Possible subsurface sediment mobilisation in Chryse Planitia, Mars

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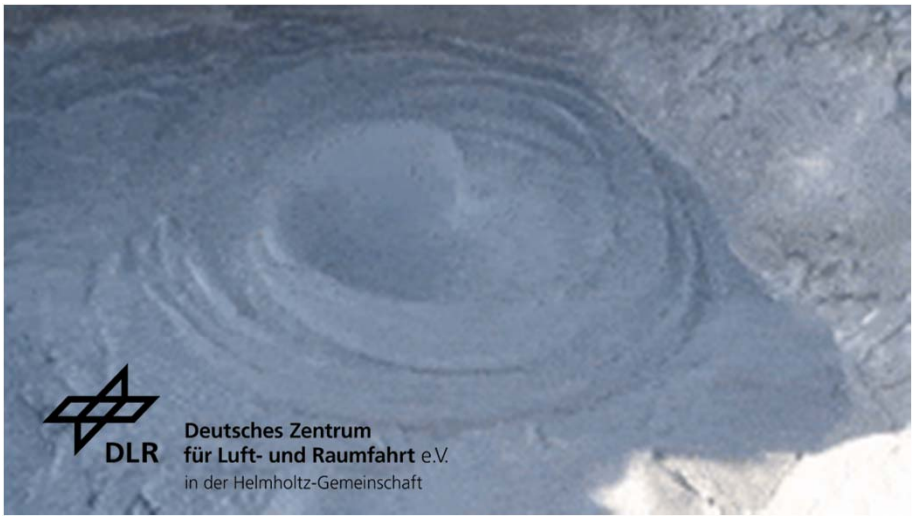
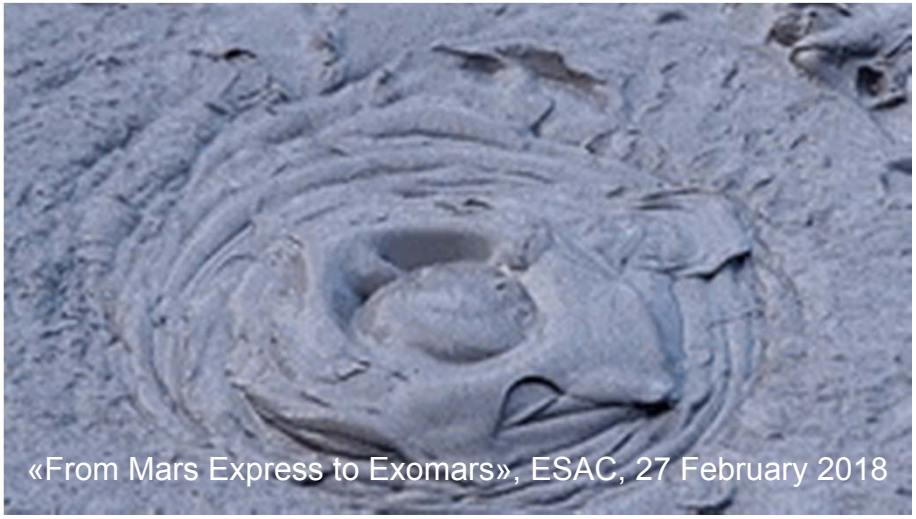
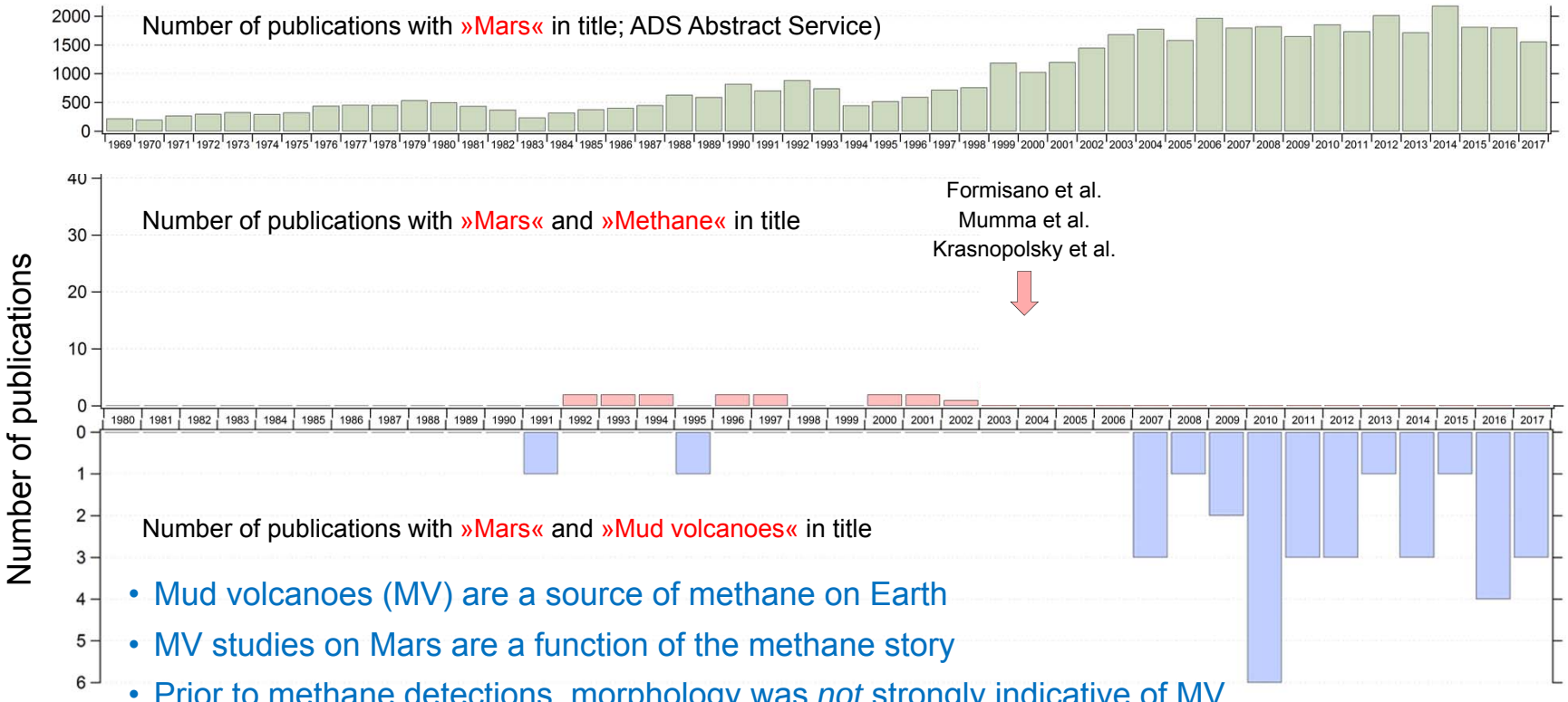




Background and Motivation



- 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).

