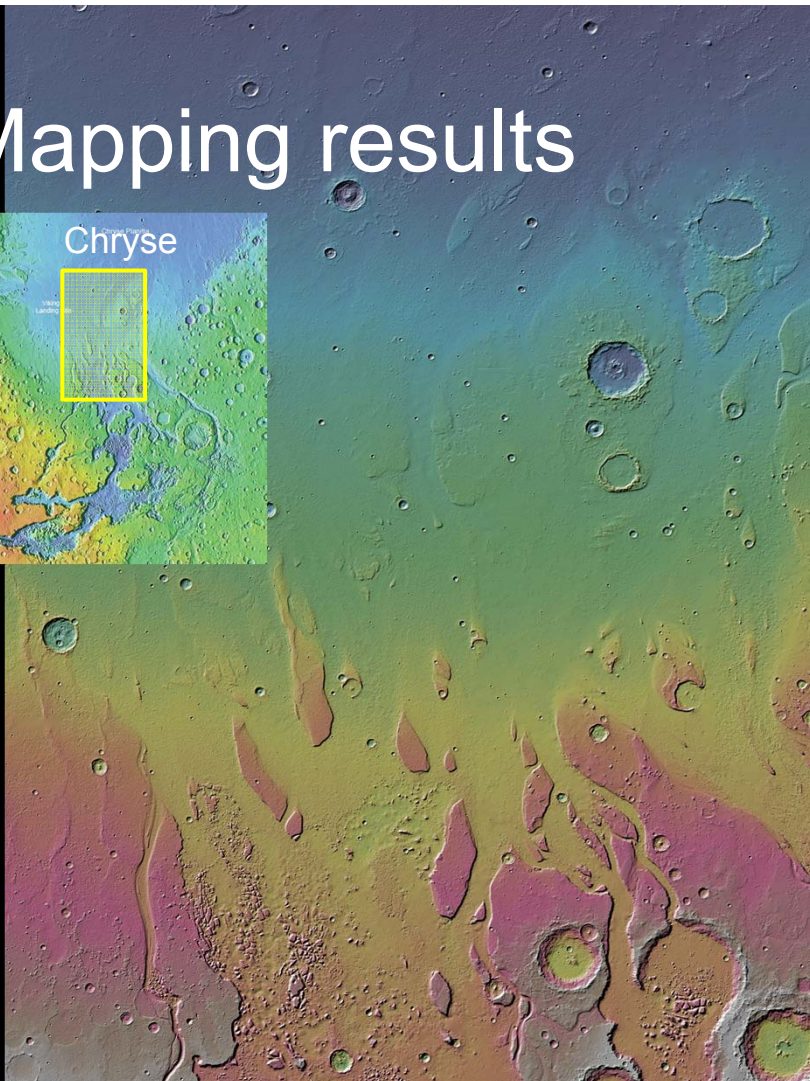
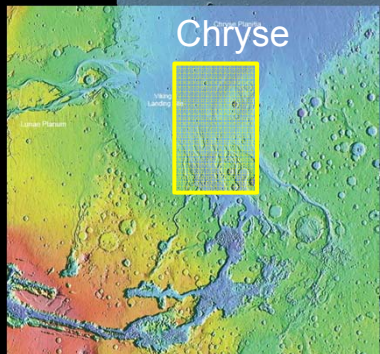
newly defined in  
this study

