VOLUMETRIC CHANGES OF EXTRUDED MUD ON MARS: REPORT FROM LABORATORY SIMULATIONS

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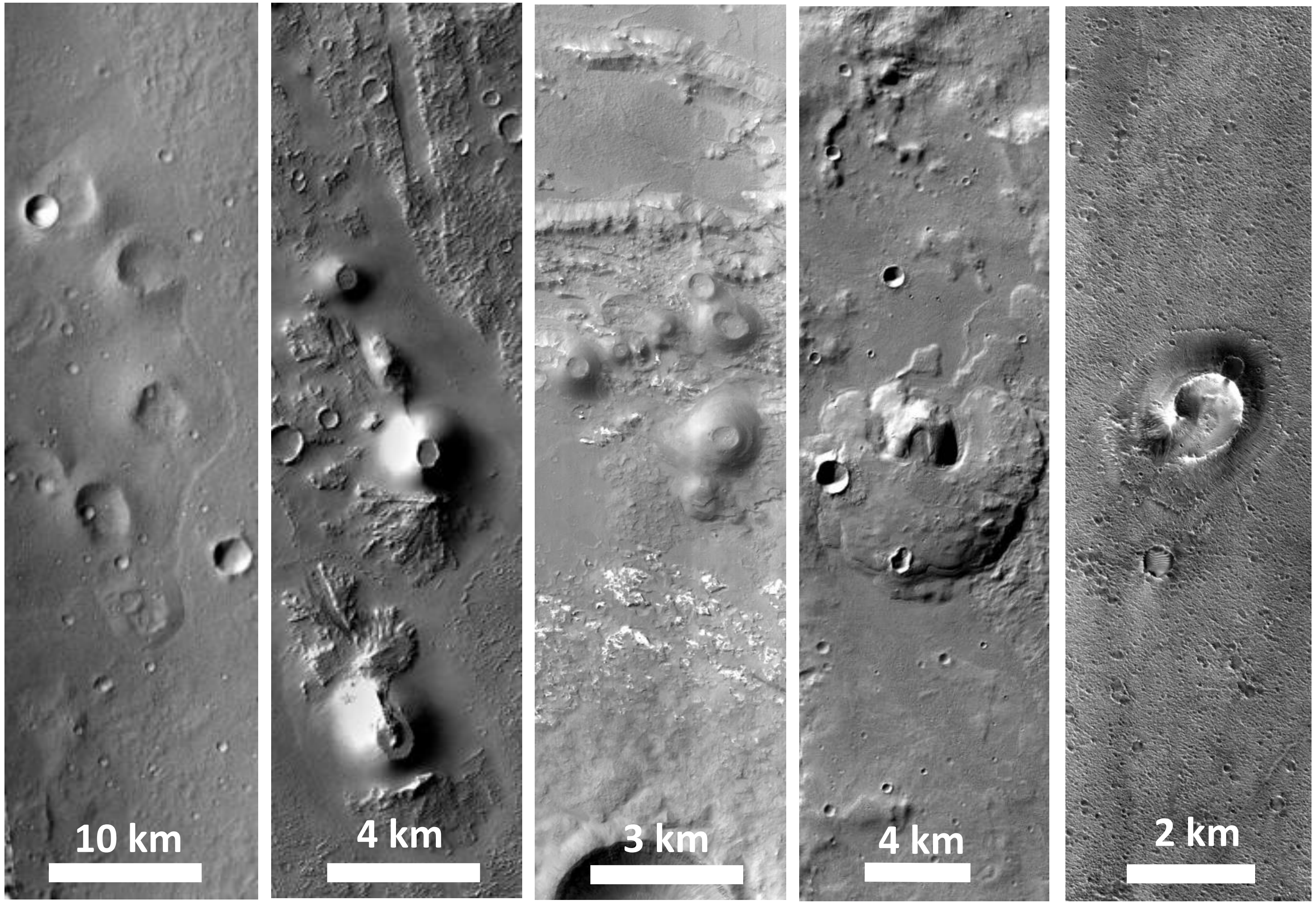
Mud volcanoes on Mars

- Their existence is proposed over many areas on Mars
- This is because many Martian features bear morphological and morphometrical similarities with terrestrial mud volcanoes (e.g., Skinner and Tanaka, 2007; Okubo, 2016, Komatsu et al., 2016)



