Origin and evolution of circular collapsed features on Mars

Manuel Roda, Maarten G. Kleinhans, Tanja E. Zegers and Rob Govers

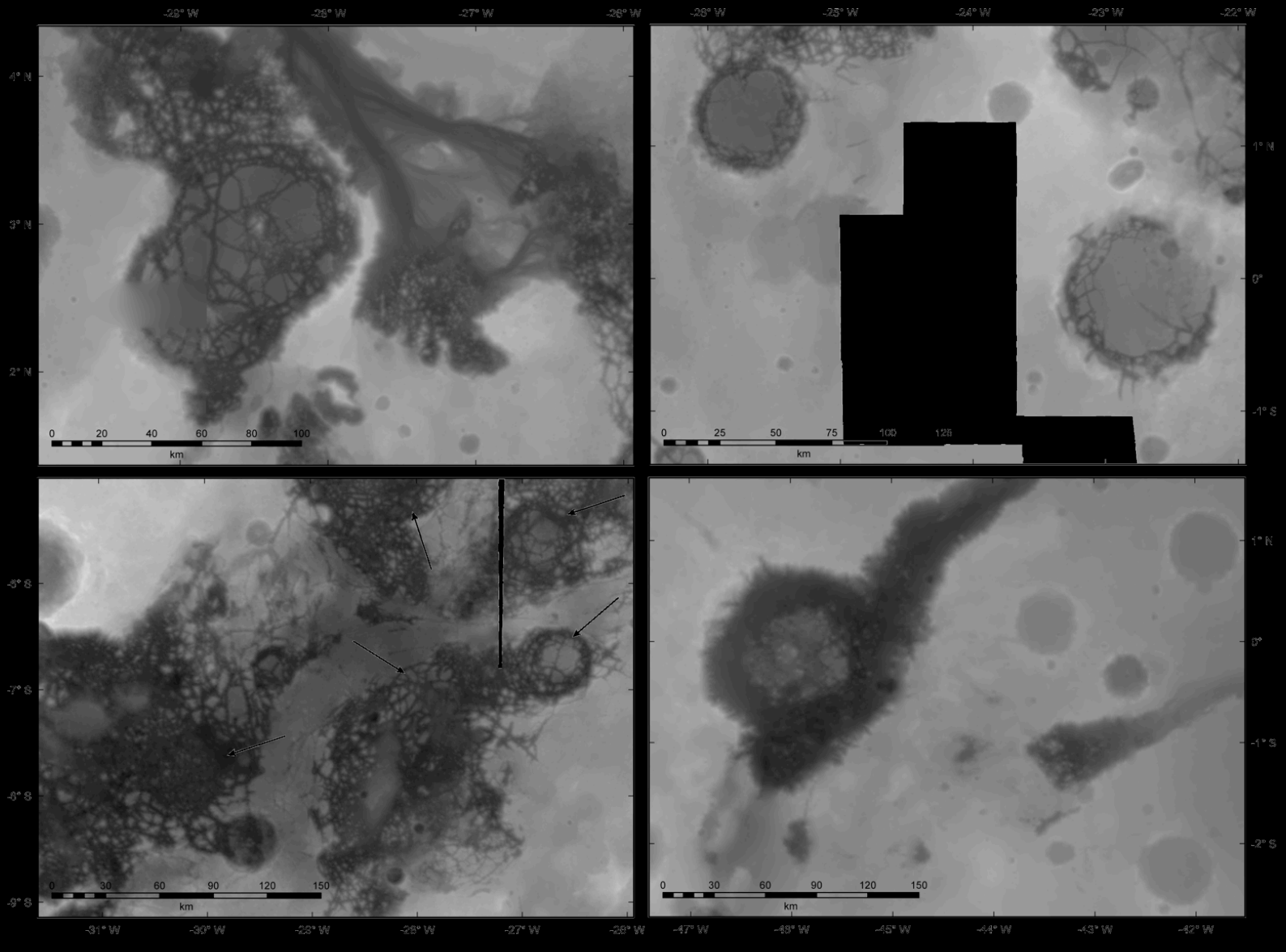
Utrecht University, Faculty of Geosciences

The Netherlands - (m.roda@uu.nl)

Universiteit Utrecht

CC BY

Circular collapsed features



Aim

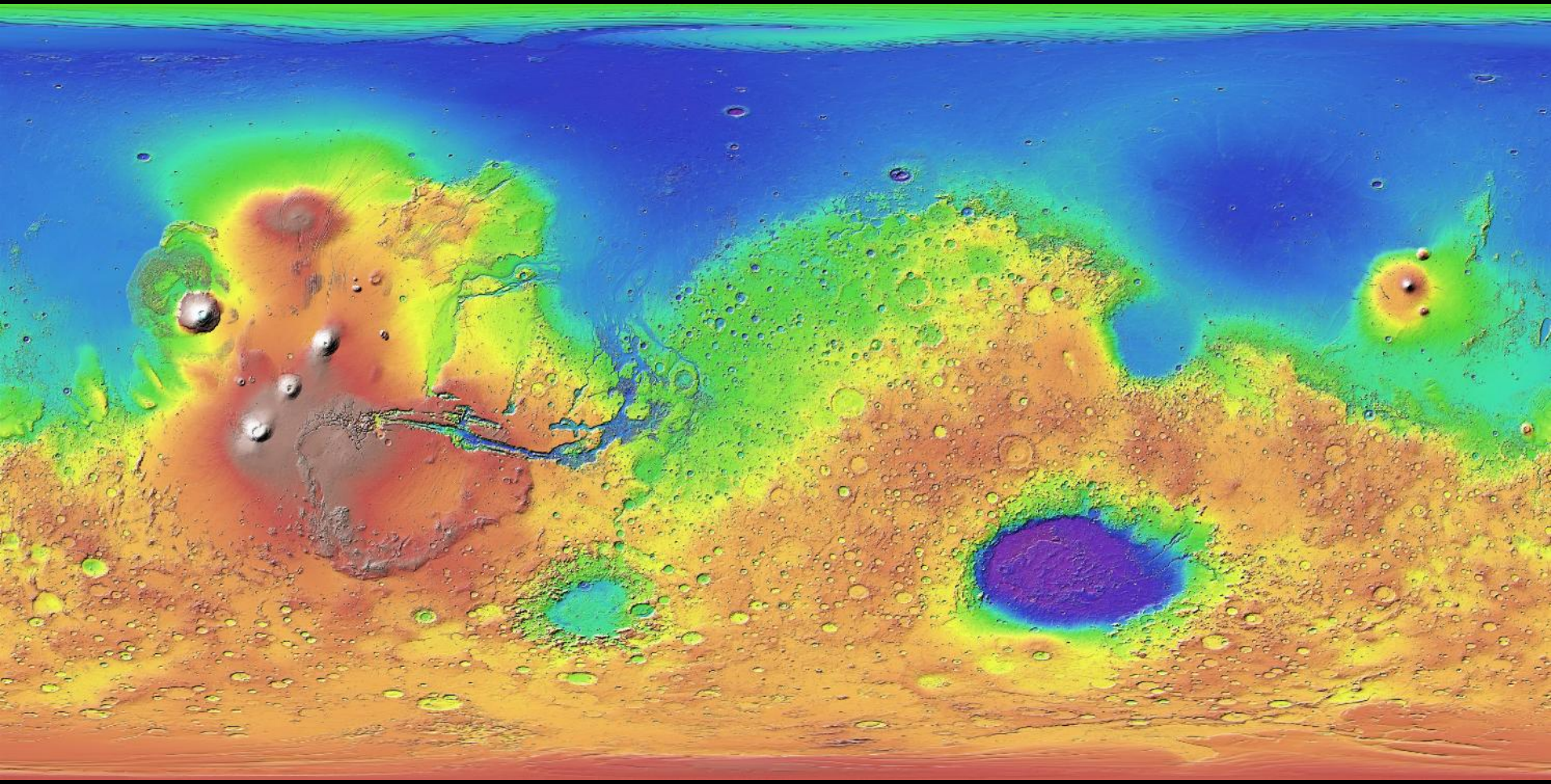
Based on morphometric characteristics:

