Size and Structural Stability Assessment of Lunar Lava Tubes

abstract #2803

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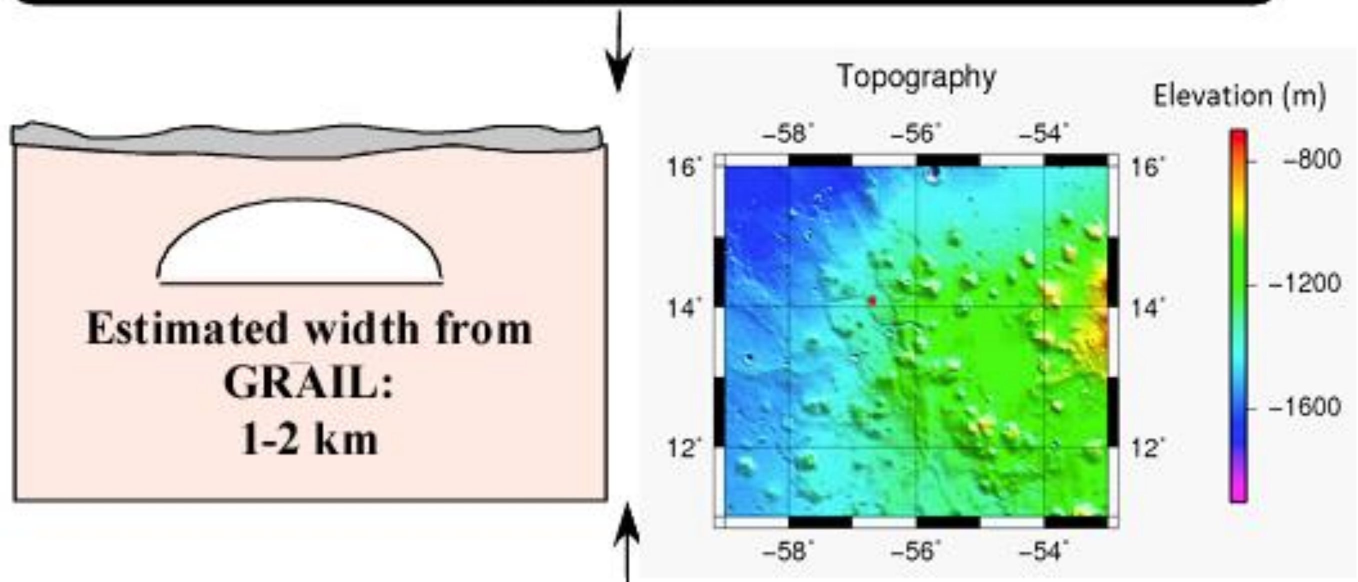
Objectives

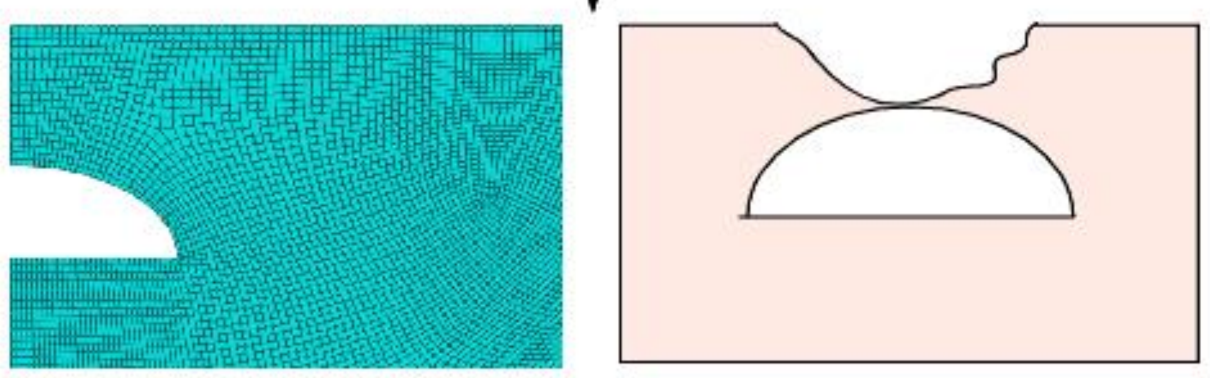
Evidence of Lava Tubes

- NASA's Lunar Reconnaissance Orbiter (LRO)
- Gravity Recovery And Interior Laboratory (GRAIL)
- SElenological and Engineering Explorer (SELENE) spacecraft