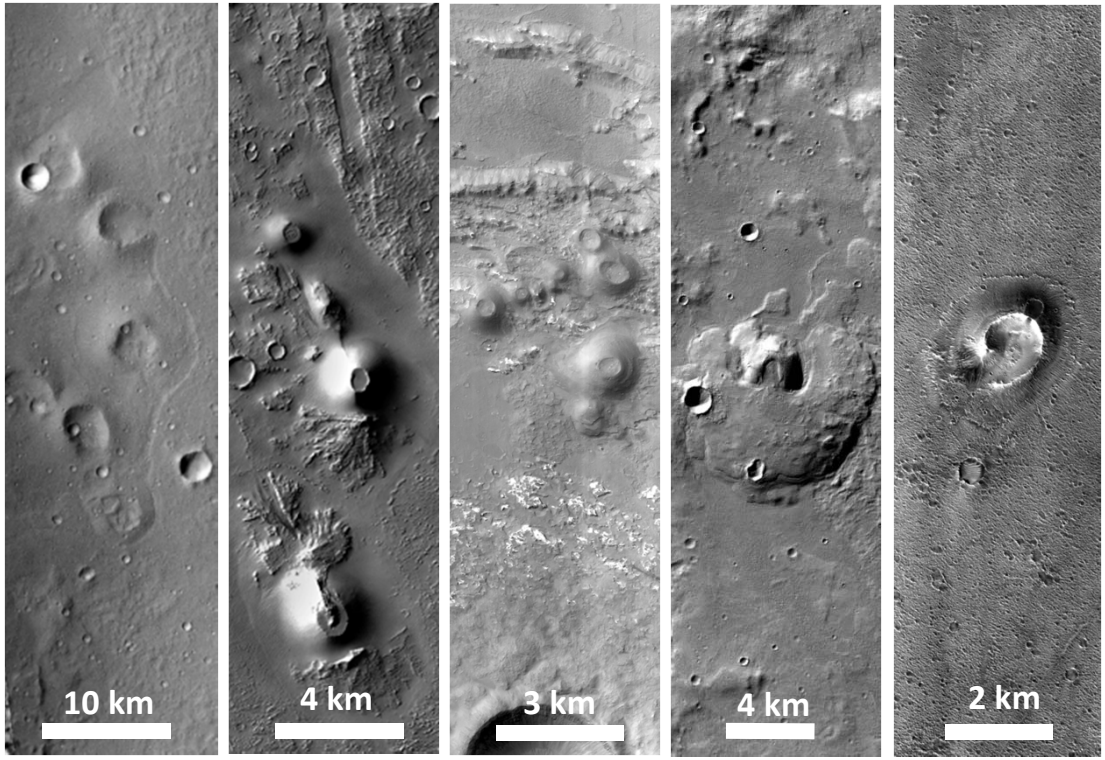
b) Gas and saline water related to a diagenetic or catagenetic hydrocarbon production system (accordingly gas is dominated by methane and subordinately C2+ hydrocarbons).

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.

Mazzarini and Etiope, Earth-Sci. Rev. (2017)