HiRISE and CTX images

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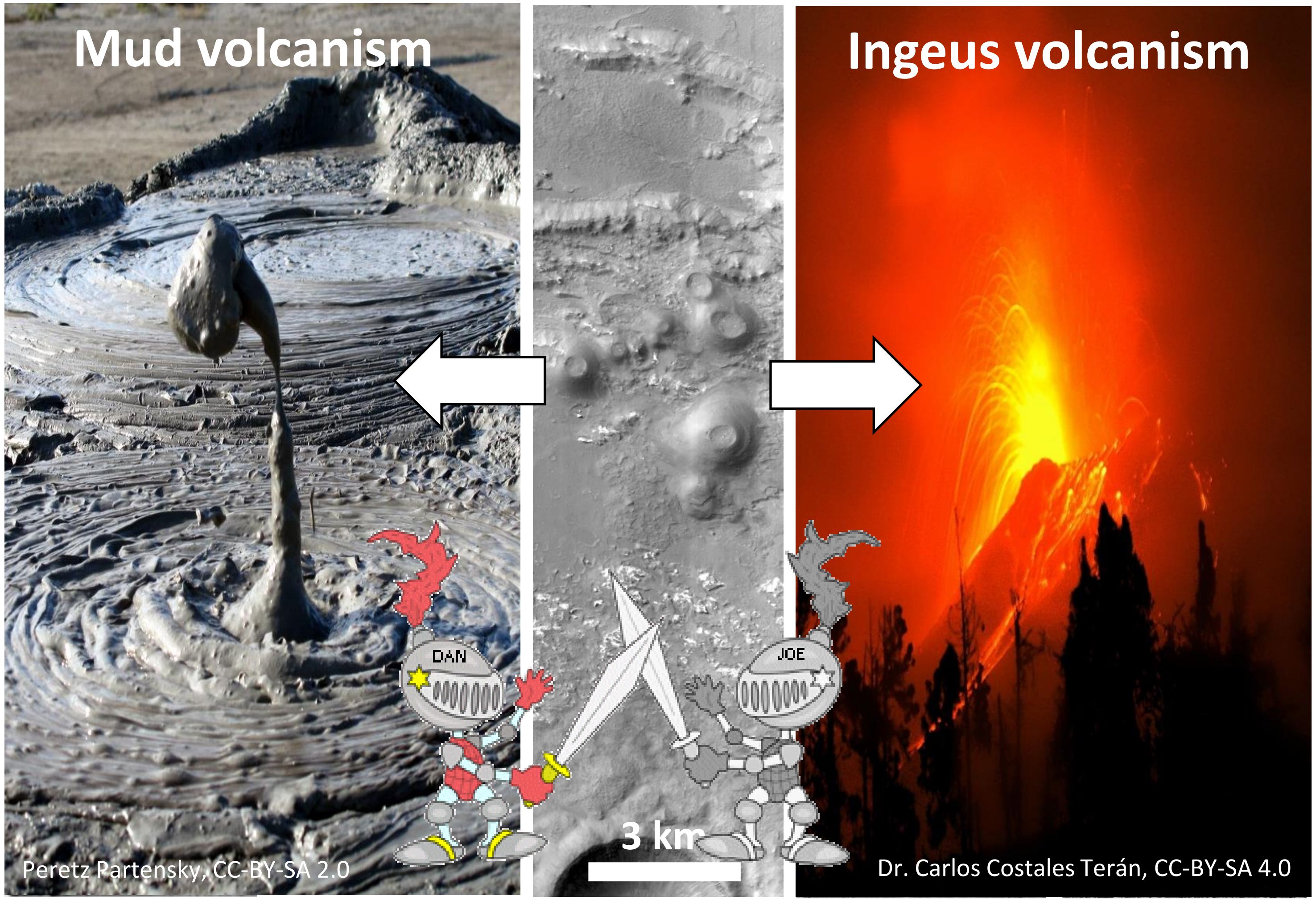
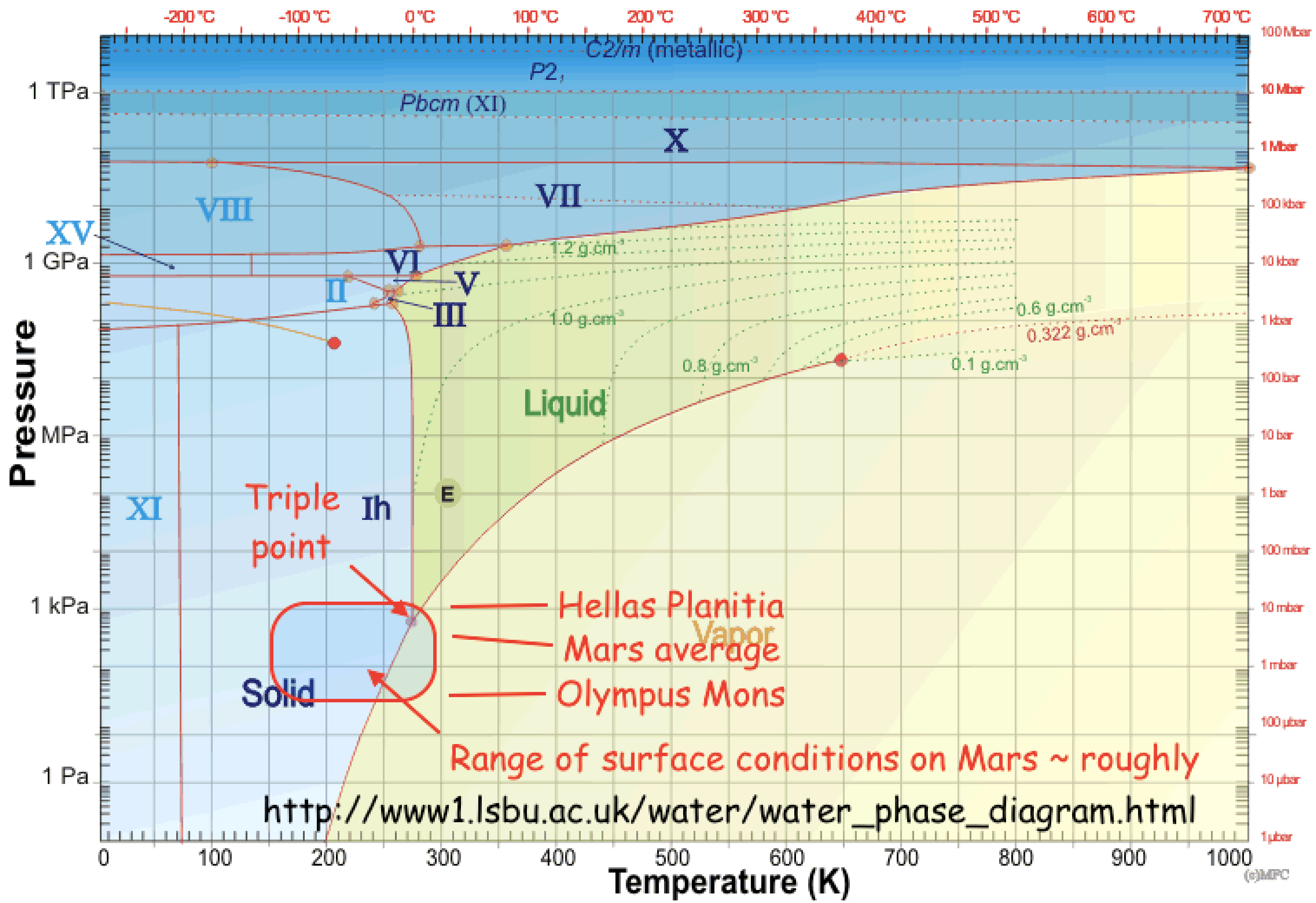
- This is because many Martian features bear morphological and morphometrical similarities with terrestrial mud volcanoes (e.g., Skinner and Tanaka, 2007; Okubo, 2016, Komatsu et al., 2016)
- However, such interpretation is not straightforward as similar-looking landforms could also result from igneous volcanism (Brož and Hauber, 2013; Brož et al., 2017)