# Different types of features

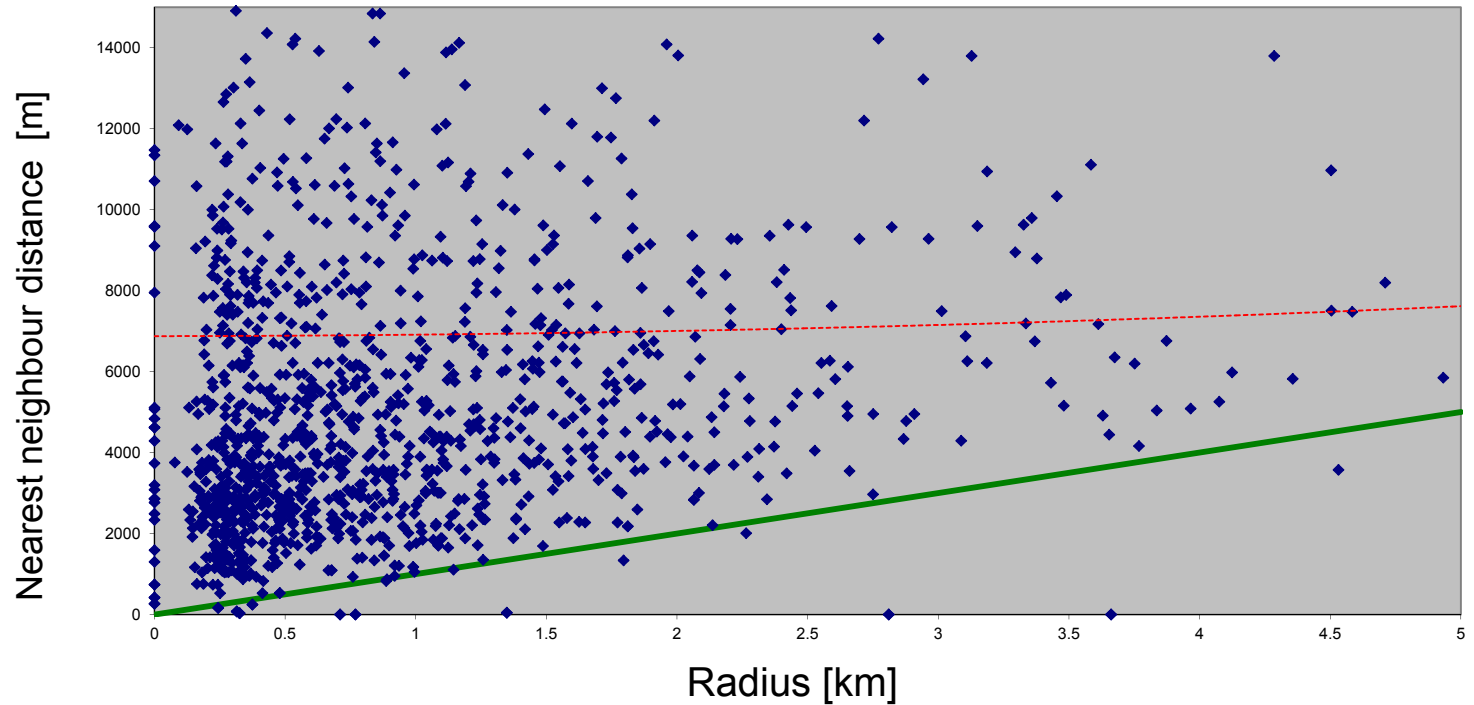


HRSC image h5210\_0000

# Mapping results