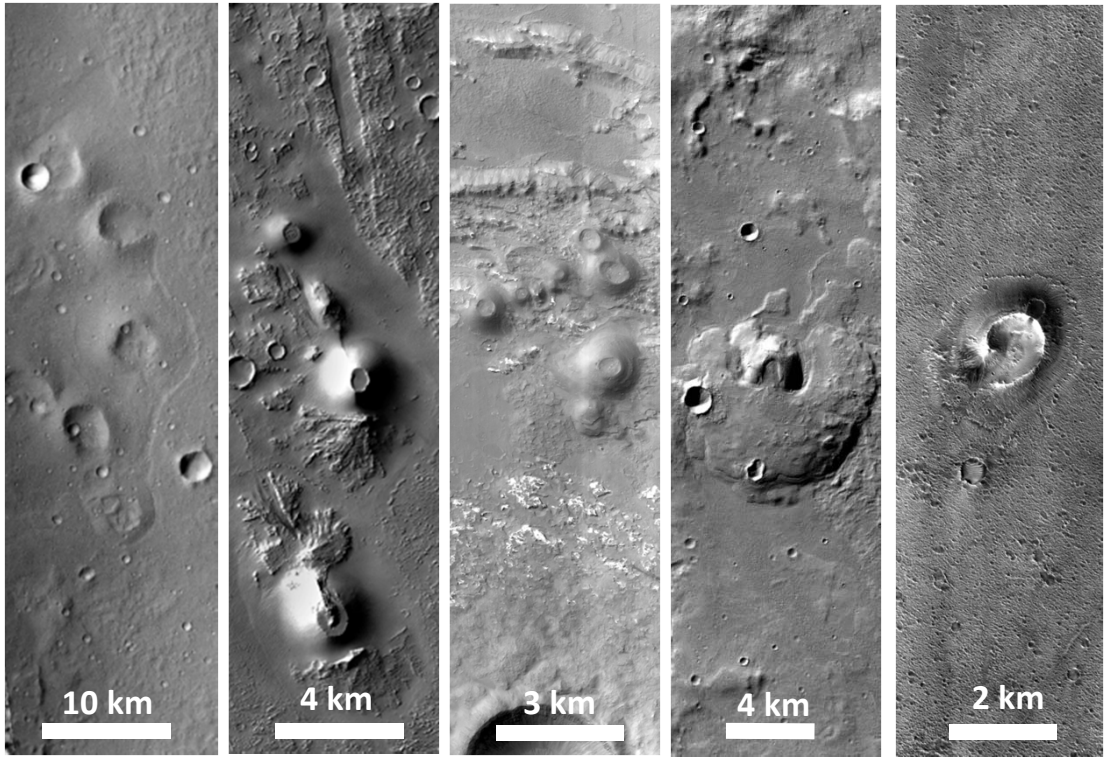
Small volcanoes on Mars



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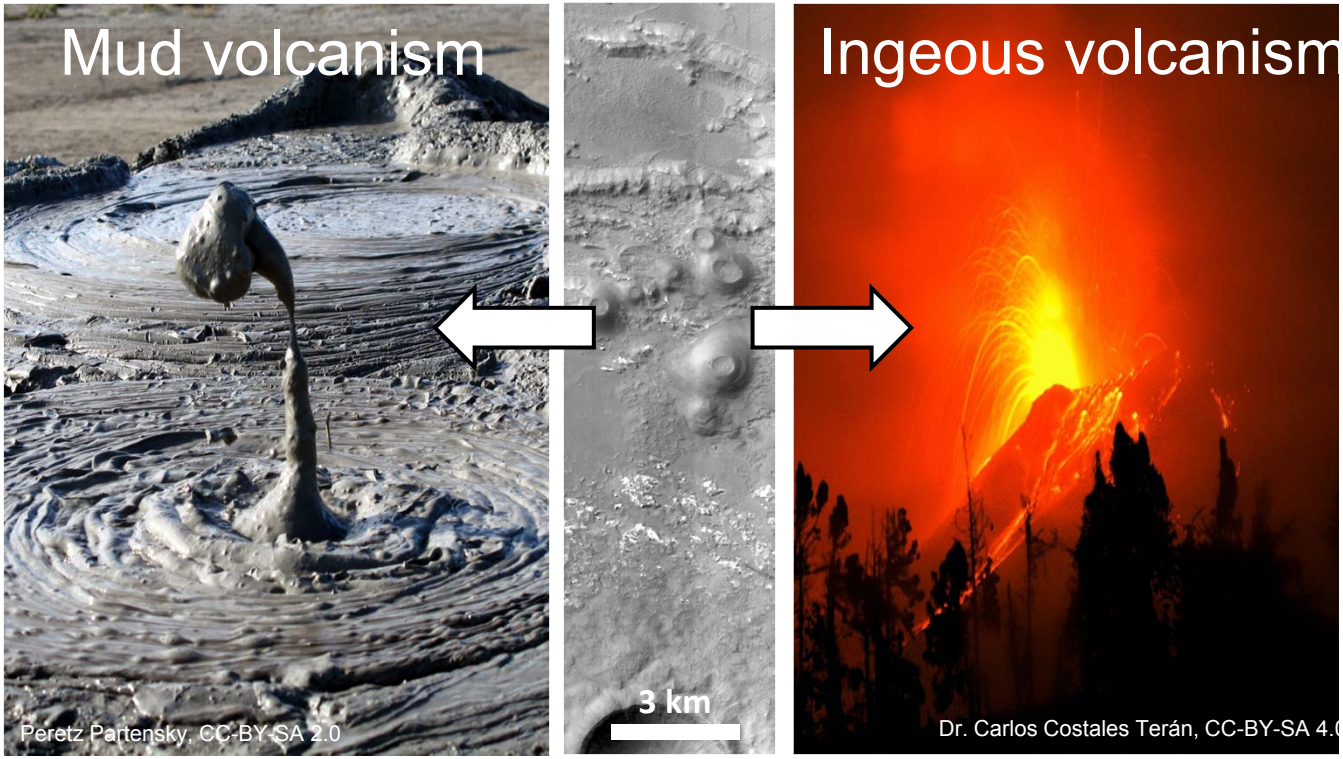
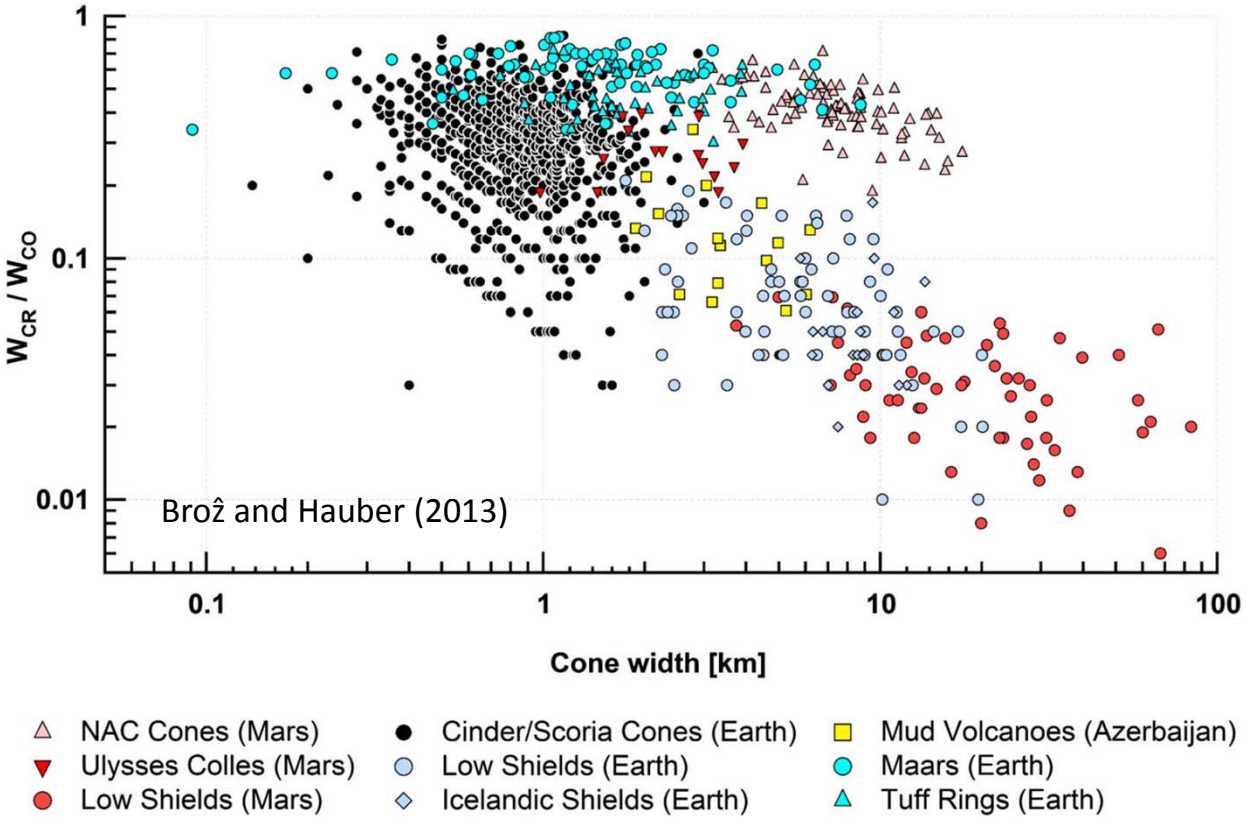
- Brož, Hauber, Platz, Balme, EPSL (2015)
- Brož, Hauber, Michael, Wray, EPSL (2017)