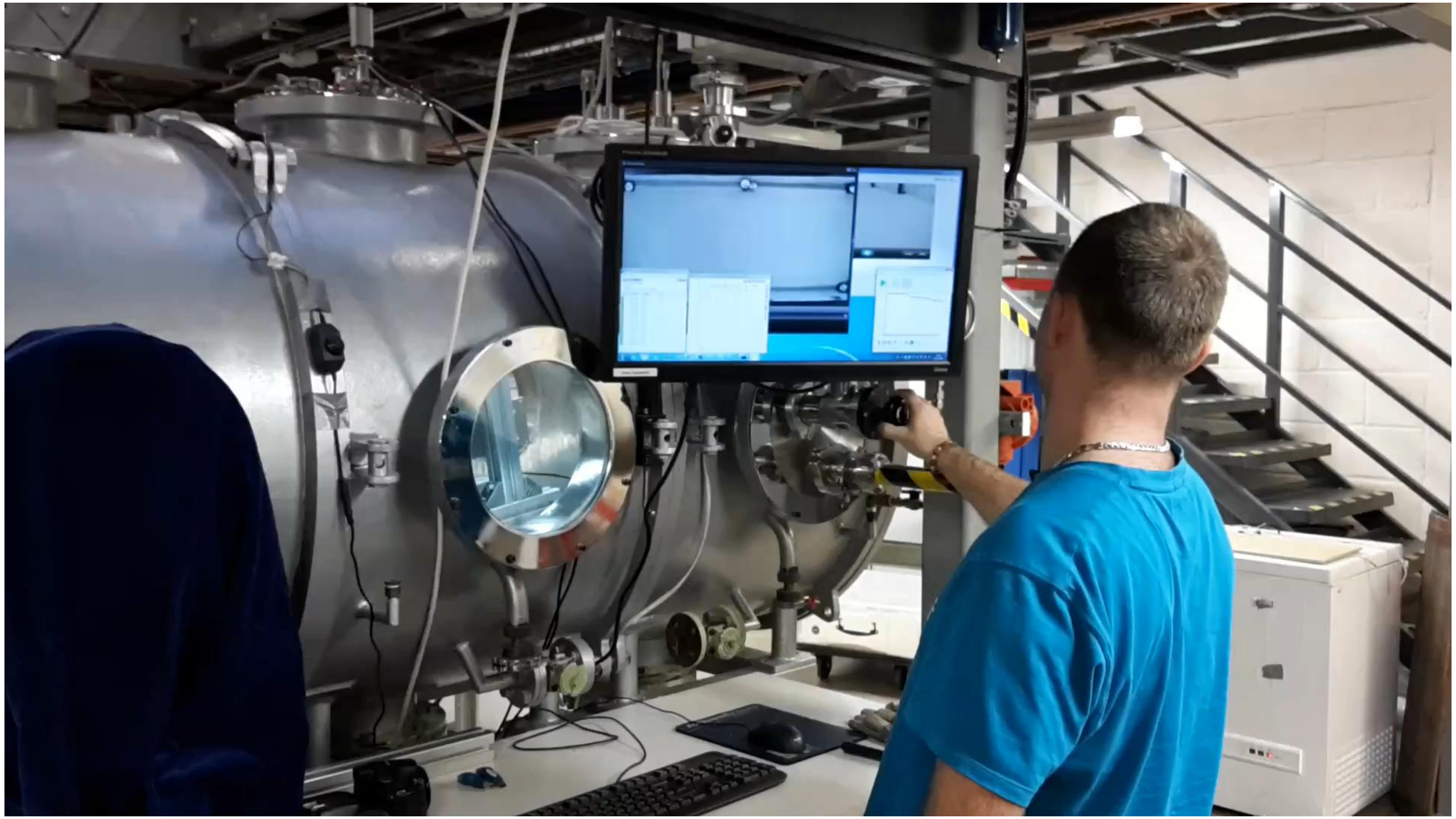
HiRISE and CTX images

Water is unstable on Mars!



The large Mars vacuum chamber at

(head of the lab Dr. Manish Patel)



0.9 m in diameter and 1.8 m in length

What do we learn?

A formation of protective crust – ‚mud tubes' and ‚mud' inflation

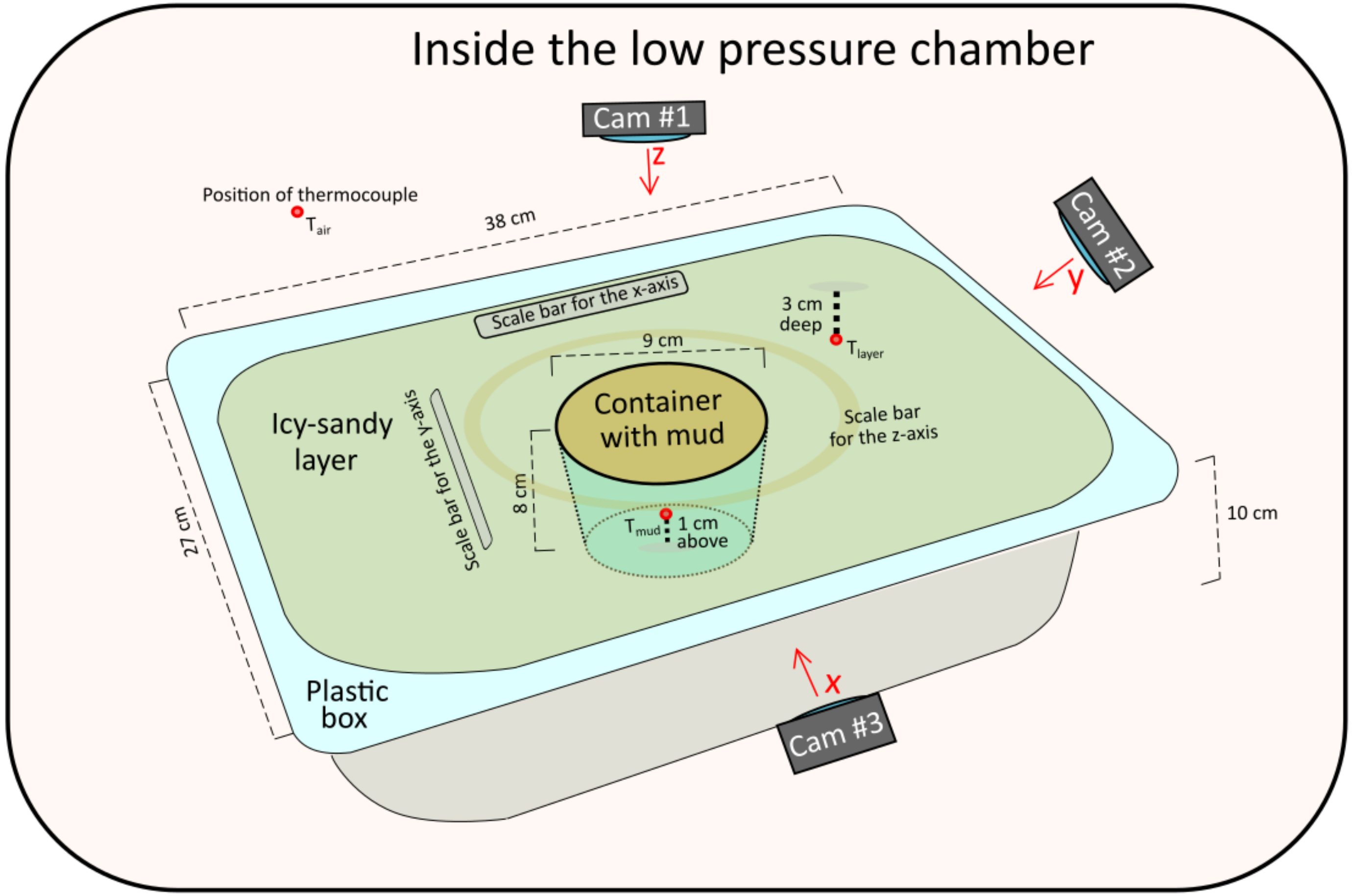
Exp. #16 – side view

Time lapse of pahoehoe lava inflation
© Volcano Video Hawaii

Mud extruded on cold surfaces under low pressure behaves in several aspecsts as pahoehoe lava