1. Are chaotic terrains really different from floor-fractured craters?

2. which mechanism can explain the morphology of quasi-circular collapsed features?

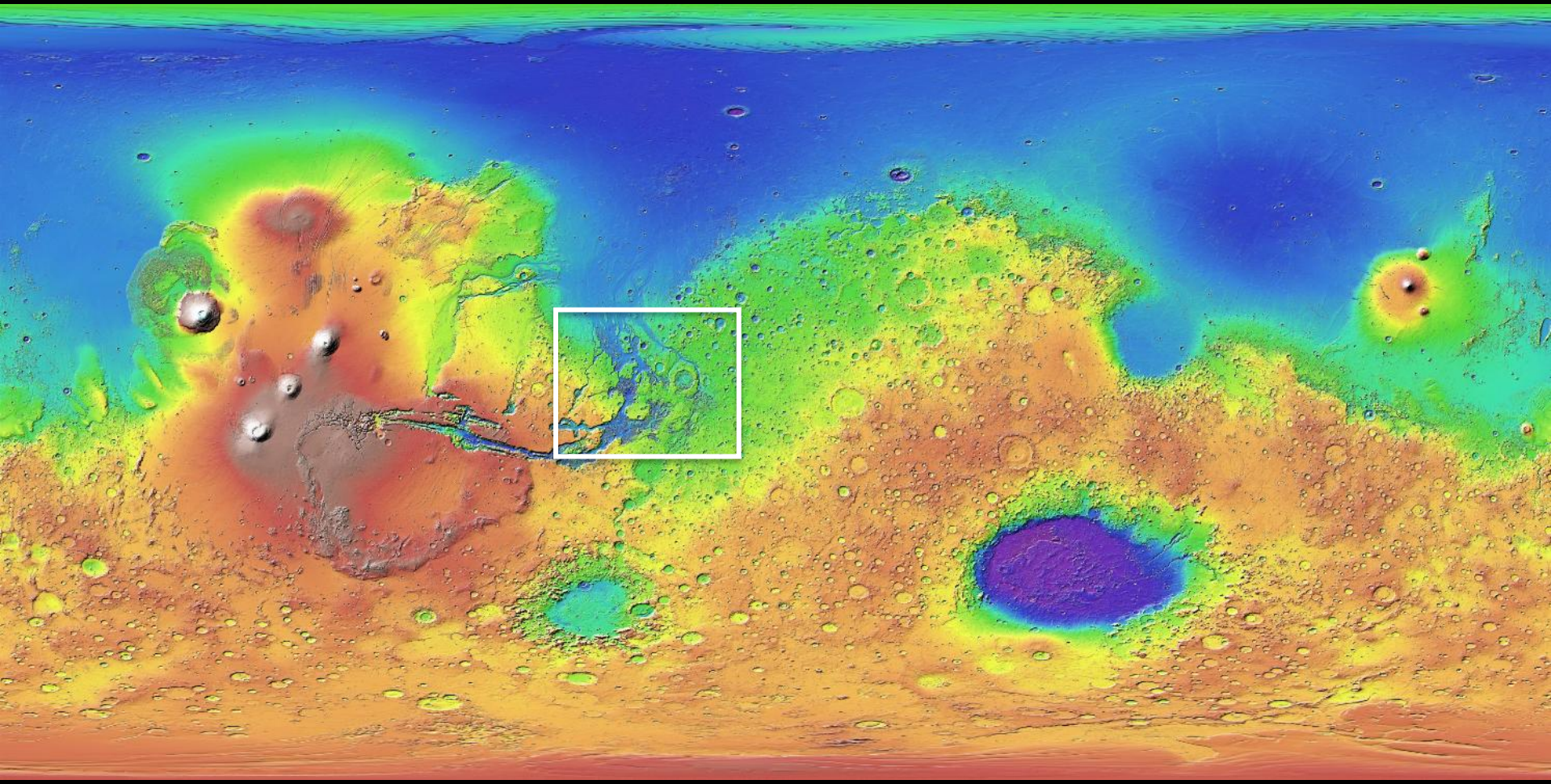
We analyze statistical relations between diameter, maximum and minimum depth, and amount of collapse