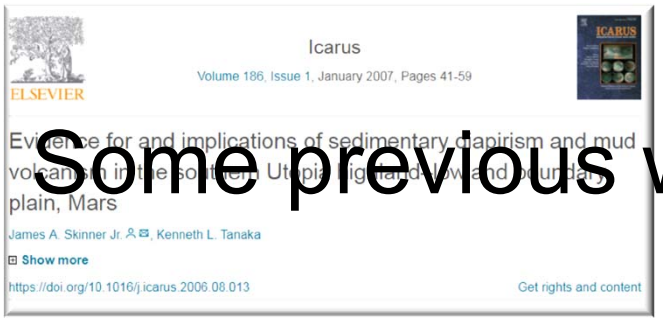
Morphology is ambiguous



Morphometry may help, but…



Some previous work


Icarus
Volume 186, Issue 1, January 2007, Pages 41-59
Evidence for and implications of sedimentary diapirism and mud volcanism in the southern Utopia highland-lowland boundary plain, Mars
James A. Skinner Jr., Kenneth L. Tanaka
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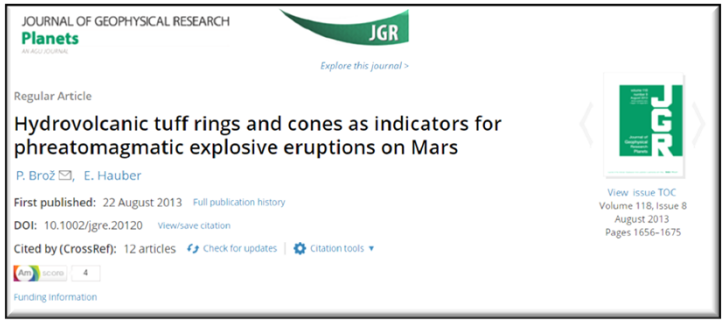
Southern rim of Utopia Basin

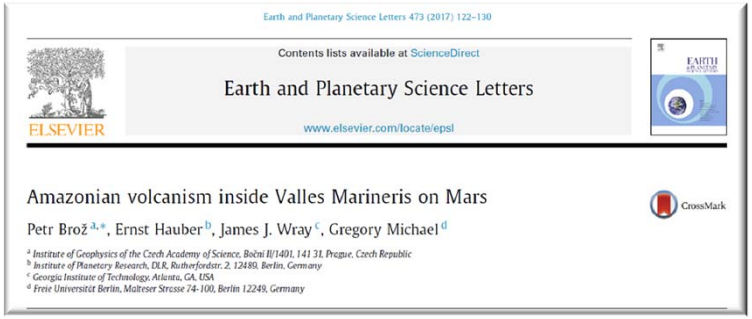
Diverging interpretations


JOURNAL OF GEOPHYSICAL RESEARCH
Planets
Regular Article
Hydrovolcanic tuff rings and cones as indicators for phreatomagmatic explosive eruptions on Mars
P. Brož, E. Hauber
First published: 22 August 2013
DOI: 10.1002/jgre.20120
Cited by (CrossRef): 12 articles
Funding information
View issue TOC
Volume 118, Issue 8
August 2013
Pages 1656–1675


Icarus 269 (2016) 23–37
Contents lists available at ScienceDirect
Icarus
journal homepage: www.elsevier.com/locate/icarus
Morphologic evidence of subsurface sediment mobilization and mud volcanism in Candor and Coprates Chasmata, Valles Marineris, Mars
Chris H. Okubo*
U.S. Geological Survey, Astrogeology Science Center, 1541 E. University Boulevard, Tucson, AZ 85721, USA

Valles Marineris

Diverging interpretations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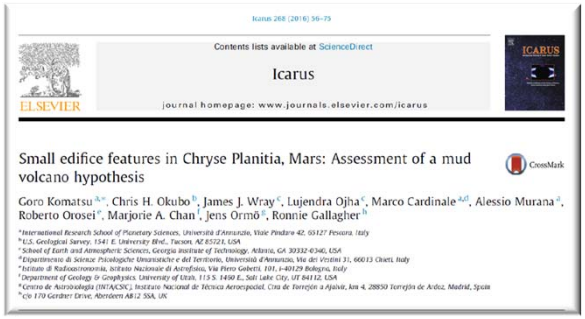
Amazonian volcanism inside Valles Marineris on Mars
Petr Brož, Ernst Hauber, James J. Wray, Gregory Michael

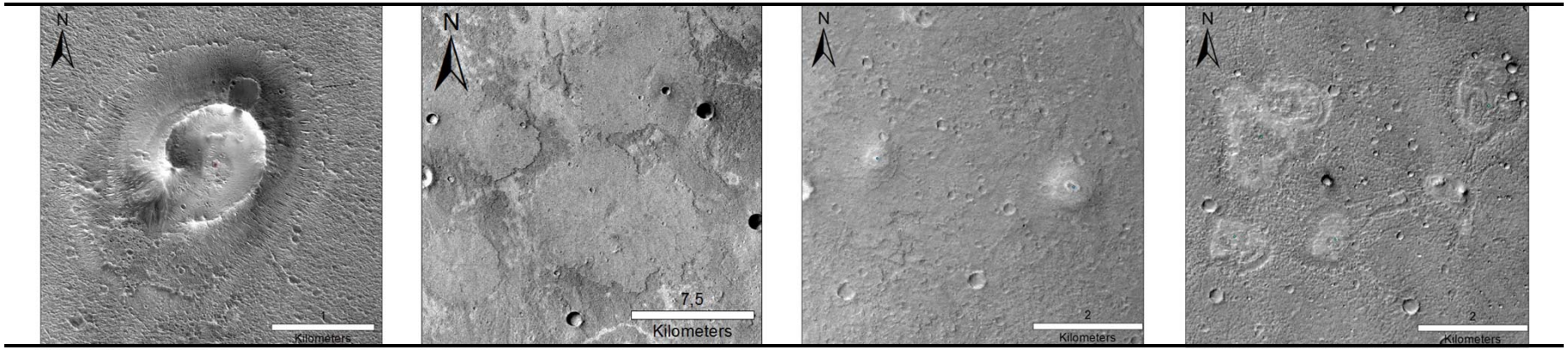

Icarus 268 (2016) 56–75
Contents lists available at ScienceDirect
Icarus
journal homepage: www.journals.elsevier.com/icarus
Small edifice features in Chryse Planitia, Mars: Assessment of a mud volcano hypothesis
Goro Komatsu, Chris H. Okubo, James J. Wray, Lujendra Ojha, Marco Cardinale, Alessio Murana, Roberto Orosei, Marjorie A. Chan, Jens Ormö, Ronnie Gallagher

Chryse Planitia

?