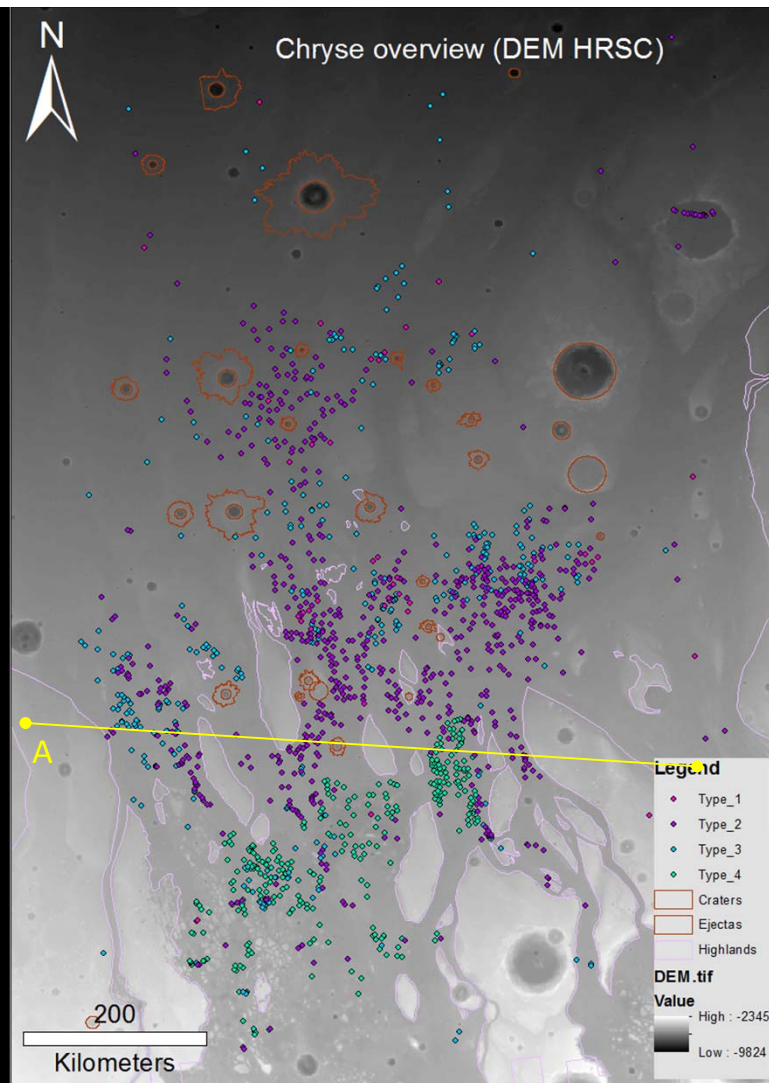
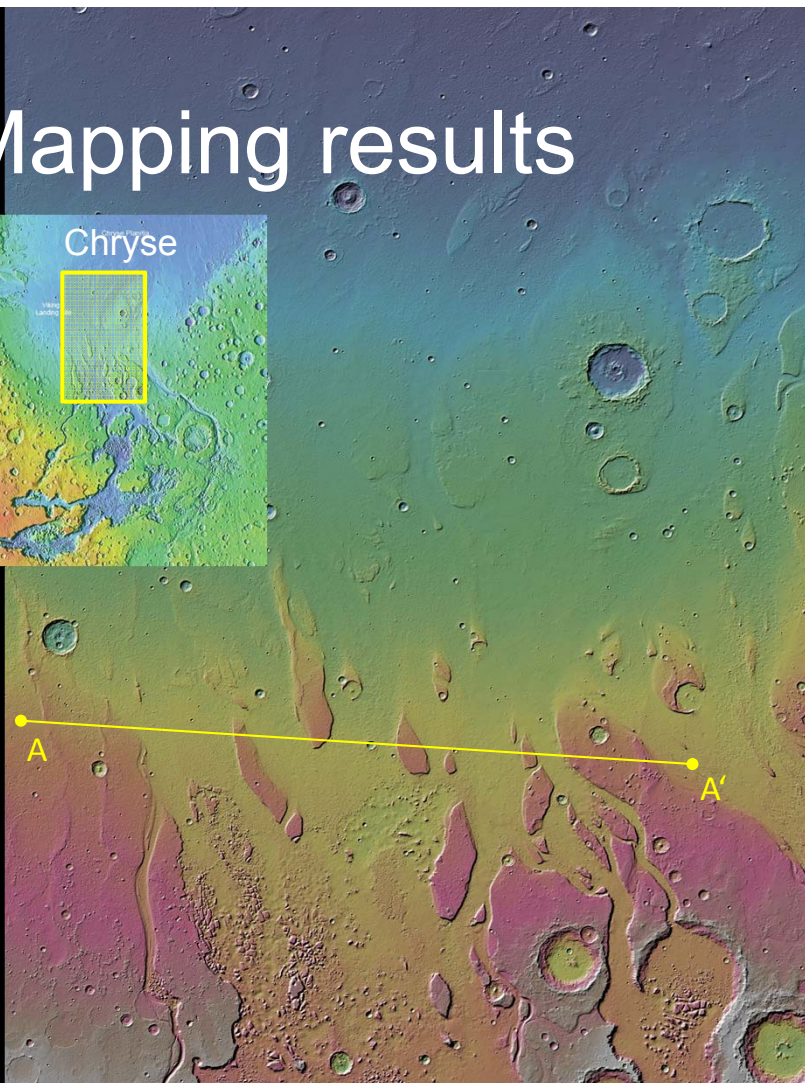
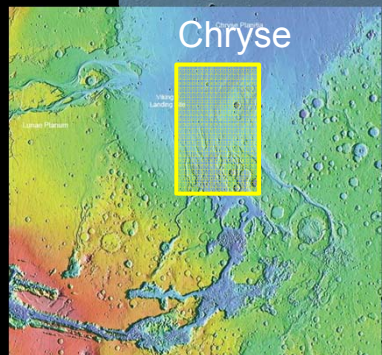