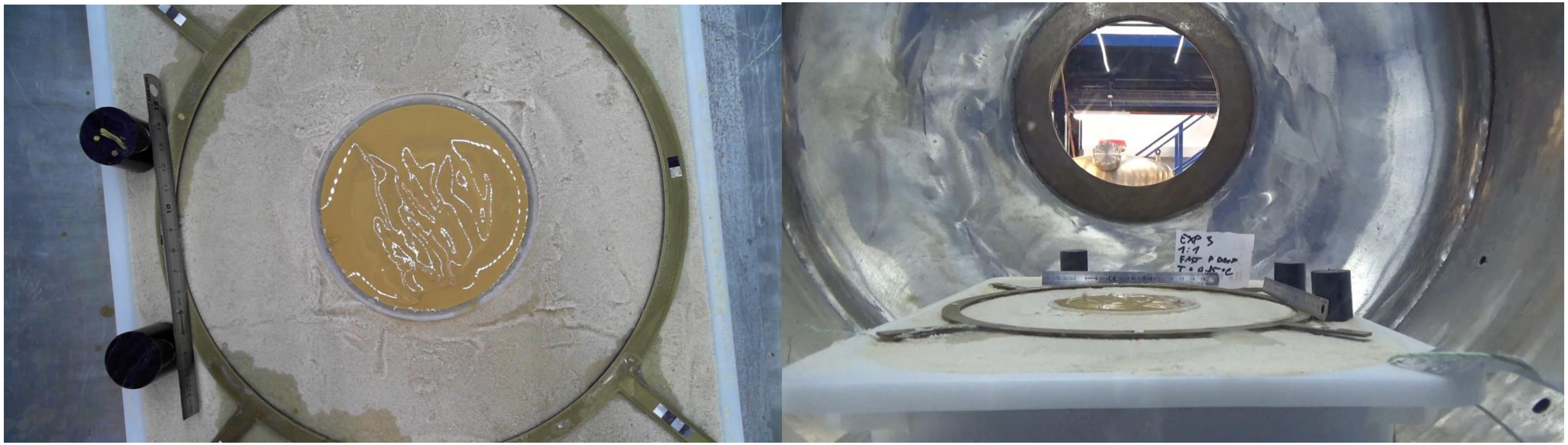
Details in Brož et al., 2020 (Nature Geoscience)

Experimental setup



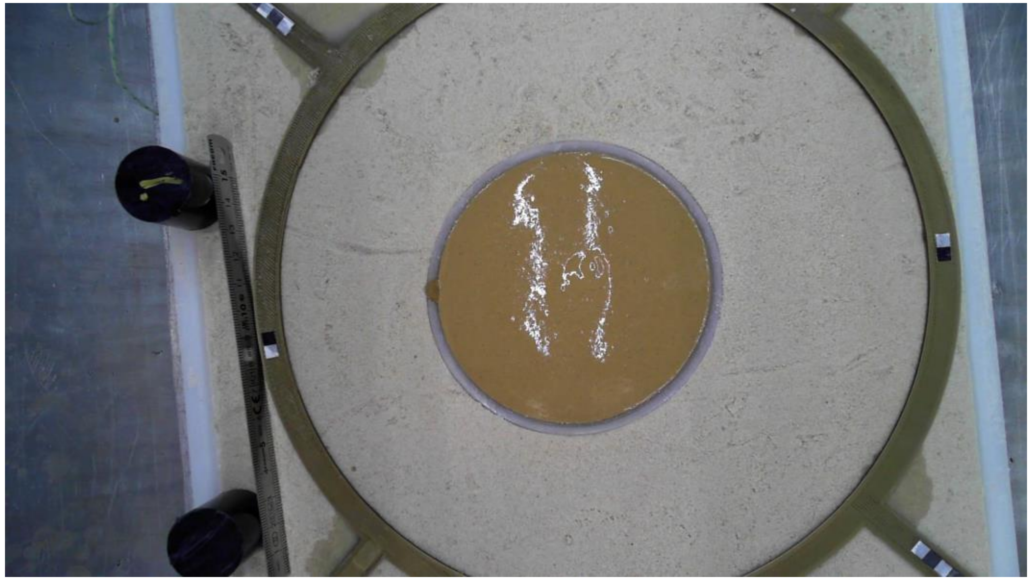
Brož et al., in prep.