Method



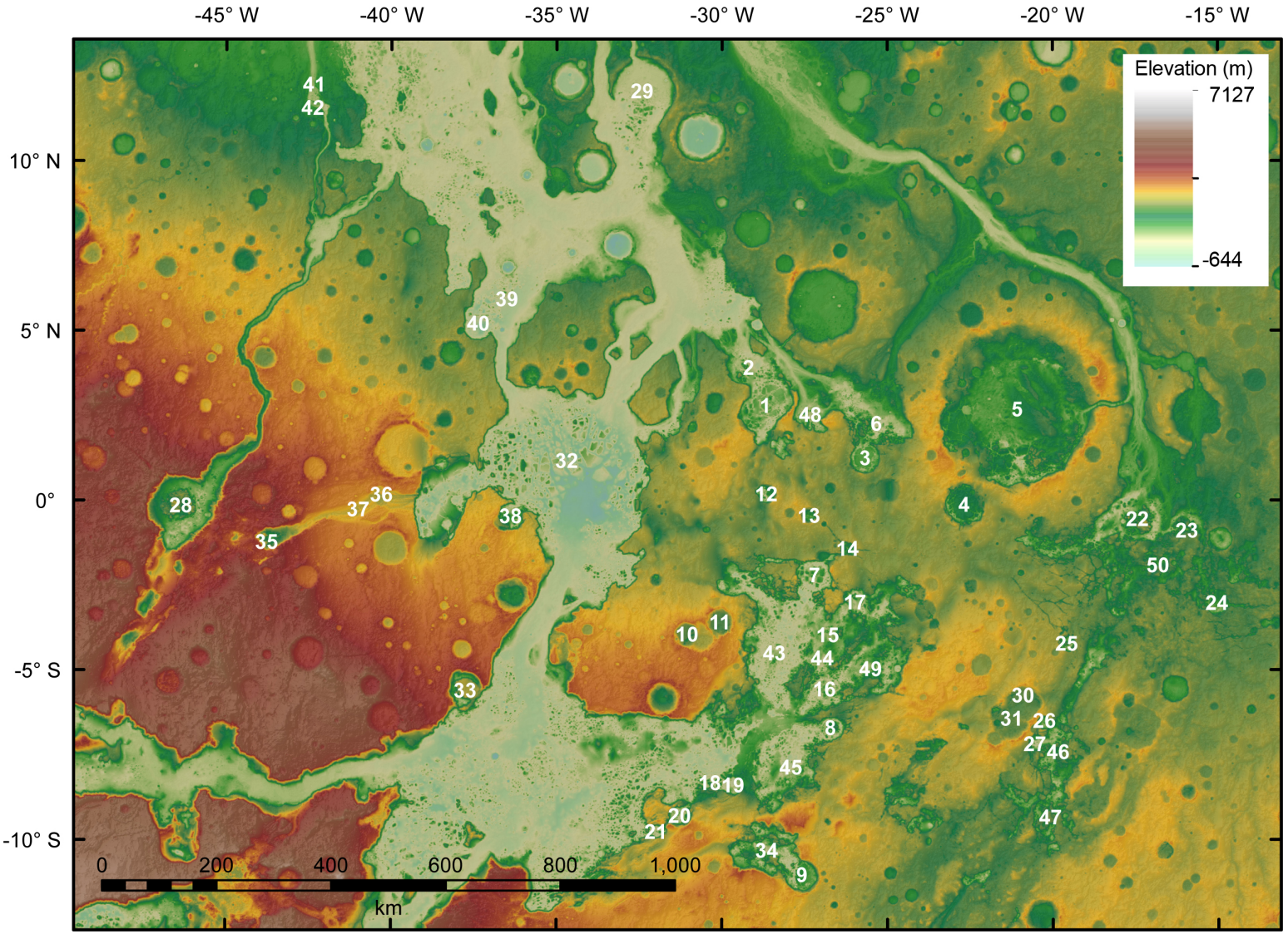
MOLA mosaic

Method



MOLA mosaic

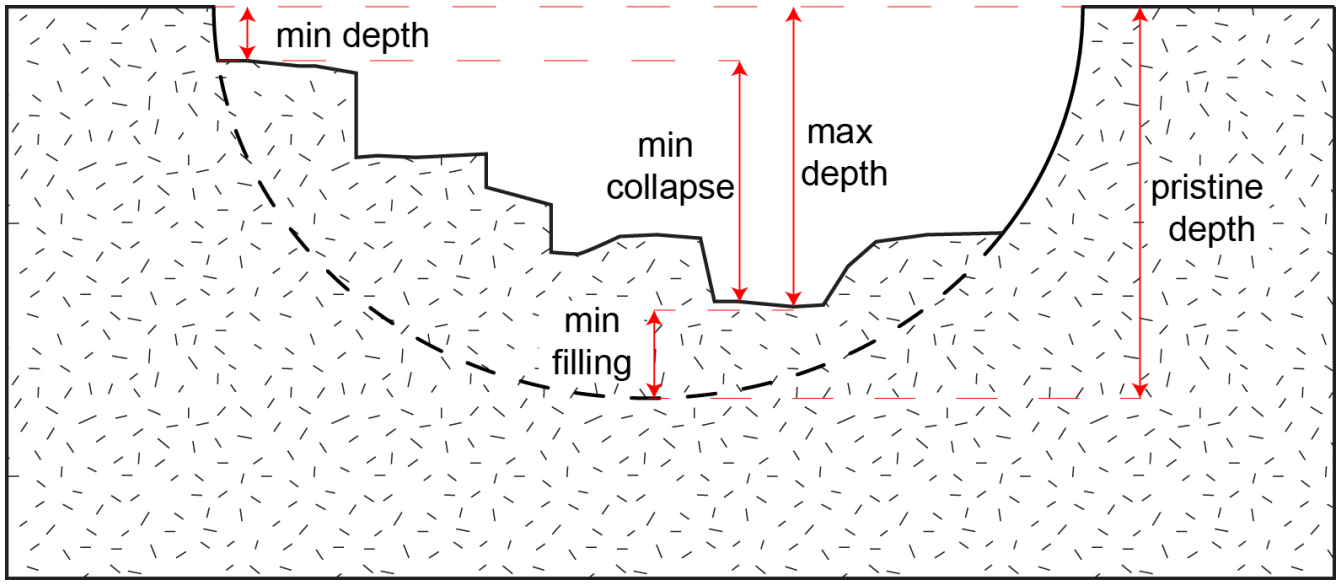
Method



MOLA mosaic

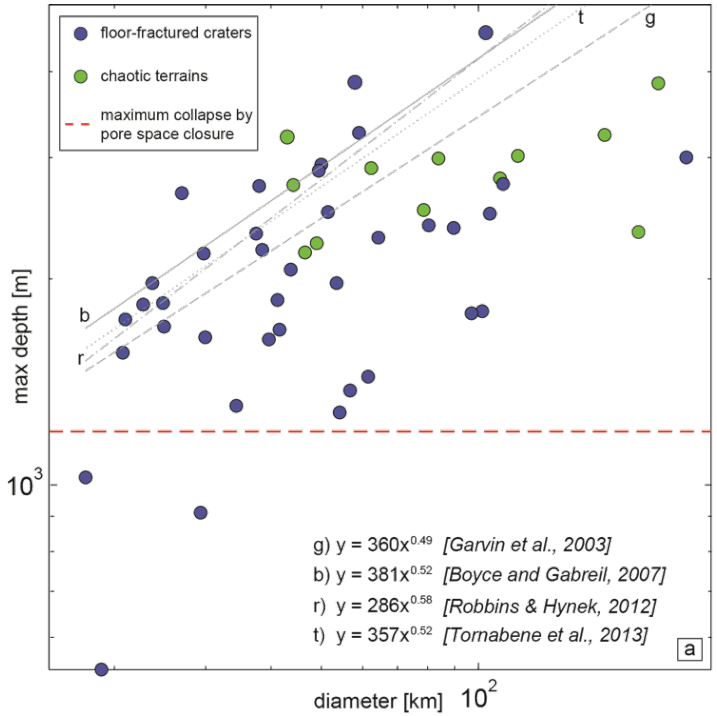
Method

We analyze statistical relations between diameter, maximum and minimum depth, and amount of collapse

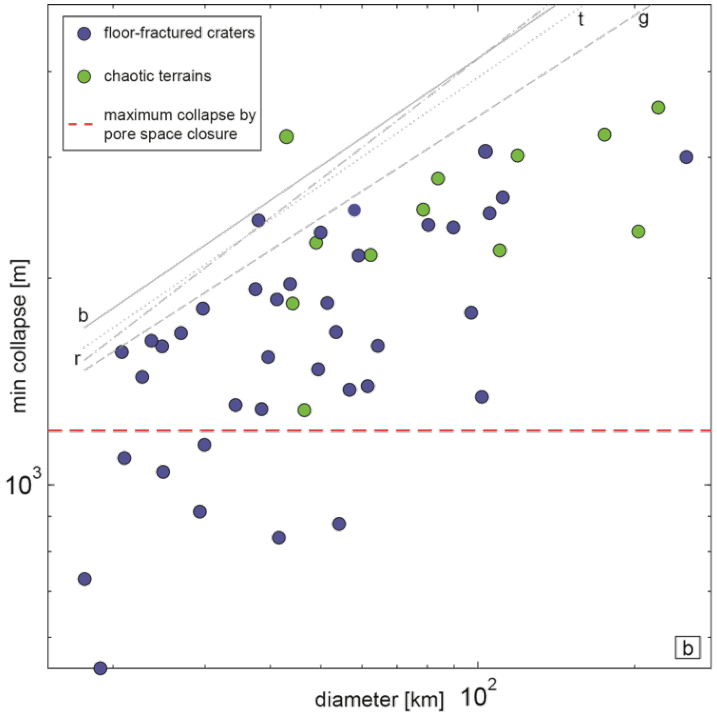


Results