# Spatial analysis

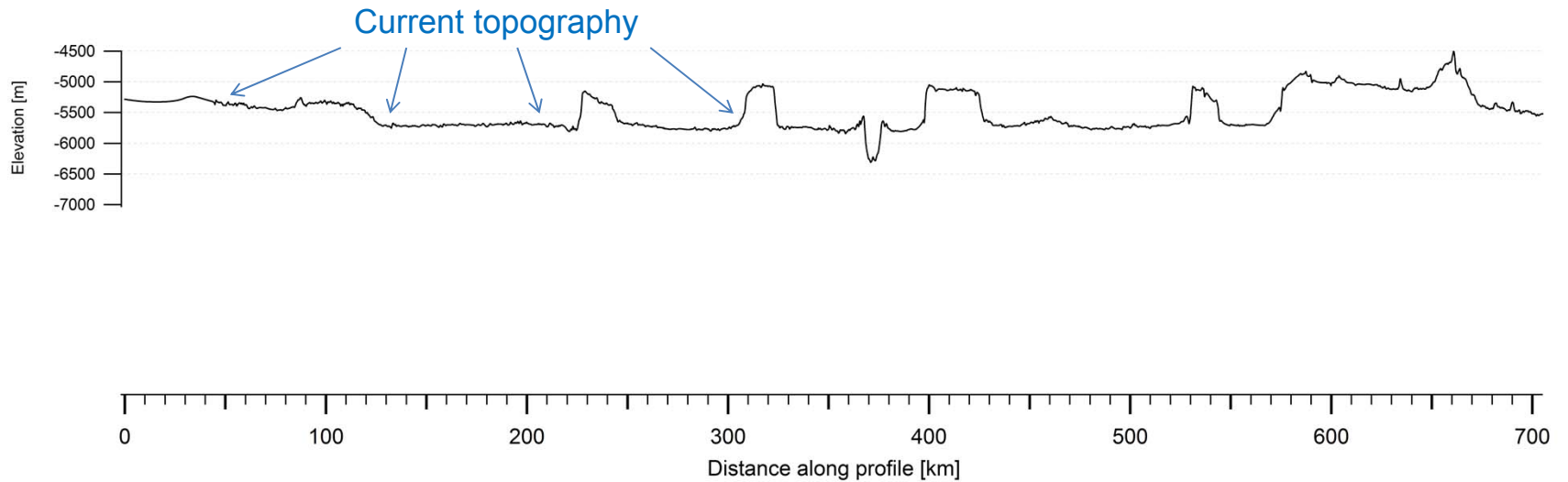


- No overlap, edifices seem to be individual features without direct association with each other