Cold mud, rapid p drop



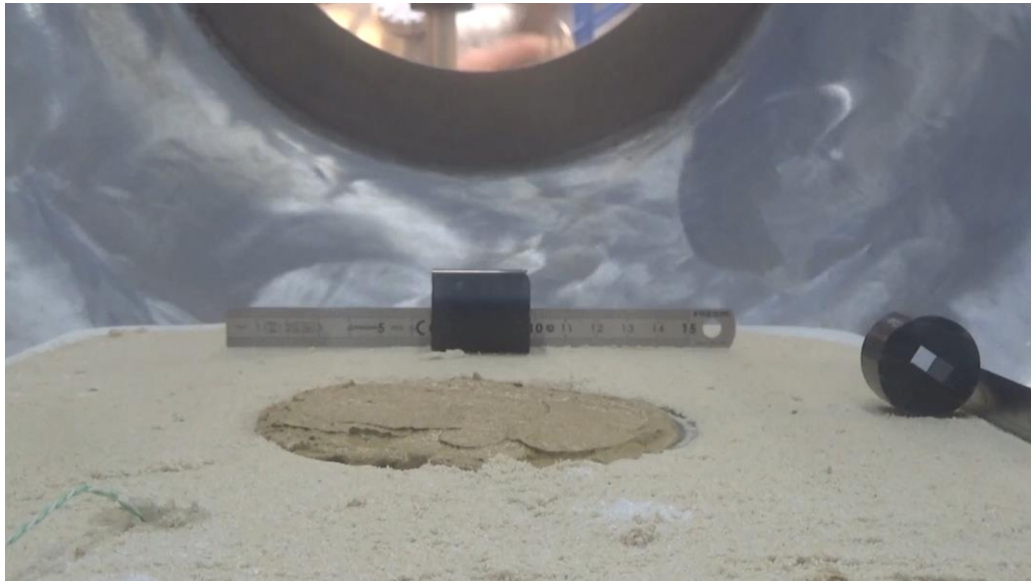
20x speed up

Slow p drop, warm mud

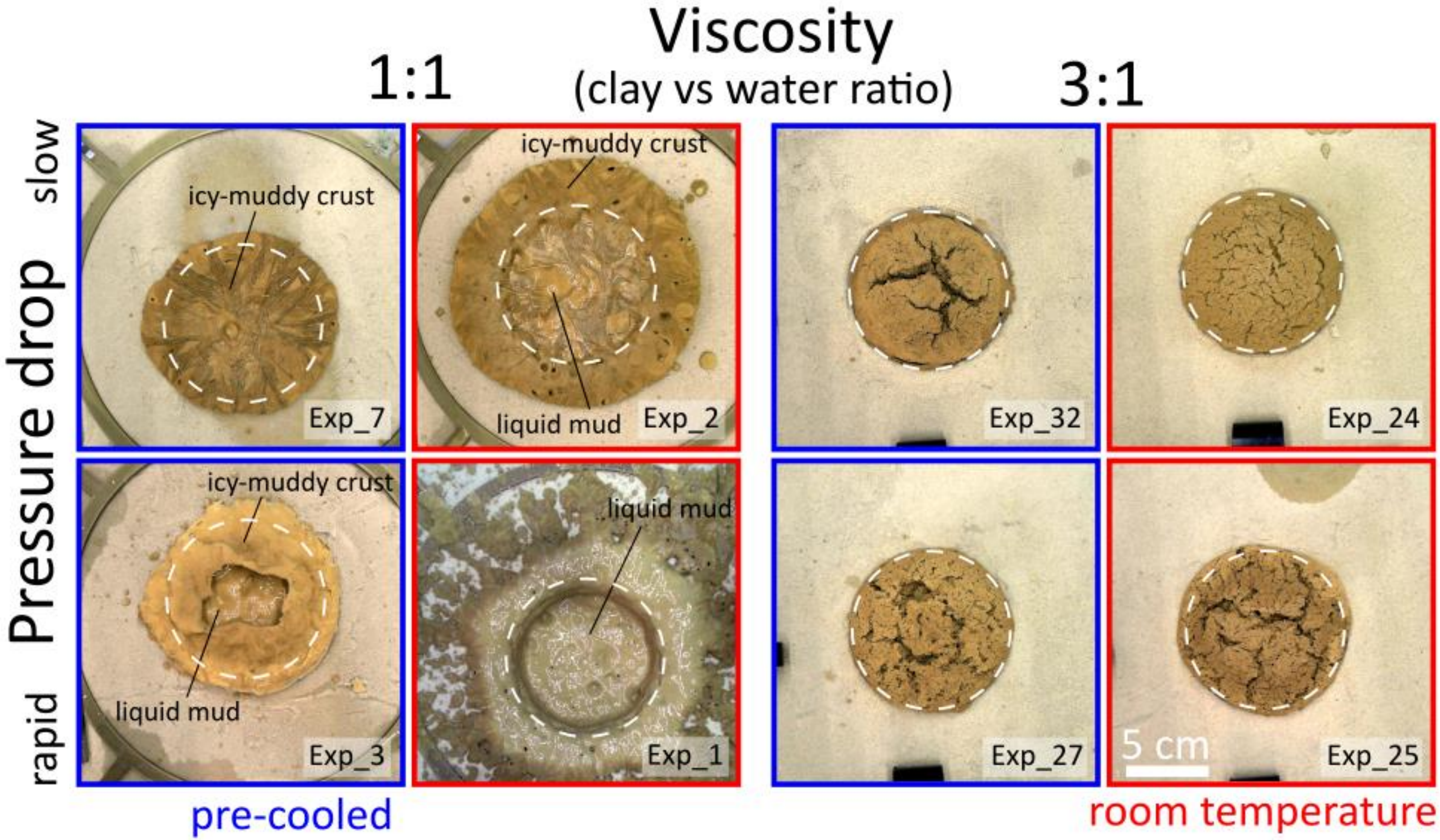


120x speed up

More viscous mud



10x speed up



Brož et al., in prep.

How much?

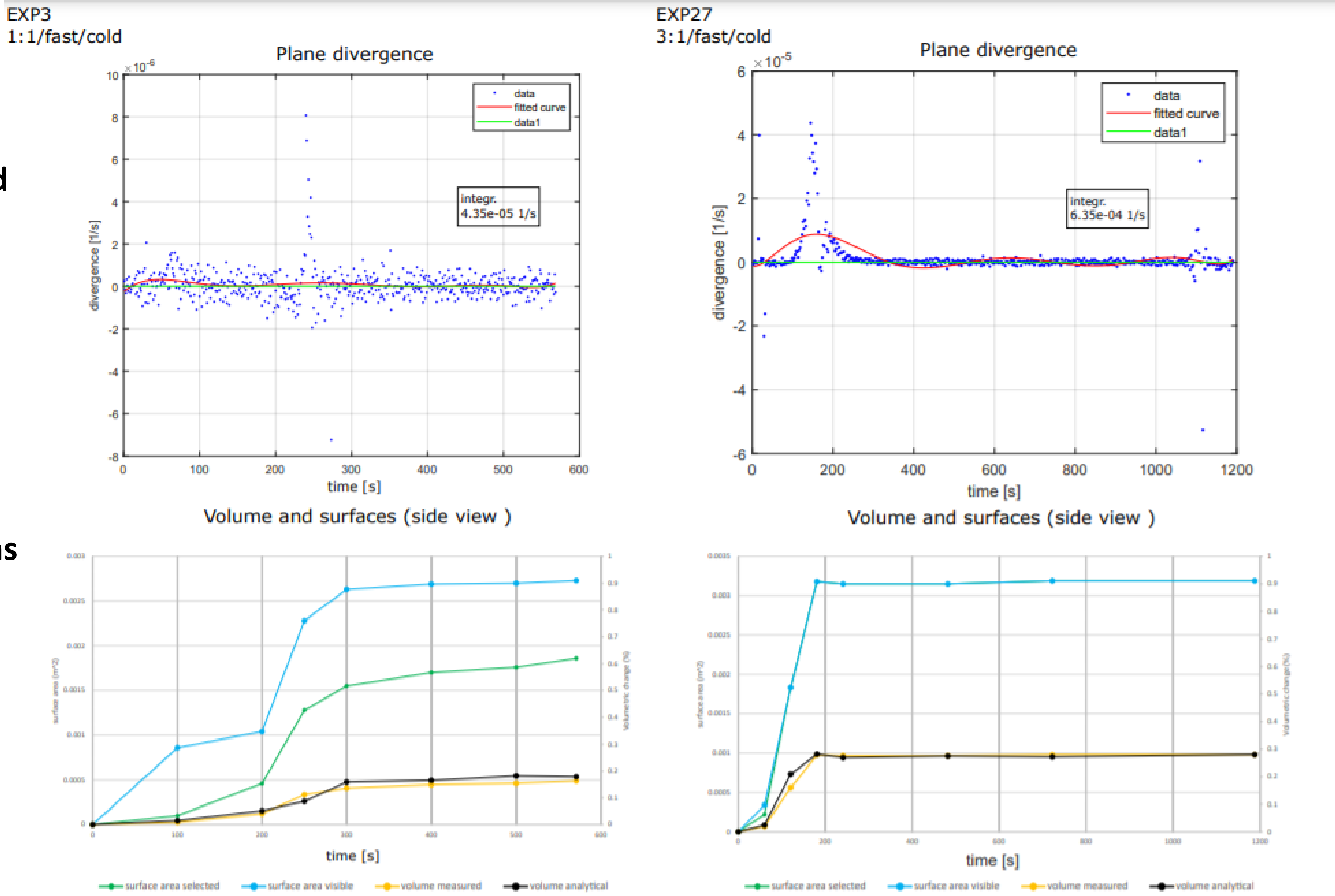
Divergence of the 2D velocity field

.. shows the rate of expansion
(surface increment in time)

$$\underbrace{\int_C \mathbf{F}\cdot\hat{\mathbf{n}}\,ds}_{\text{Flux integral}} = \iint_R \operatorname{div}\mathbf{F}\,dA$$