Maximum depth vs diameter



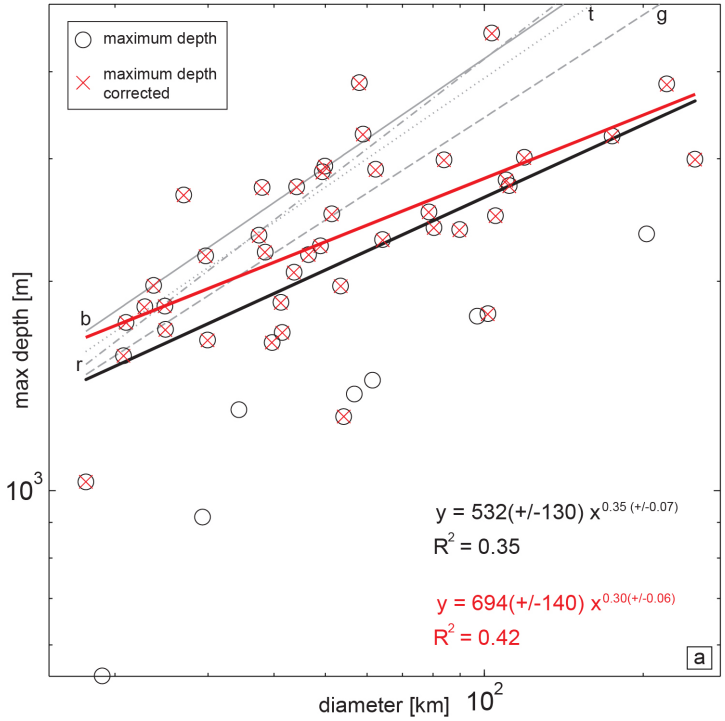
Minimum collapse vs diameter



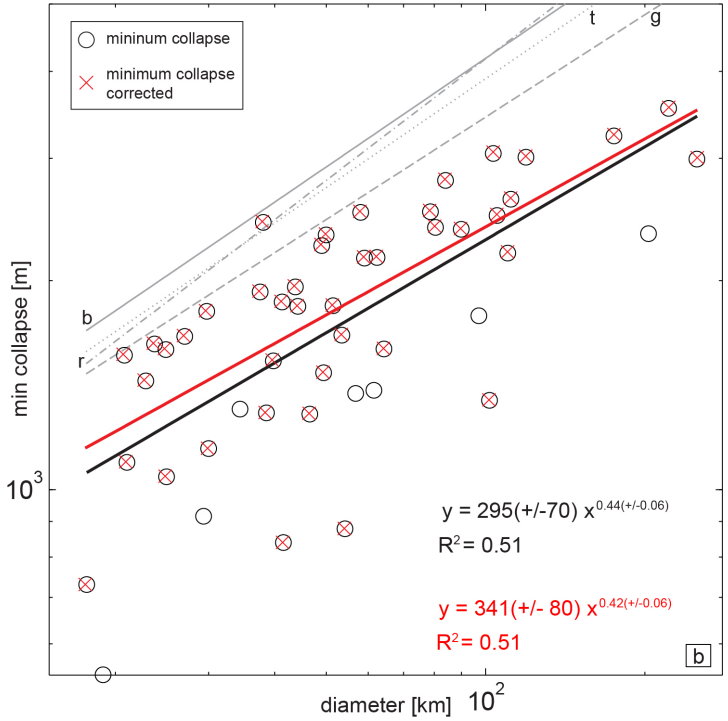
- chaotic terrains and FFC have likely a common origin
- groundwater discharge cannot be responsible for the high collapse
- Impact craters and circular collapsed objects have similar distribution with diameter