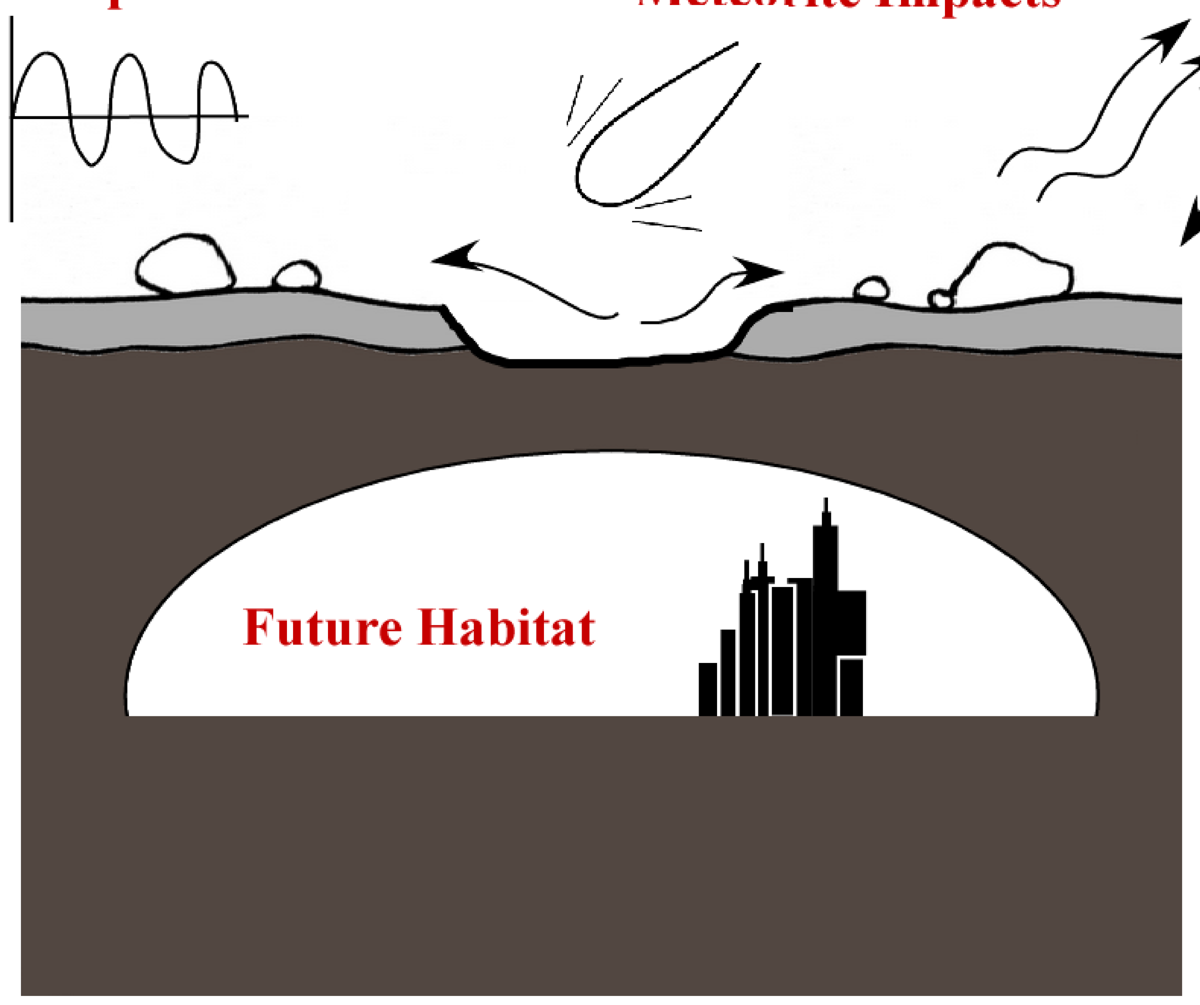


Objective 1: Develop analytical solution to find the width and size.