(this study)

Morphological classes

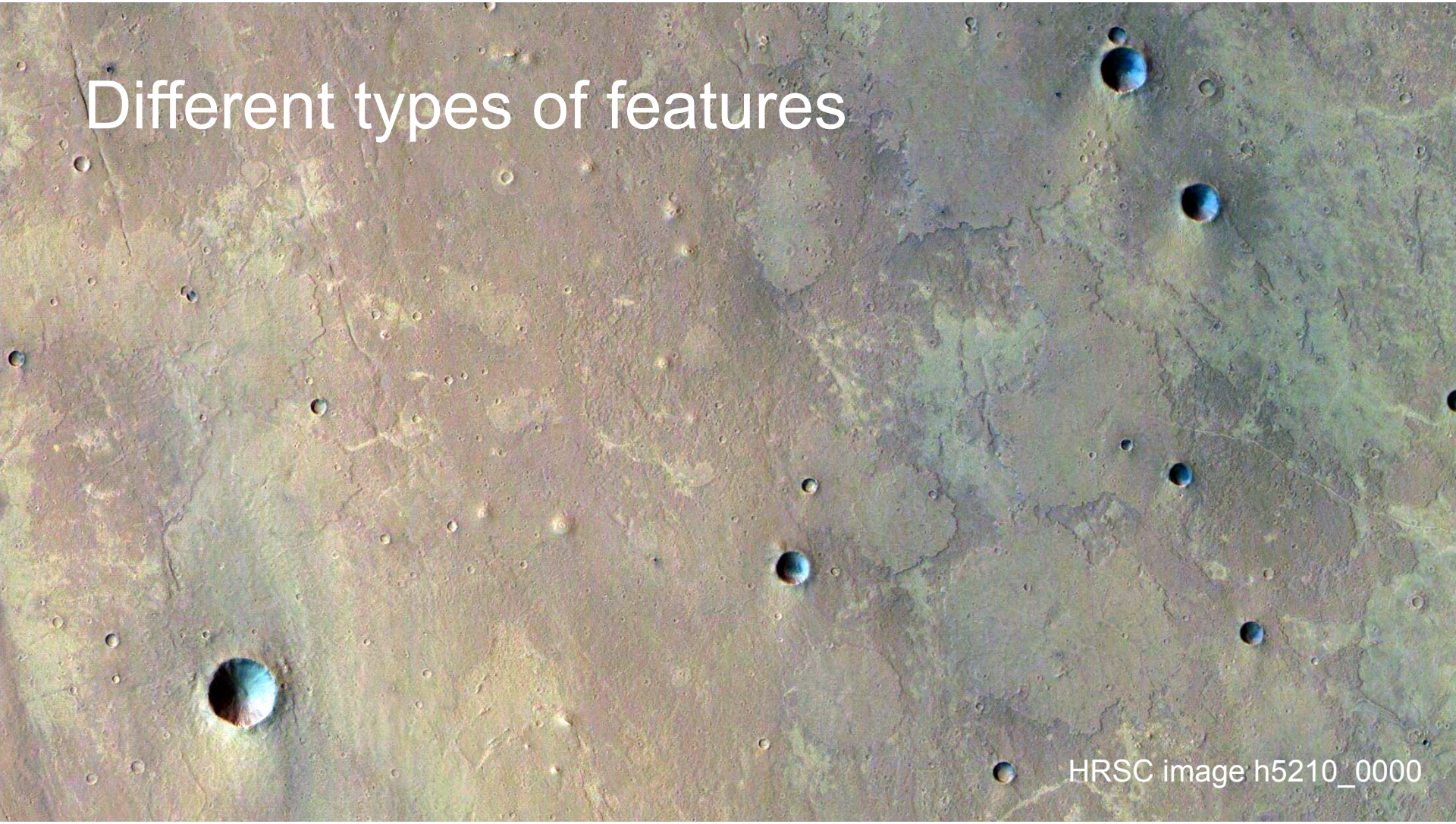


cones pies domes irregular patches

already used by Komatsu et al. (2016)