Results

Maximum depth vs diameter



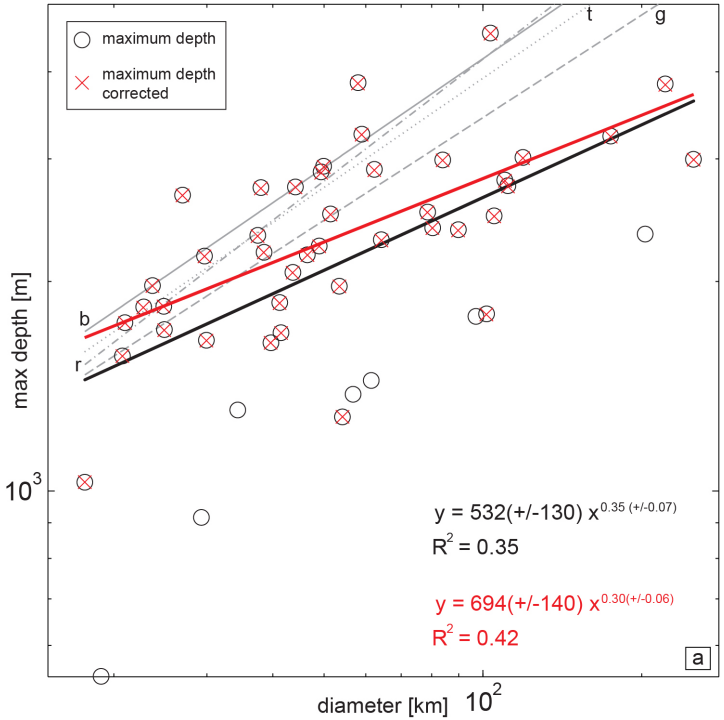
Minimum collapse vs diameter



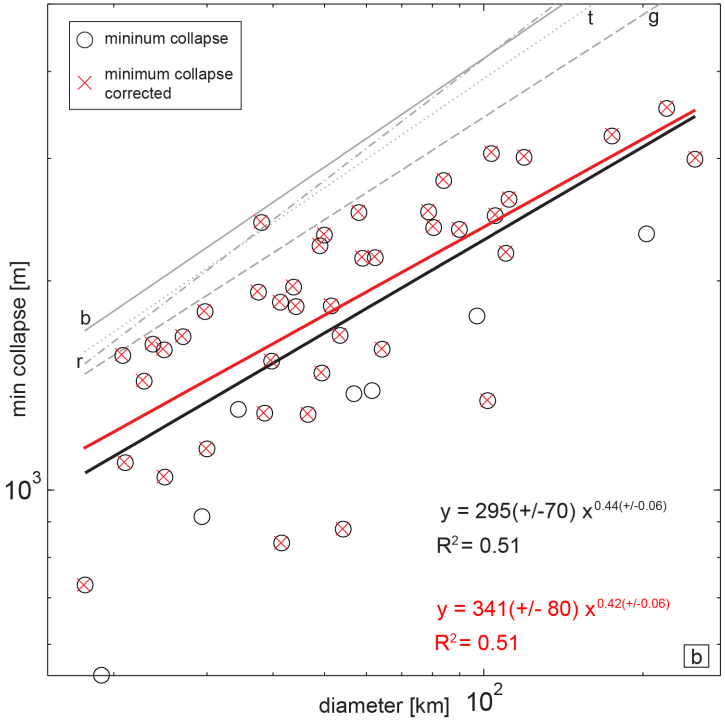
- collapsed features can be originated as impact craters – *Sato et al., 2005*