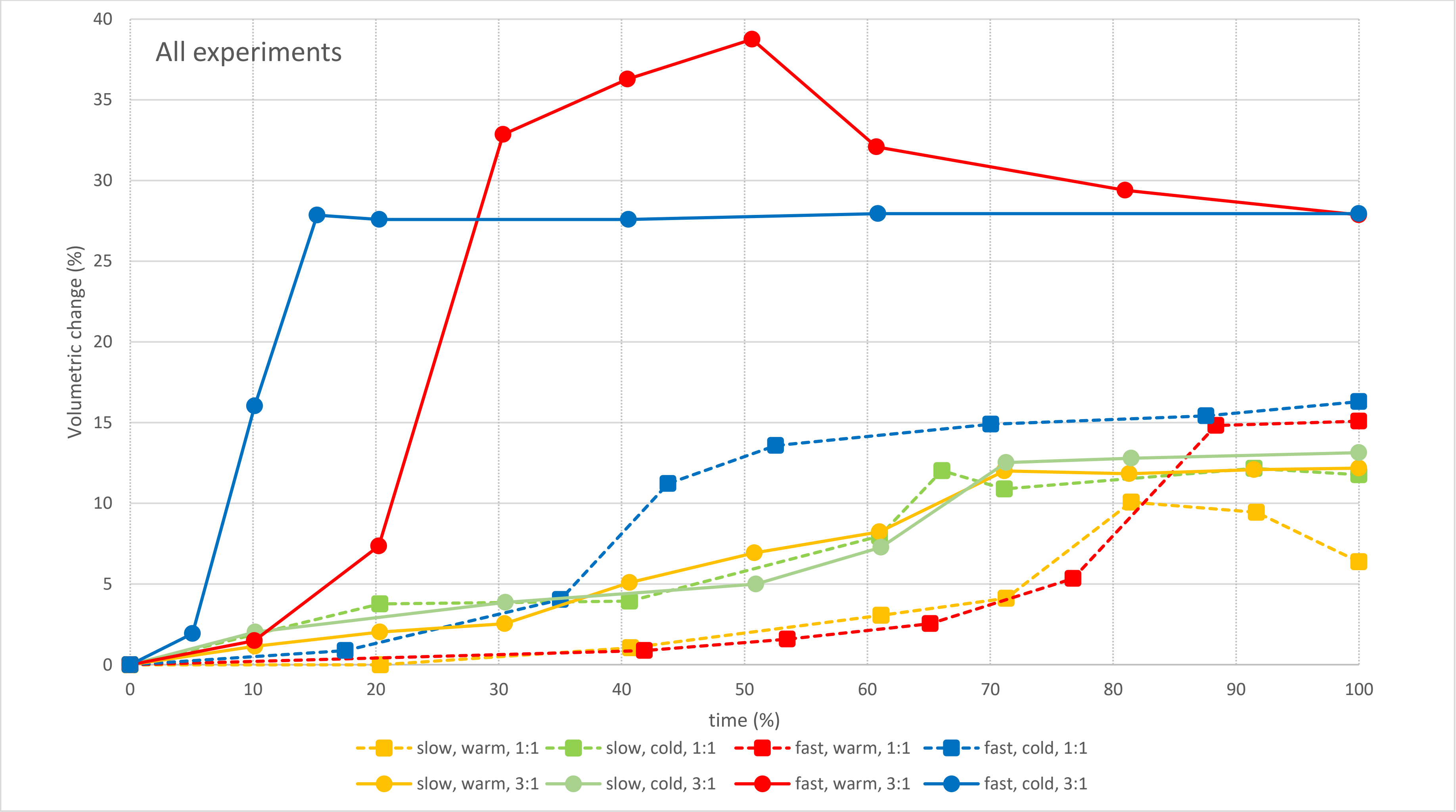
Volume from the plane projections

ImageJ analysis from the ortho-
gonal planes vs analytical model
From generalized ellipsoid based
on the height of the structure



How much?