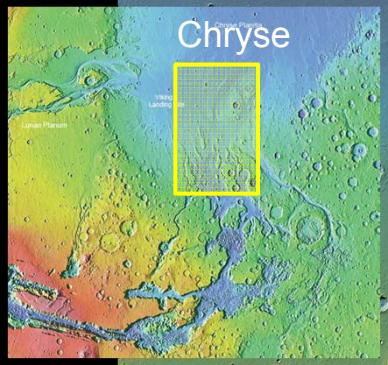
newly defined in this study

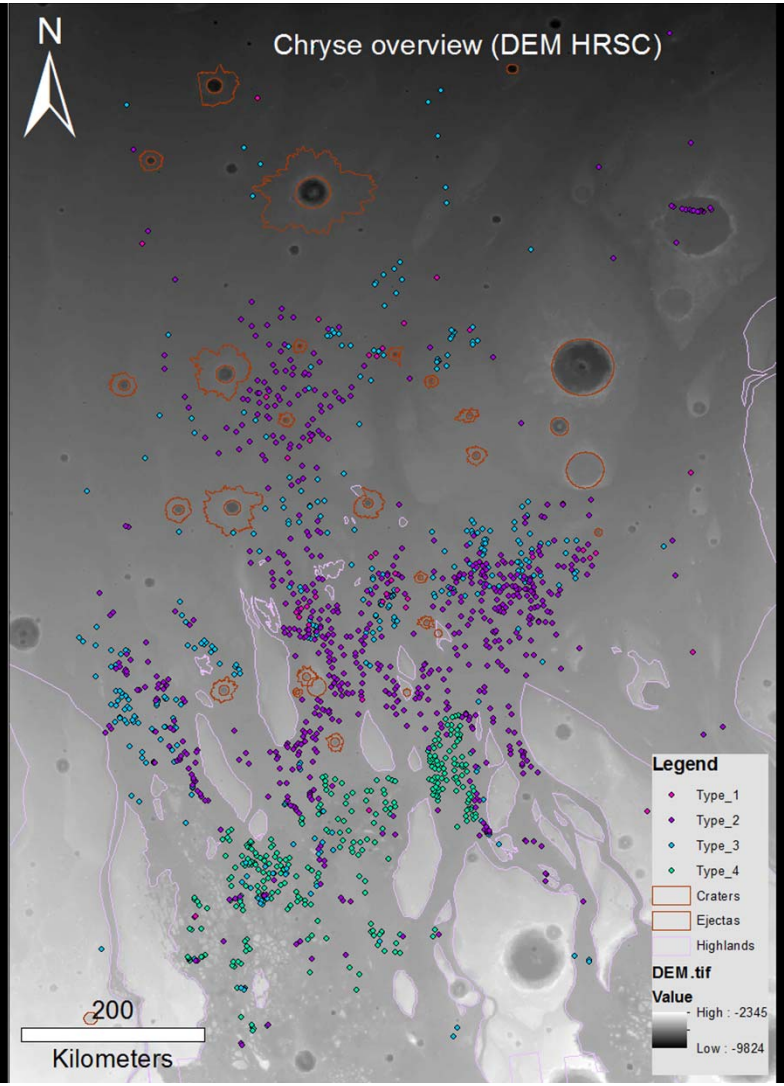
Different types of features



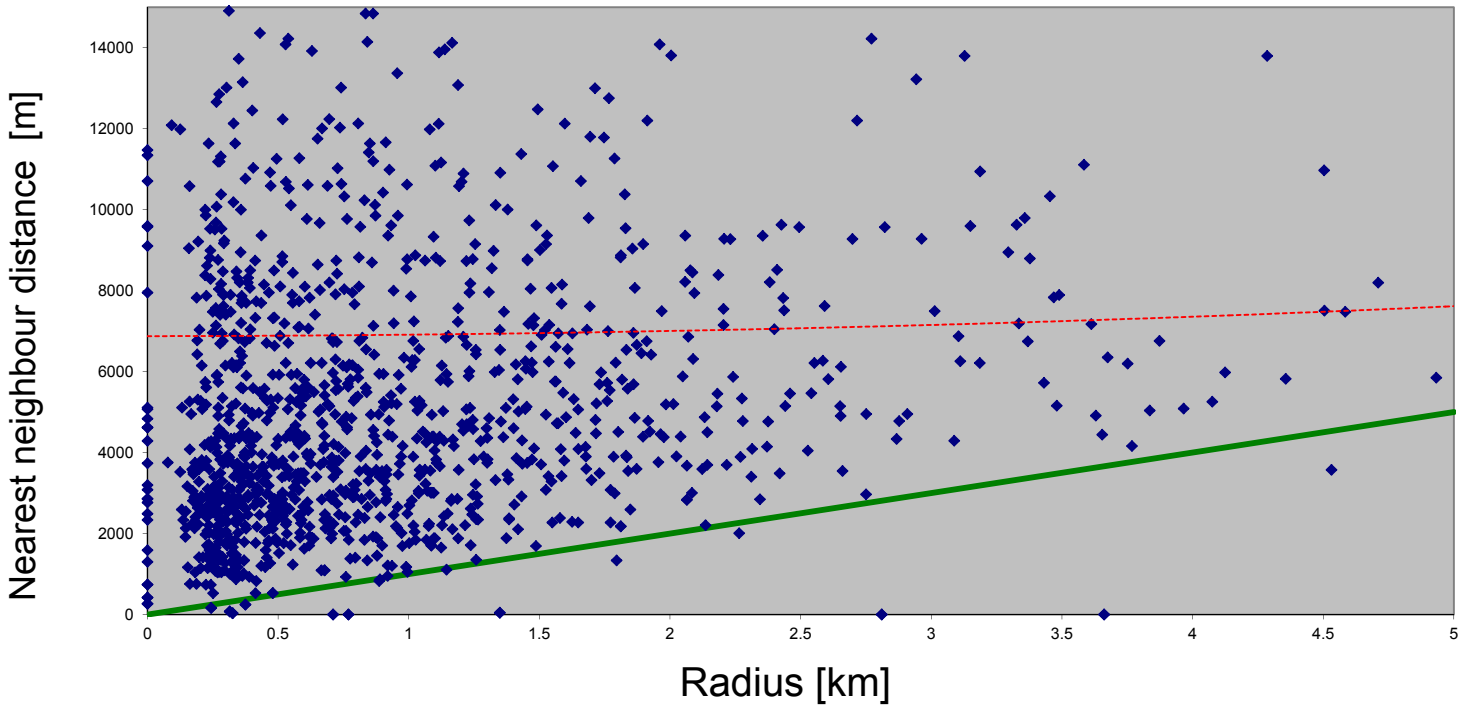
HRSC image h5210_0000

Mapping results



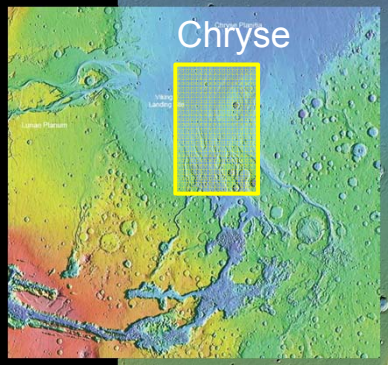


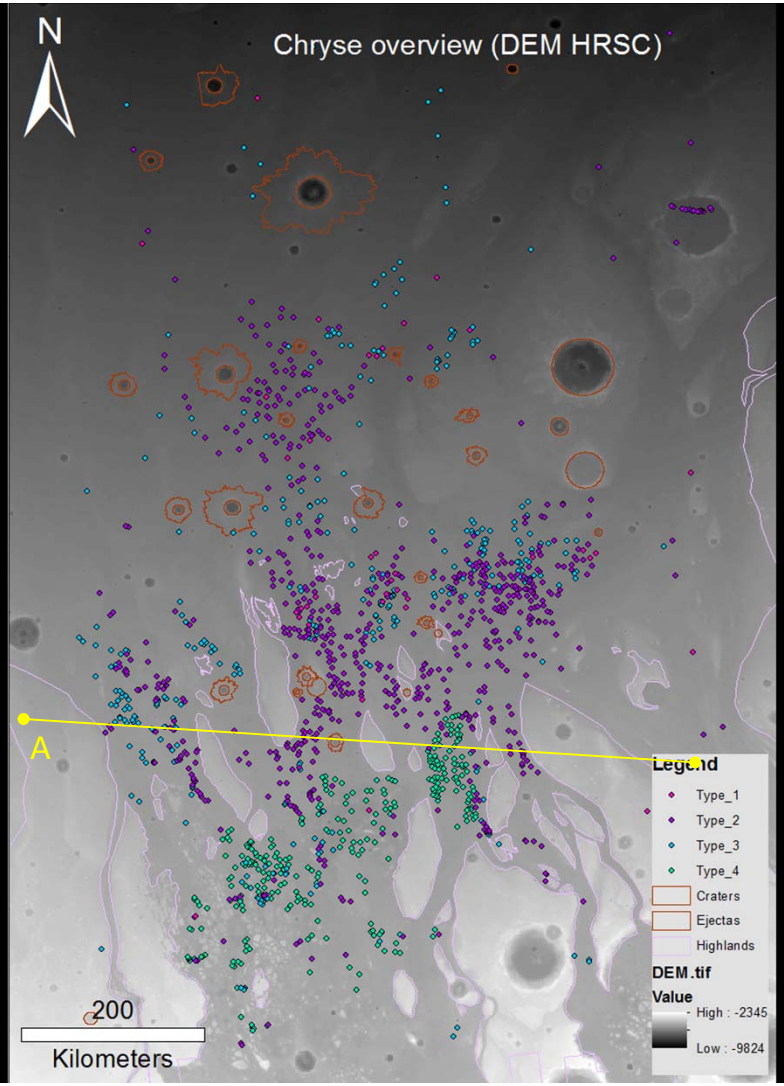