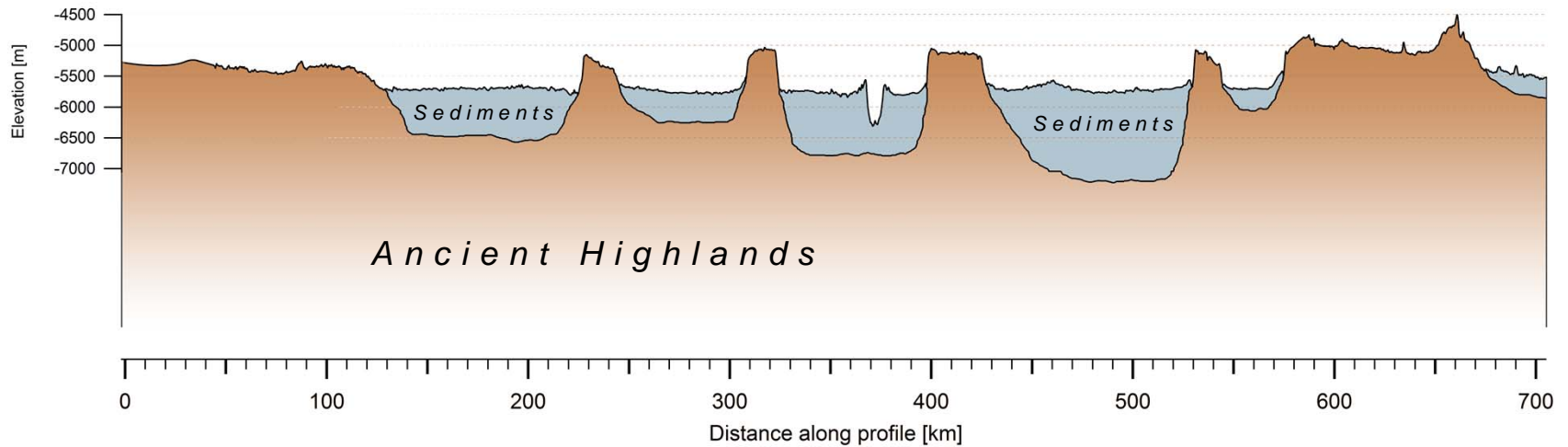
# Mapping results



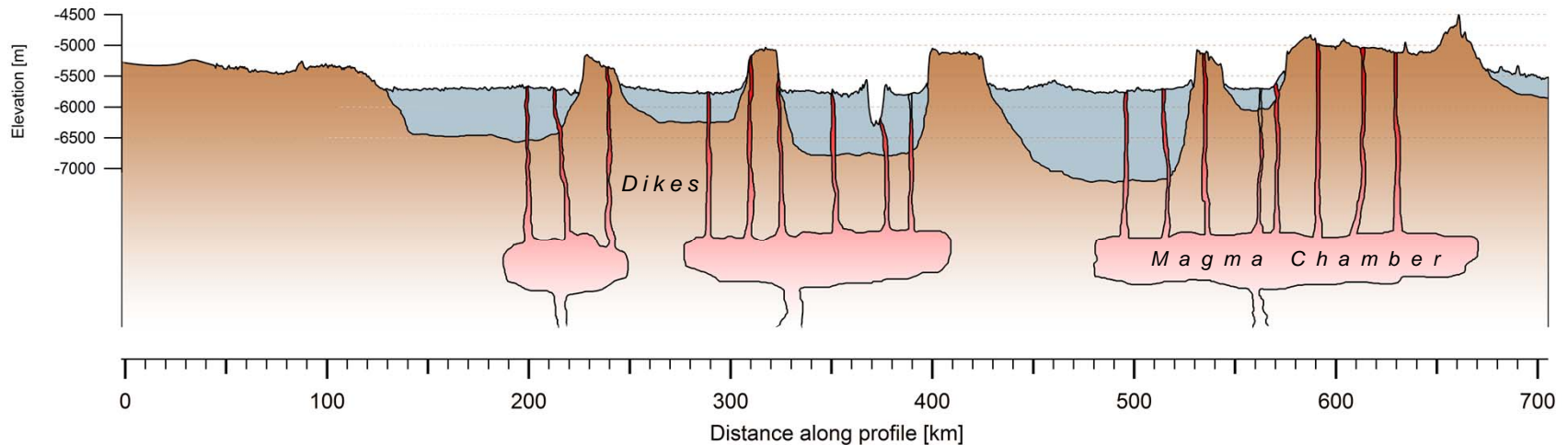
# How diagnostic is the distribution?



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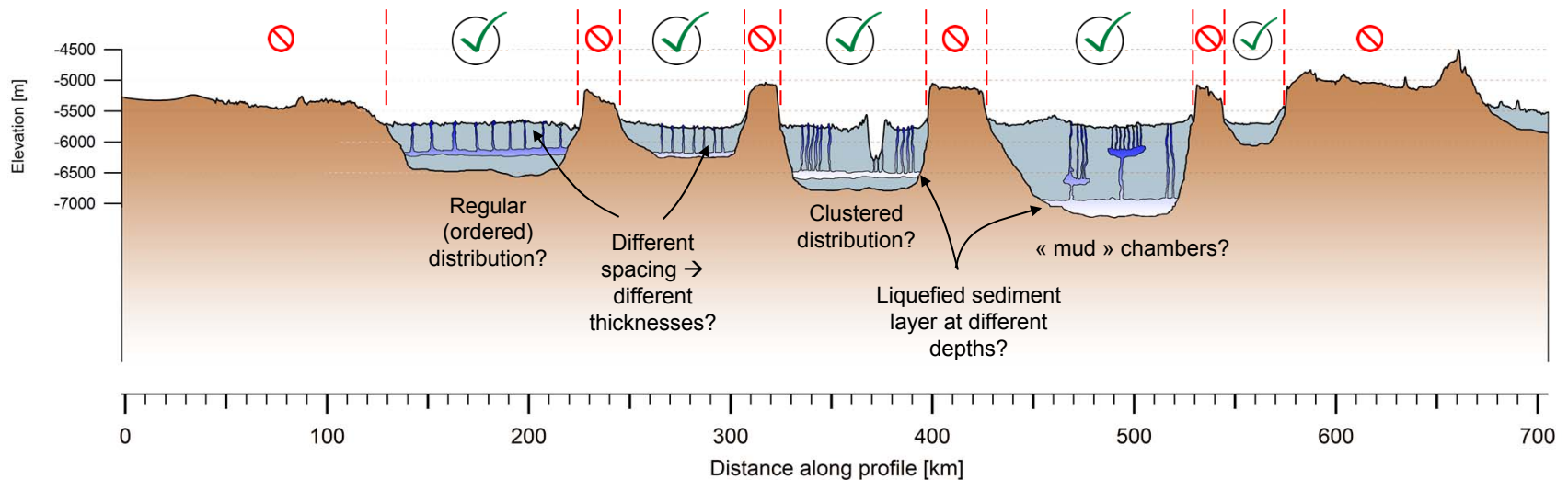