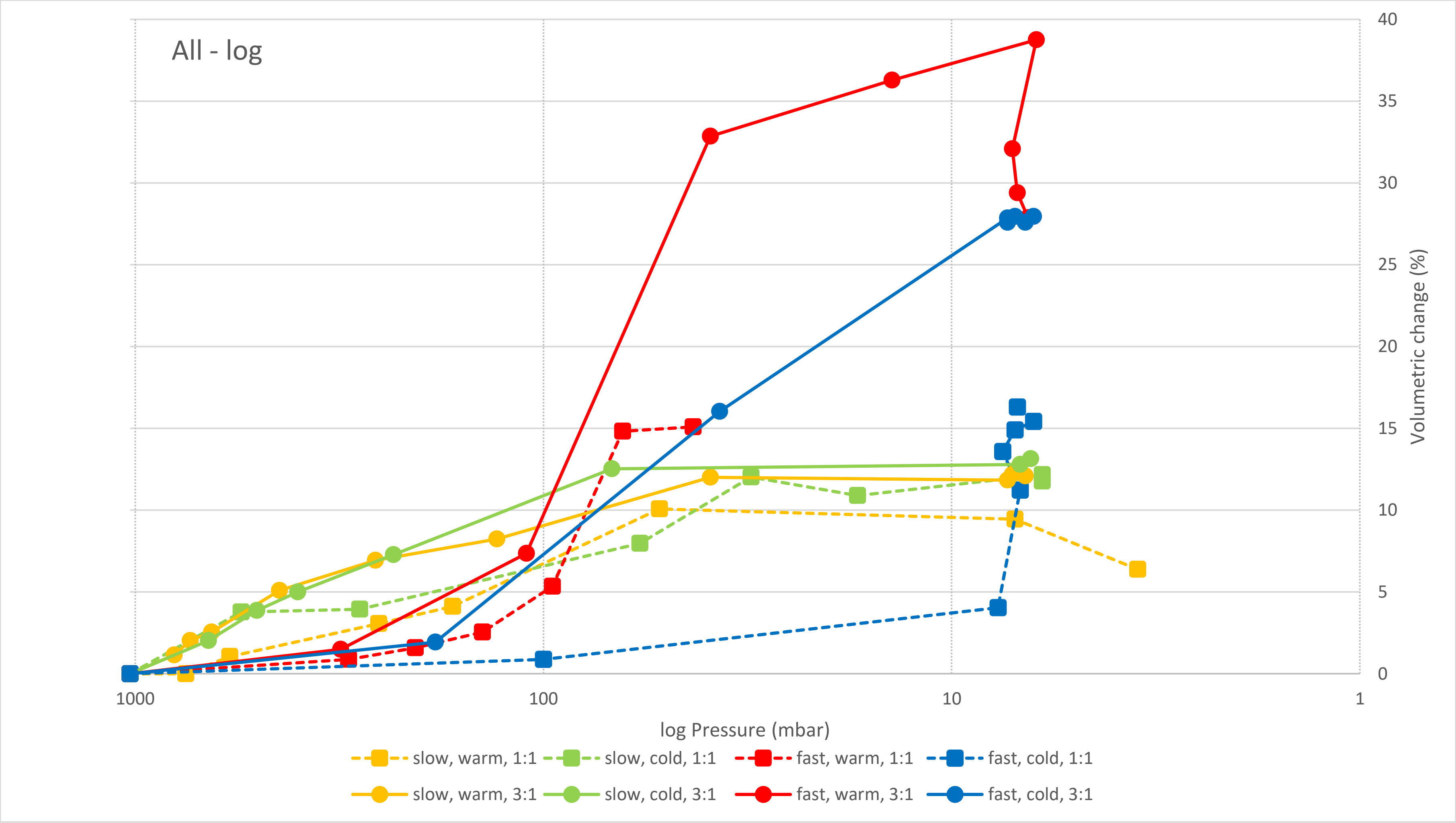
Volume vs Time



Visualization is invariant on absolute time = we can easily see diff for rapid/slow depressurization

How much?

Volume vs Pressure



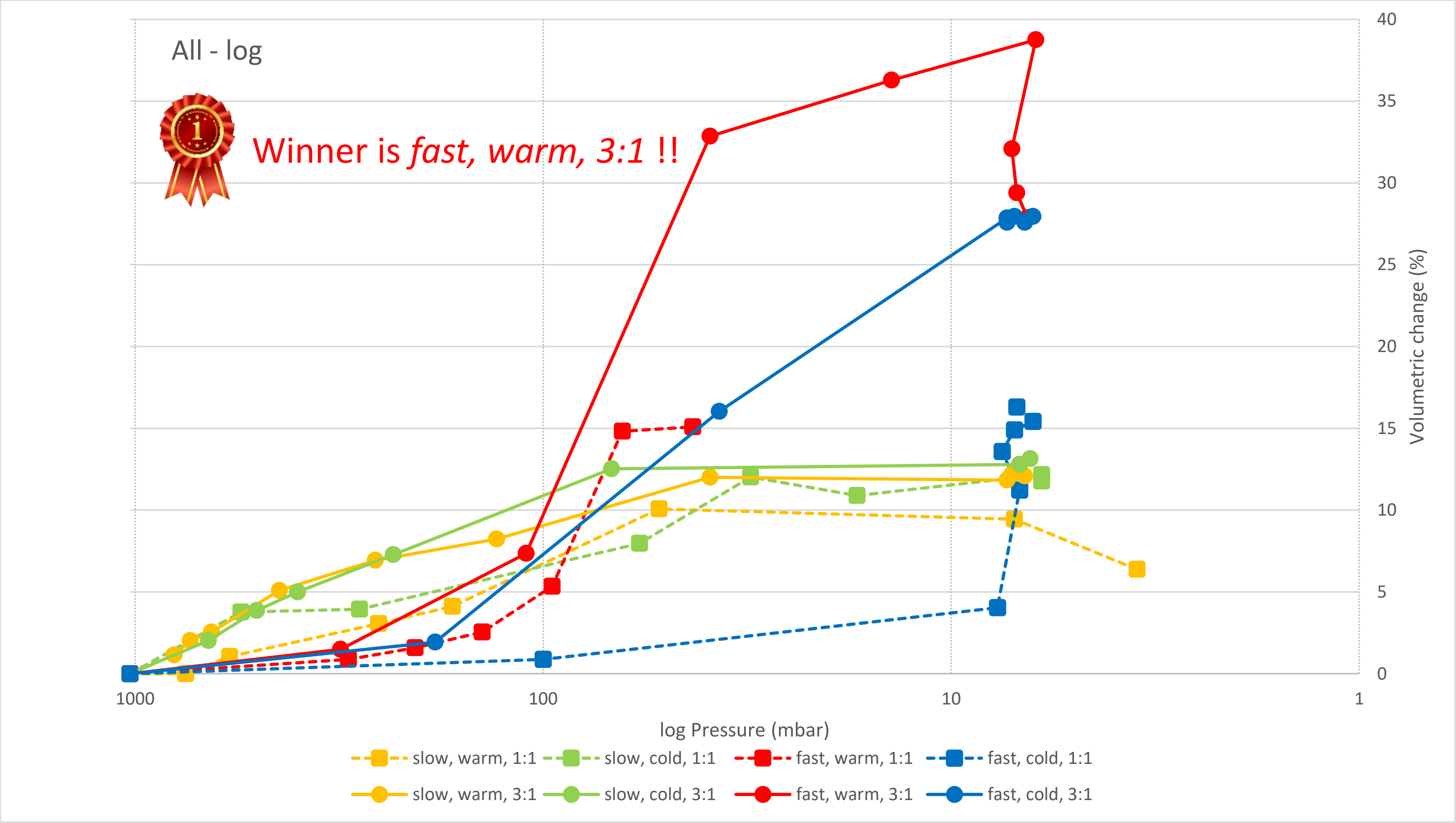
1) Higher viscosity = larger vol. change

2) Higher T = larger vol. change

3) Larger dP = larger vol. change

How much?