Spatial analysis



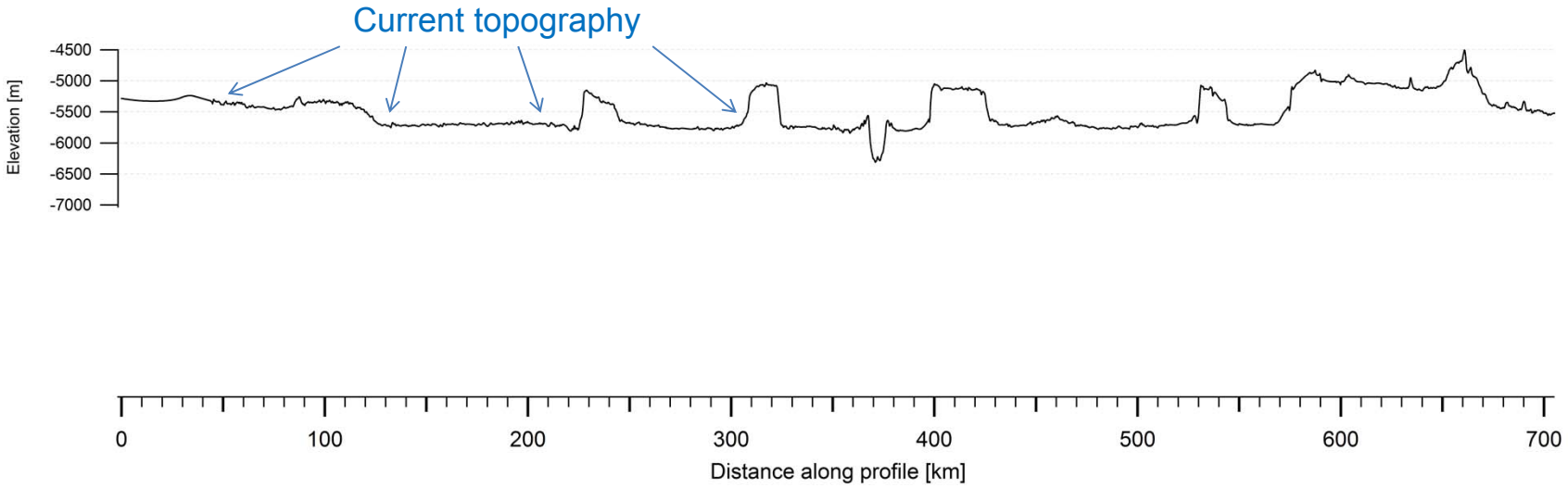
- No overlap, edifices seem to be individual features without direct association with each other

Mapping results





How diagnostic is the distribution?



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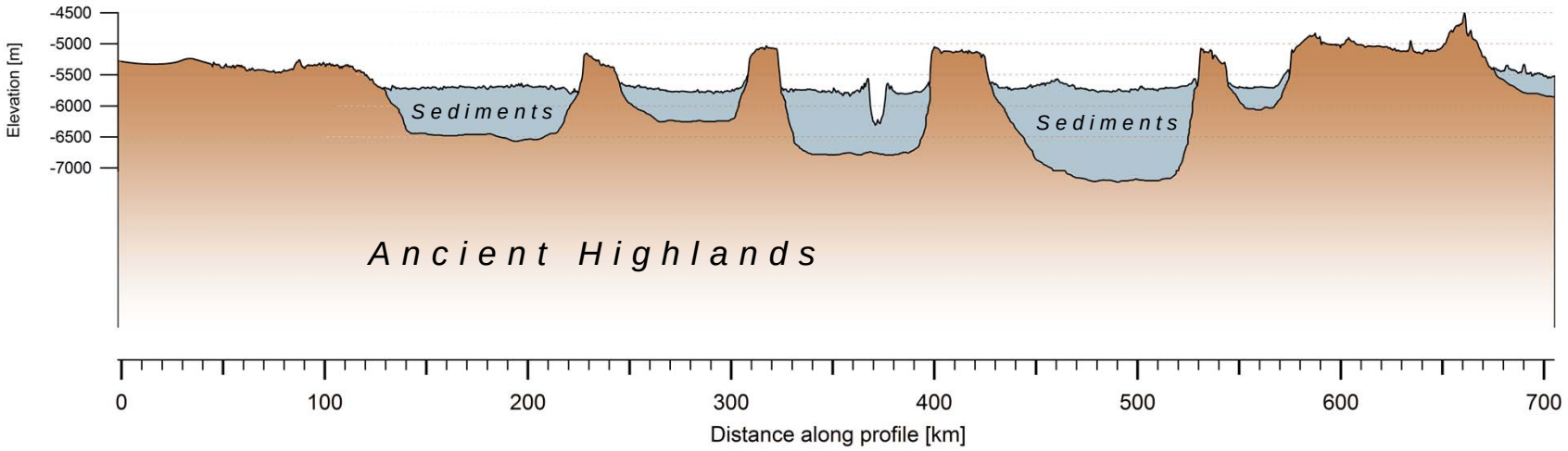