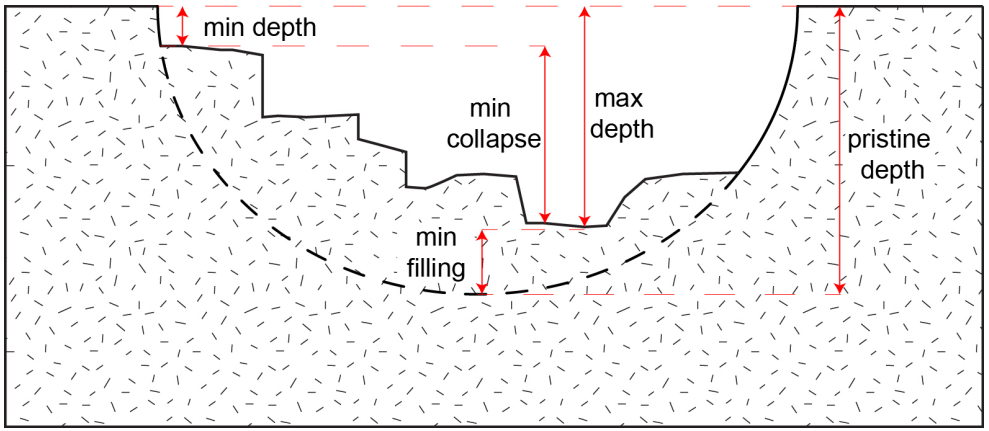
Results

Maximum depth vs diameter

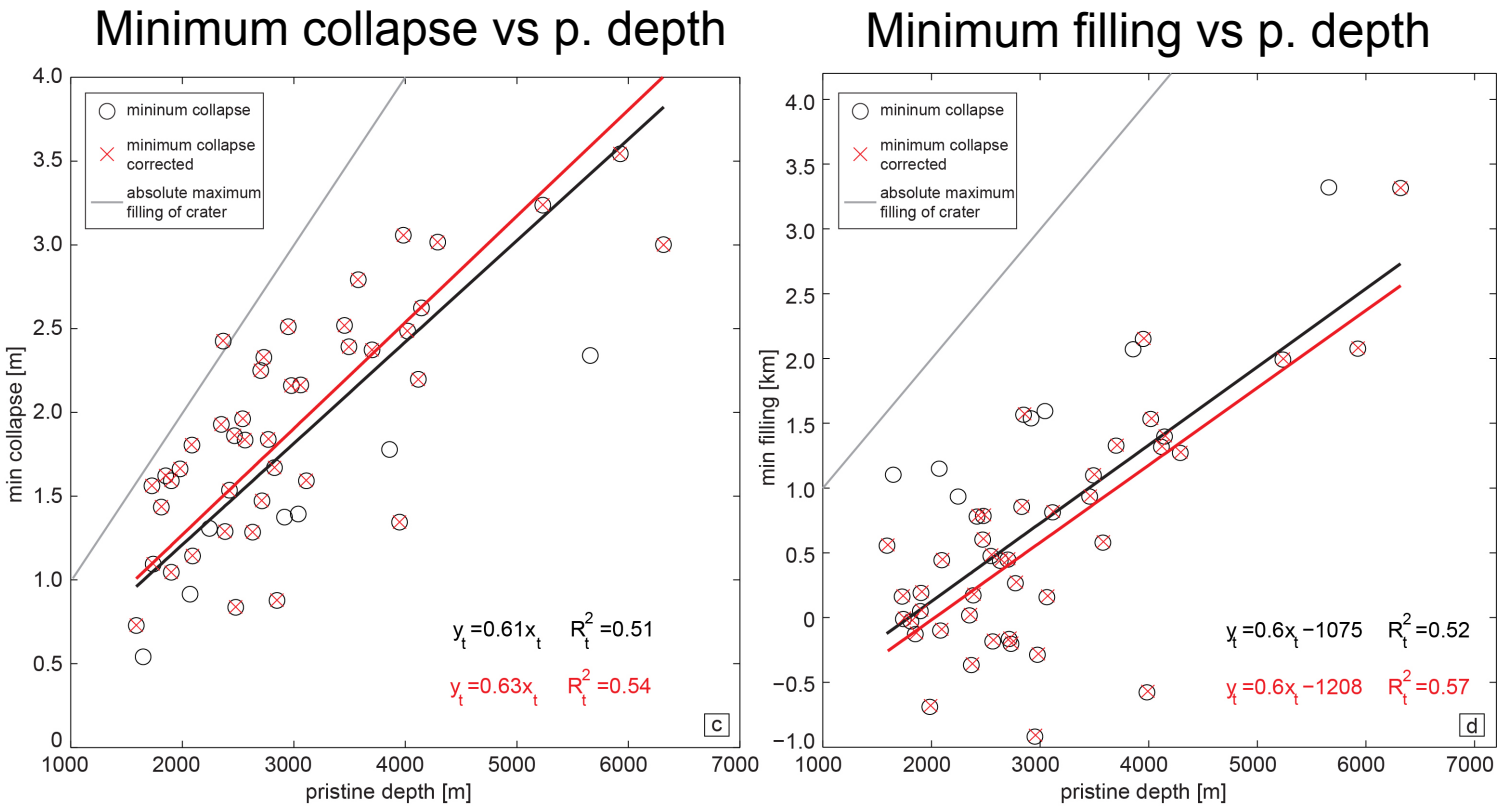


Minimum collapse vs diameter



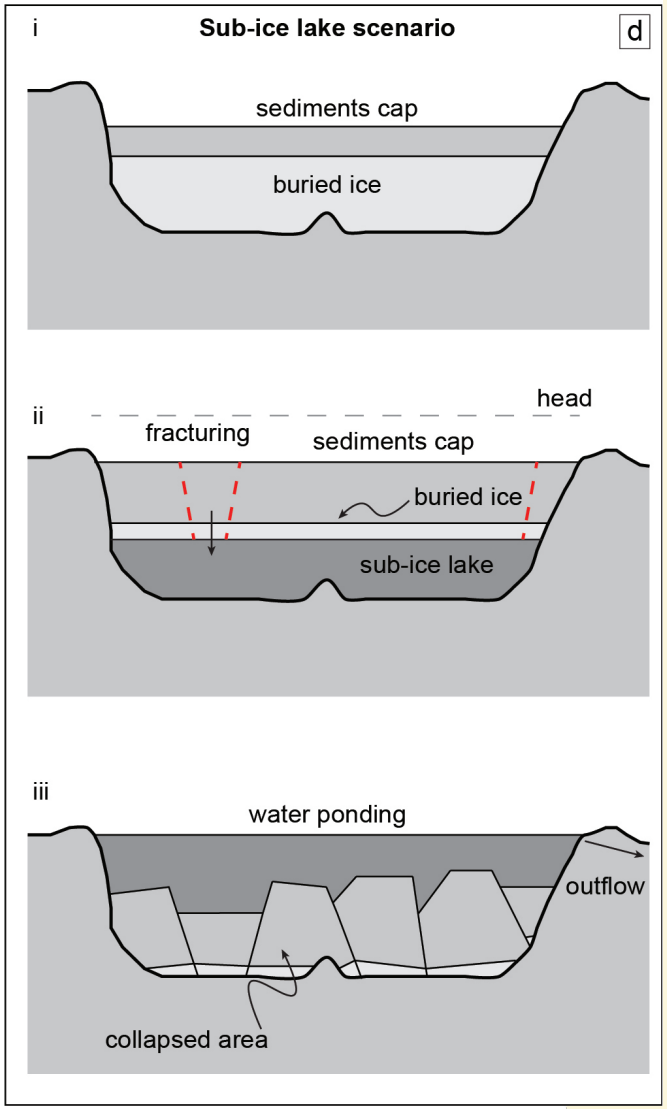


Results



- the linear correlation of minimum collapse with pristine depth → the crater size
- The sediment thickness is also linearly related to crater depth