Objective 2: Numerical simulation of structural stability.



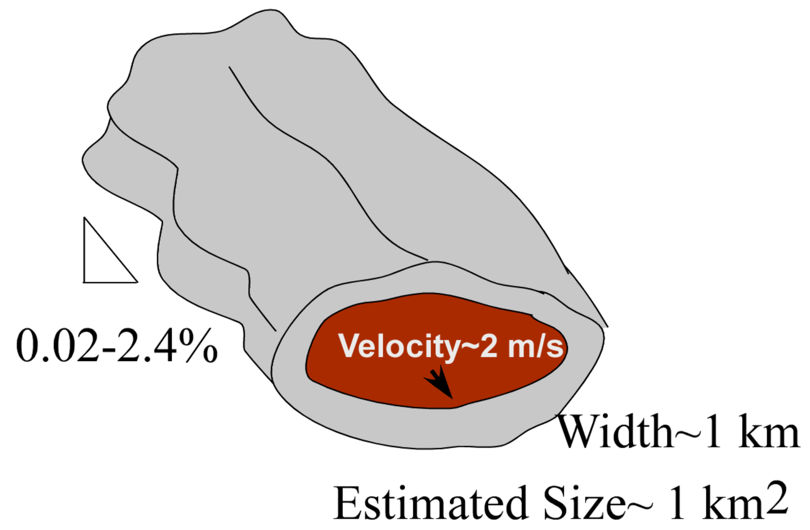
- Lava tubes could be potential future habitats on the moon and will provide protection against hazards.



Geometry and Size

- The analytical solution incorporates knowledge of the parameters of lunar rocks and the mechanics of lava flows. Our results below are comparable with GRAIL data.

$$Q_E = \frac{\kappa A G_z}{Y_B} \rho g sin\theta$$

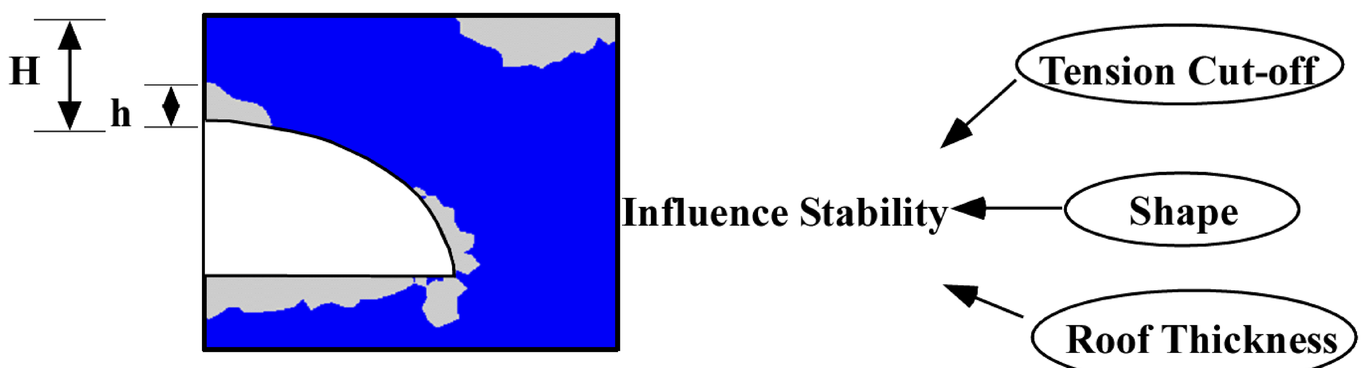


Geometry and material properties of lunar lava flows

Parameter	Value
Thermal diffusivity; κ	$10^{-6}\ m^2/s$
Density; ρ	$2{,}790\ kg/m^3$
Gratz number; G_z	30
Bingham yield stress; Y_B	3.8-59,151 Pa
Area of flow; A	$0.3\text{-}2{,}434\ km^2$
Slope; θ	0.01-1.4 degree
Velocity of flow; V	$1.5\text{-}3\ m/s$