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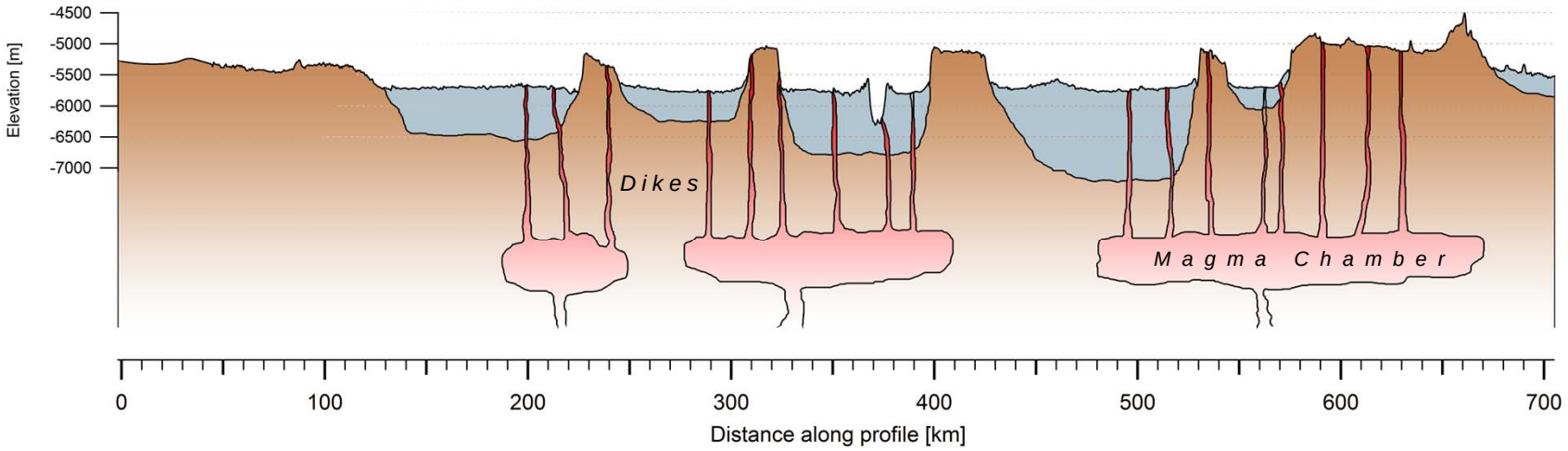
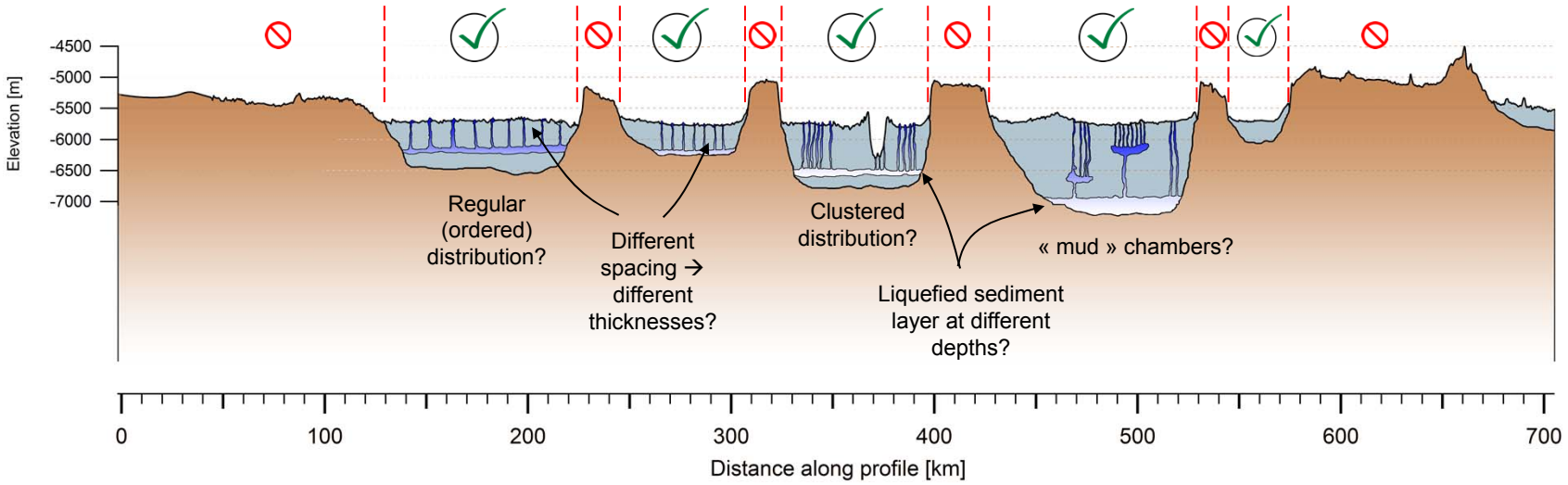


Igneous volcanism

- 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?

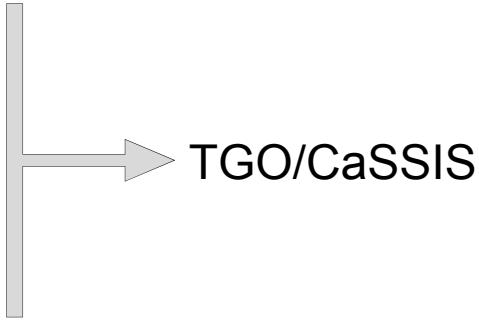


Sedimentary volcanism

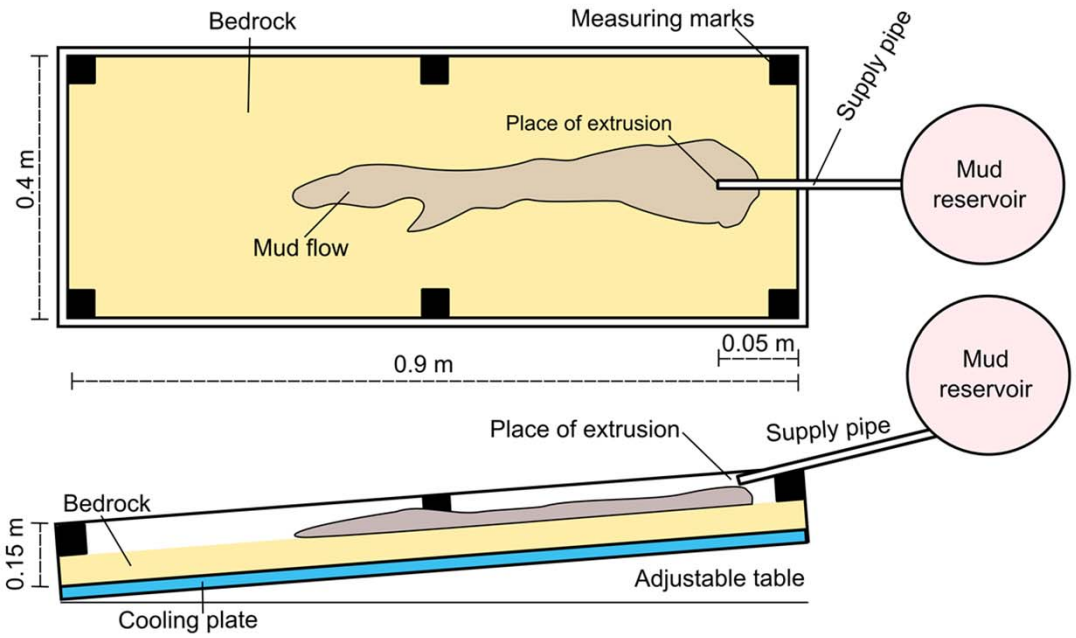
- Relatively shallow source layers in sedimentary rocks, ascent mechanism unknown
- Location of edifice (clusters) *only* above sedimentary rocks

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?