## Igneous volcanism

- Relatively deep magma chambers, magma ascent by dikes and vent locations not strongly controlled by shallow crustal lithology
- Location of volcano (clusters) independent of surface units



# How diagnostic is the distribution?

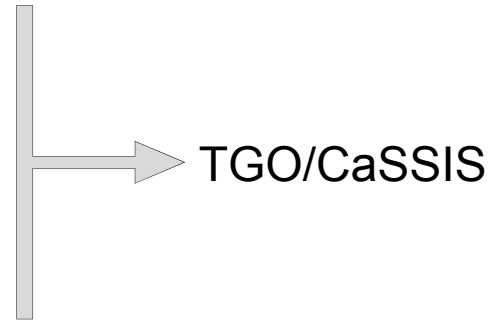


## Sedimentary volcanism

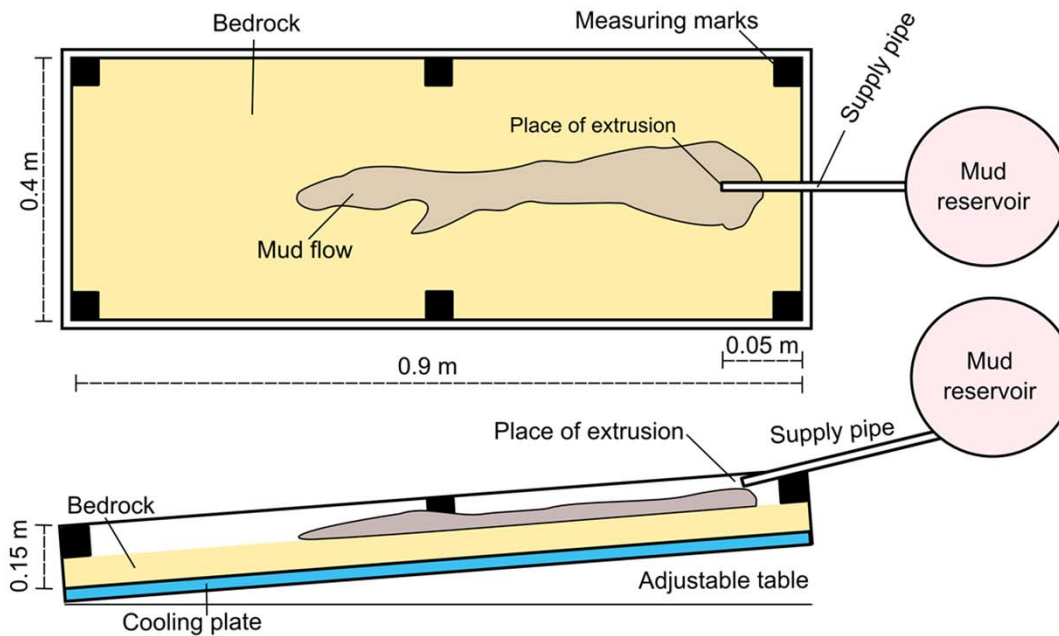
- Relatively shallow source layers in sedimentary rocks, ascent mechanism unknown
- Location of edifice (clusters) *only* above sedimentary rocks

# Next steps

- Analyze spatial distribution
  - structural control?
  - Detailed relation to outflow channels (source of sediment?)
- Measure 2.5D properties
  - Use all topography data sets
- Determine local and regional stratigraphy
  - Thickness of sediments
  - Relative and absolute ages
- Make numerical model of mud ascent in Martian crust
- Mud behaviour in physical laboratory experiments under Martian conditions



# Planned laboratory experiments



- **OU Mars Simulation Chamber (M. Patel)**
  - 0.9 × 0.4 m tray
  - 5 cm sediment (sand)
  - T = -20°C, P = 7 mbar
  - clay (altered pyroclastics) with different water content
  - Control experiments
- **Proposal to Europlanet TNA submitted**

# One intriguing question whose answer we would like to know

- What physical conditions are required to trigger subsurface sediment mobilisation (*vulgo „mud volcanism“*) on Mars?
  - Density differences?
  - Pressurisation at depth?
  - Rheology of liquefied sediment?
  - Thickness of overburden?
  - Temperature (gradients)?

Is subsurface sediment mobilisation *physically possible* in the Martian environment – and if yes, when?