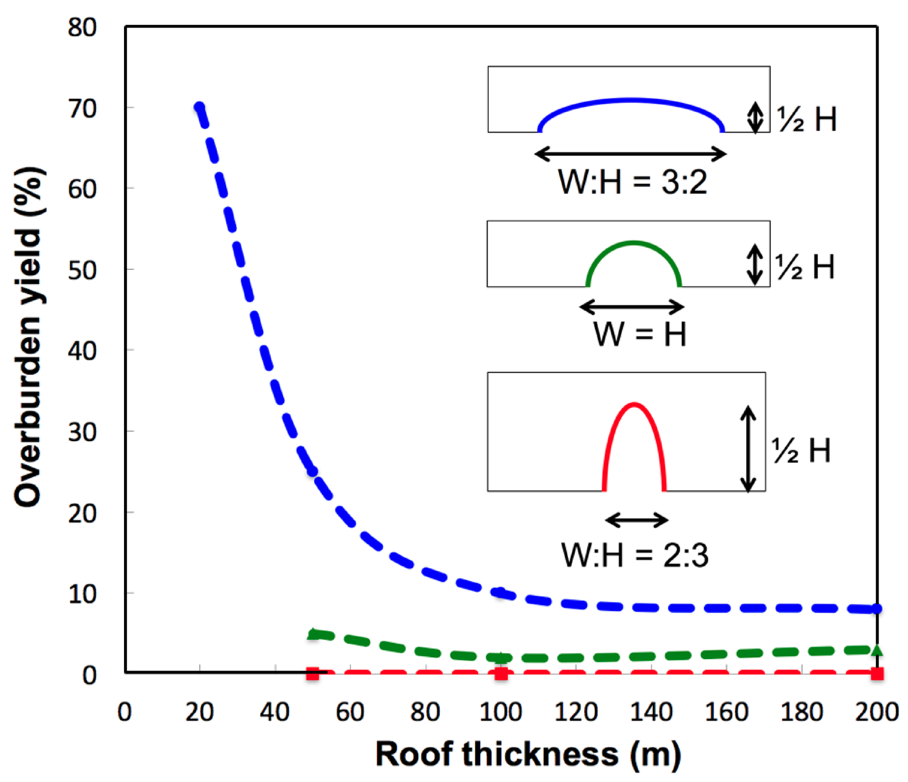
Structural Stability

- Are lava tubes stable and what factors might affect stability?



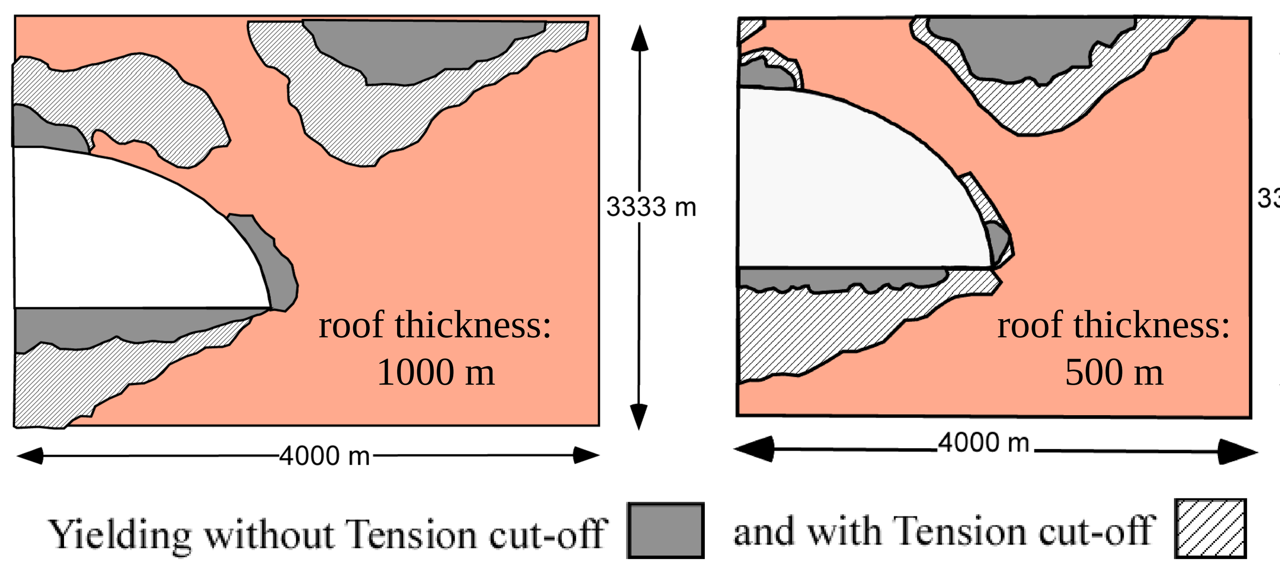
h (yielding height) =0...... Stable
0<h/H<50,...................... Quasi-Stable
h/H>50, ...Unstable