Results



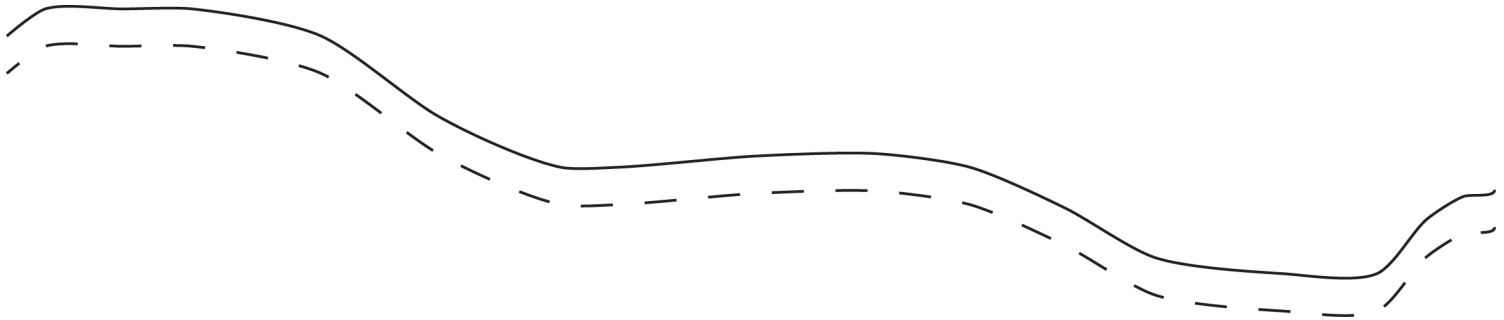
- **Collapsed features originated as impact crater**
- **Linear correlation of collapse (ice thickness) with pristine depth**

impact crater → temperature increase → cryosphere melting → crater lake → freezing → ice layer

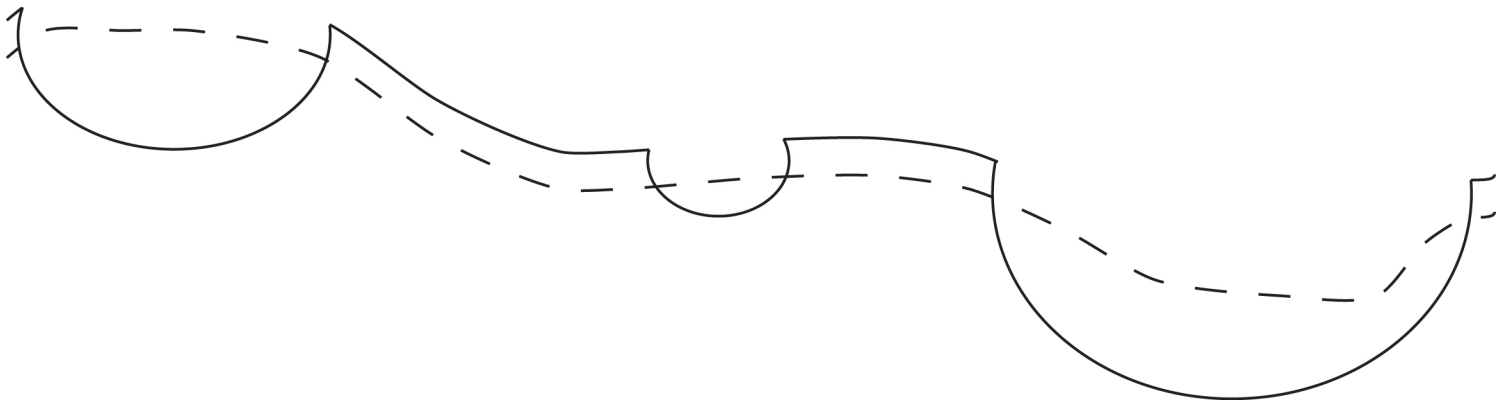
Larger impact → larger melt volume → larger ice layer (e.g. *Segura et al., 2002, 2008*)