Volume vs Pressure



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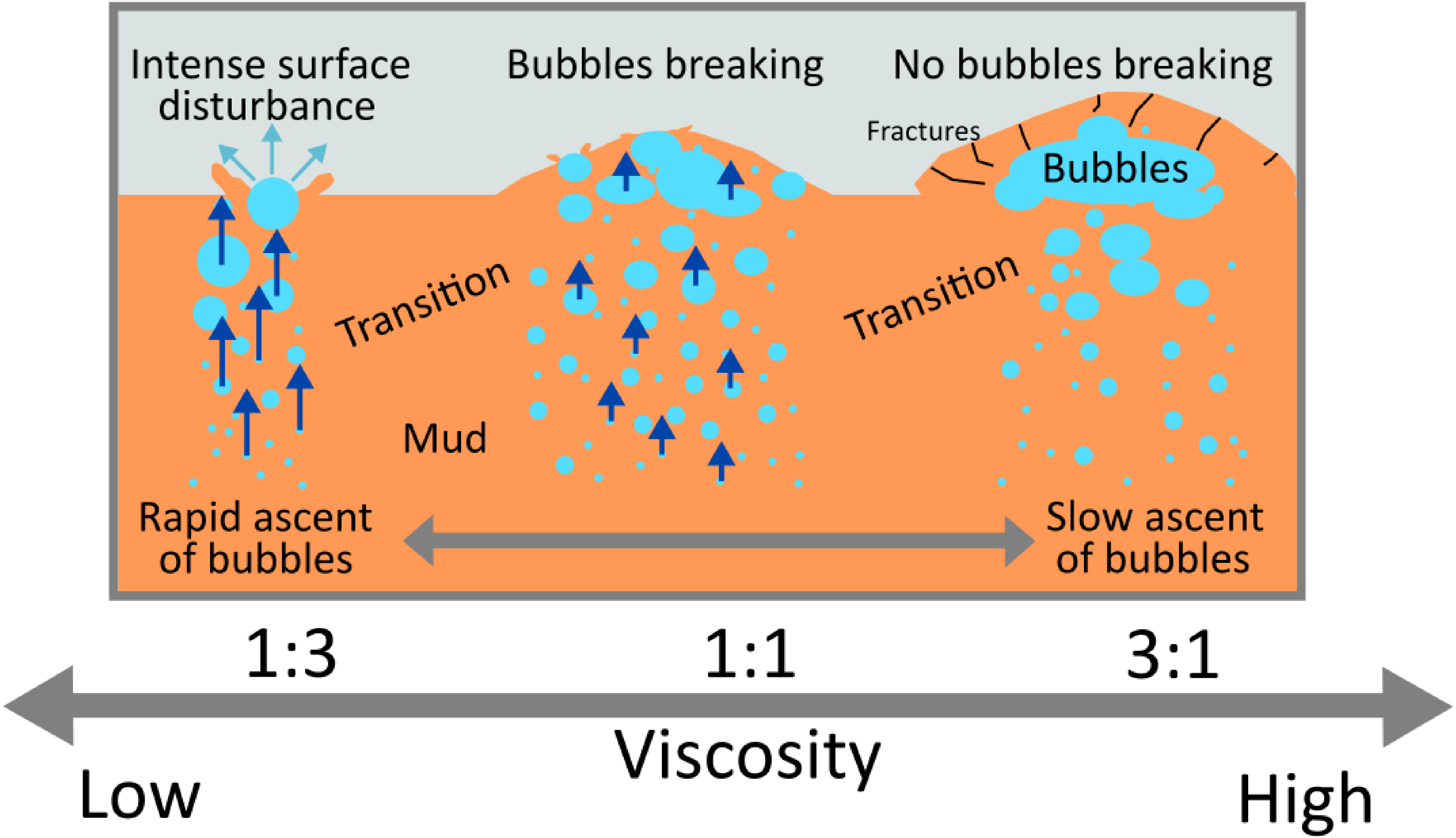
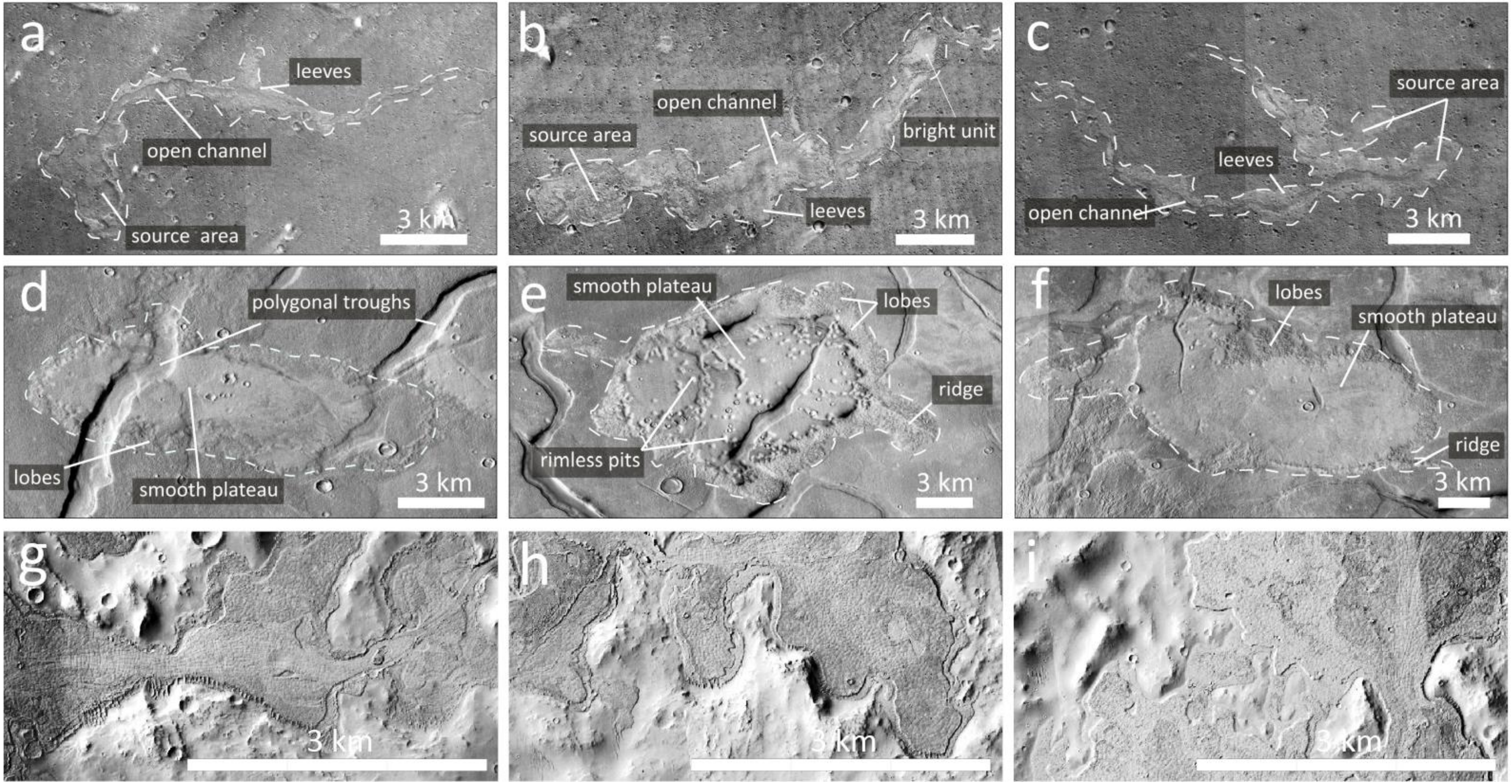
Conceptual model for volumetric changes



Differences in Putative Martian Mud Flows



Brož et al. (Icarus, under review)
Cuřín et al. (Icarus, under review)

- Chryse (a,b,c), Adamas (d,e,f), SW of Cerberus Fossae (g,h,i)
- Varying **p/T conditions** or viscosity during emplacement

Take home messages

- Hard to distinguish between igneous and sedimentary volcanoes on Mars – both are theoretically possible
- Mud behavior strongly depends on composition and low P conditions amplify differences in this behavior
- The most significant is viscosity and rapid pressure drop which result in maximum volume increase
- To quantify and theoretically predict morphology of mudflows we can apply simple lab experiments

Thank you for your attention!

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