Influence of roof thickness and shape

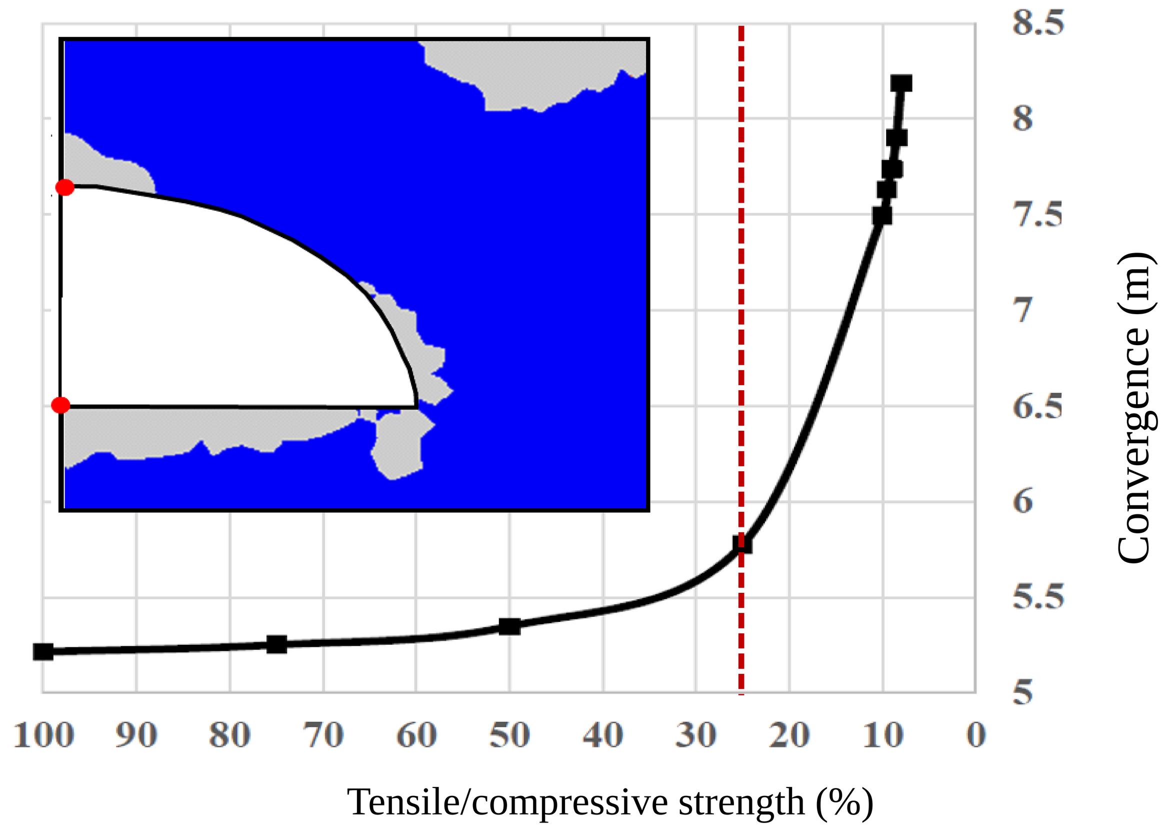


Structural Stability (Cont.)

Tension cut-off influence for roof thickness:1000m and 500 m



Convergence with different tensile strength limits



Conclusions

- **Size and width of lunar lava tubes are comparable to data from GRAIL.**
- **Stability of lunar lava tubes decreases as the cross section becomes more elongated horizontally.**
- **As the roof thickness and/or tensile strength of the lava increases, yielding decreases.**

Future Experimental Modeling

- **Modeling columnar jointing and geological formation of lava tubes**