Zegers et al., 2010
Roda et al., 2014

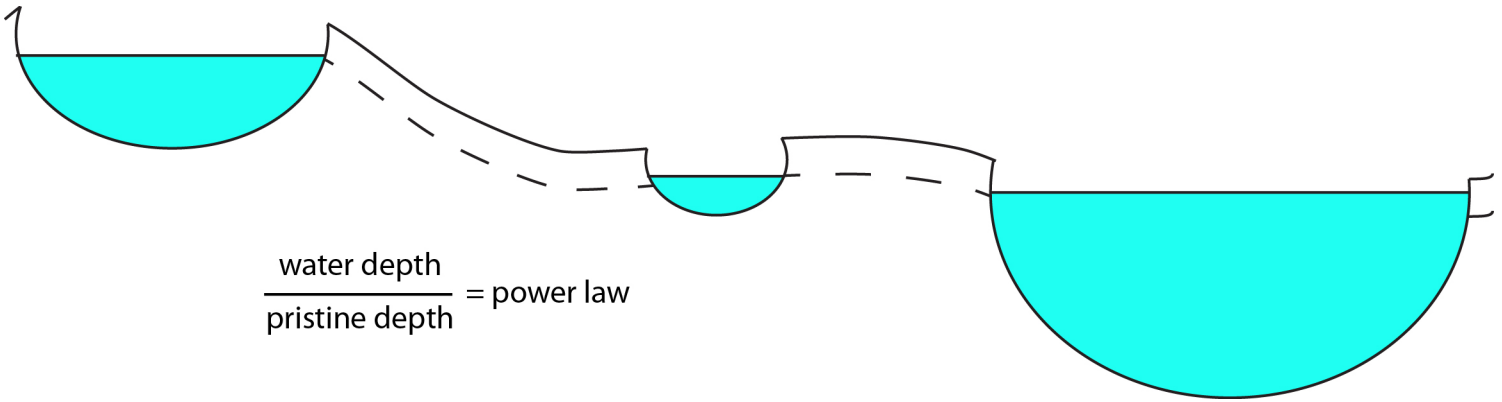
Results



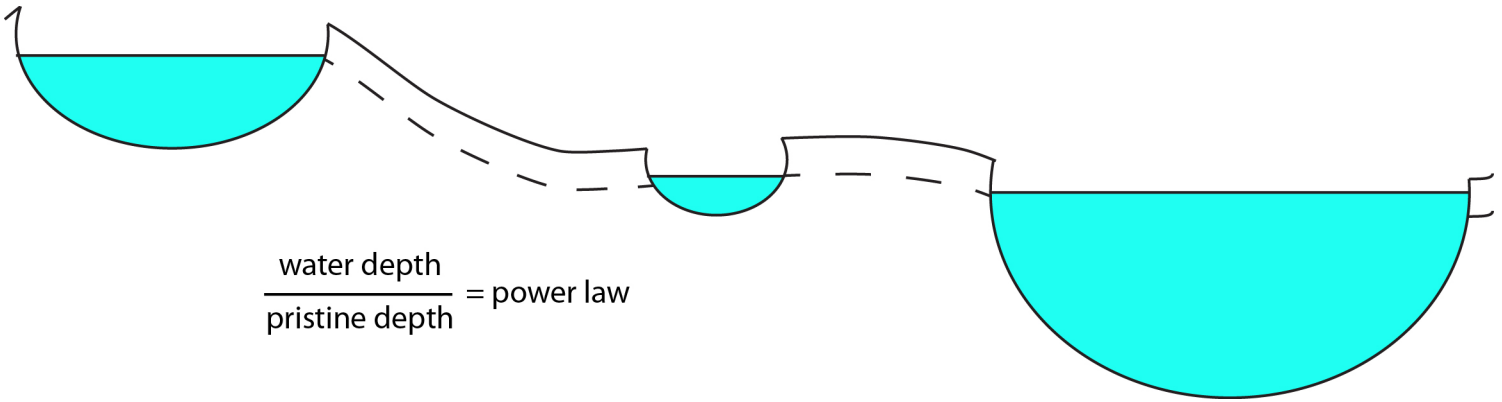
Results

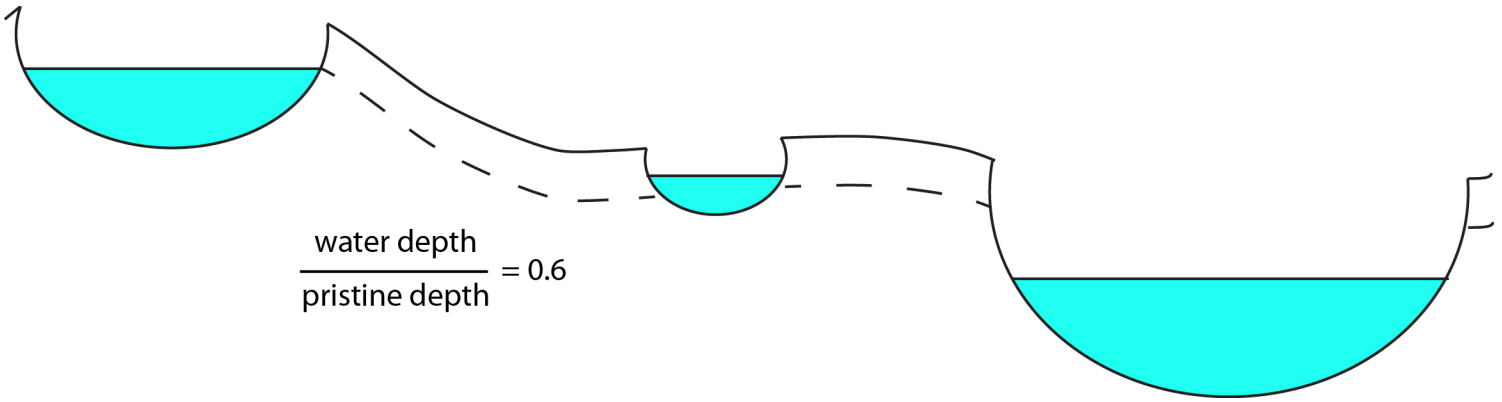


Results

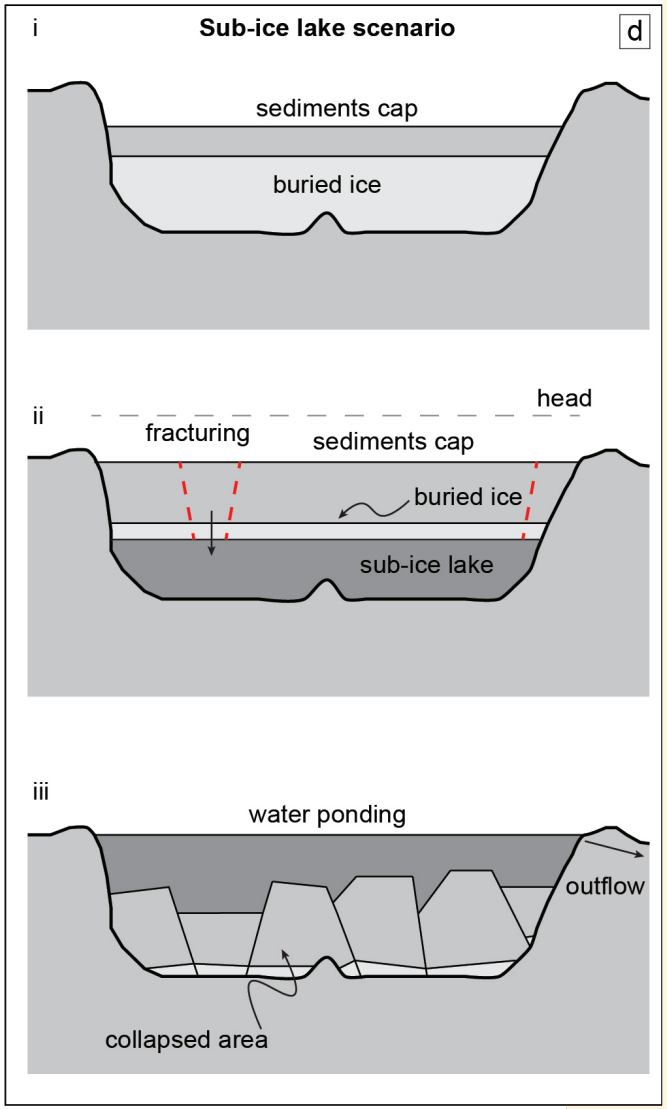


Results


water depth
pristine depth
= power law


water depth
pristine depth
= 0.6

Results



- **Collapsed features originated as impact crater**
- **Linear correlation of collapse (ice thickness) with pristine depth**

impact crater → temperature increase → cryosphere melting → crater lake → freezing → ice layer

Larger impact → larger melt volume → larger ice layer

- **Sediment thickness linearly related to crater depth → it represents accommodation space available after freezing of crater lake**

Zegers et al., 2010
Roda et al., 2014

Conclusion

Based on their morphometric characteristics:

- circular collapsed features have a common origin
- the maximum depth and minimum amount of collapse are strongly correlated to diameter and impact craters show the same relations → impact crater origin
- the morphometric characteristics of the crater infill agree with melting and subsequent collapse of an ice layer below a sediment layer → buried sub-ice lake scenario

non-climatic mechanism for producing liquid water under martian conditions, and that eventually may become available for valley carving