# Hawaiian Lava Tubes with Extraterrestrial Habitat Applications

**Jacob Just**[1],
Audai Theinat[2], Dr. Amin Maghareh[2],
Dr. Shirley Dyke[1,2], Dr. Antonio Bobet[2]

[1] School of Mechanical Engineering, Purdue University
[2] Lyles School of Civil Engineering, Purdue University

# Purdue RETH Team

Faculty Members





Postdoctoral and Graduate Researchers

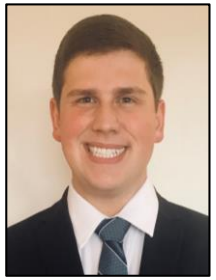



Undergraduate Researchers



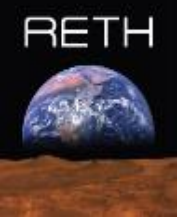




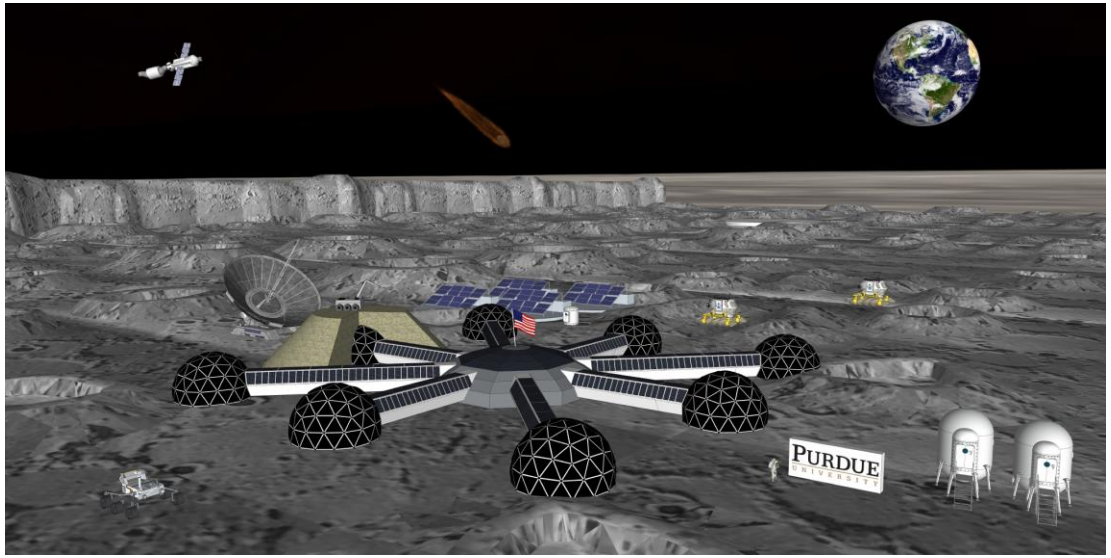

# Overview

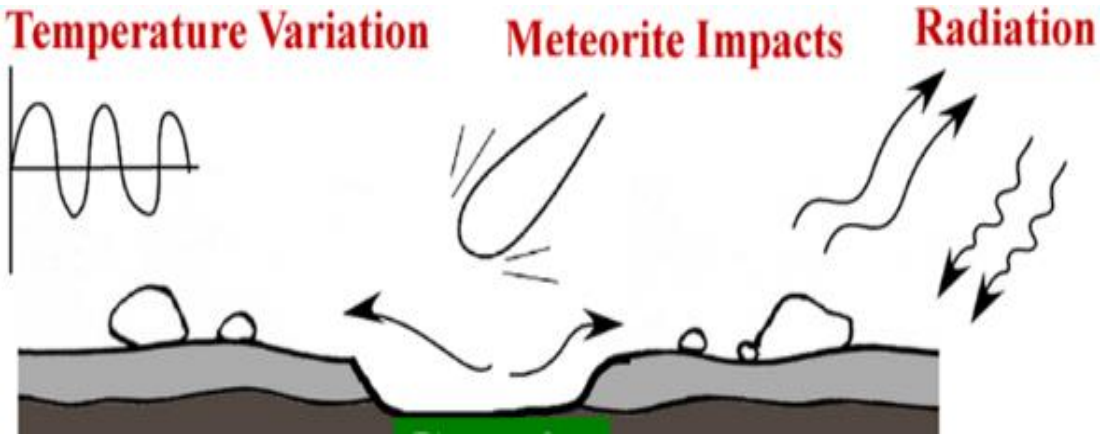
- Extraterrestrial habitats
  - Problem statement
  - Potential solution
- Hawaiian lava tube
  - Formation
  - Morphology
- Case study
  - Lunar applications
- Conclusions and future work



# Problem Definition

- Extraterrestrial habitats are the next step in space exploration
- Numerous hazards pose threats to these habitats

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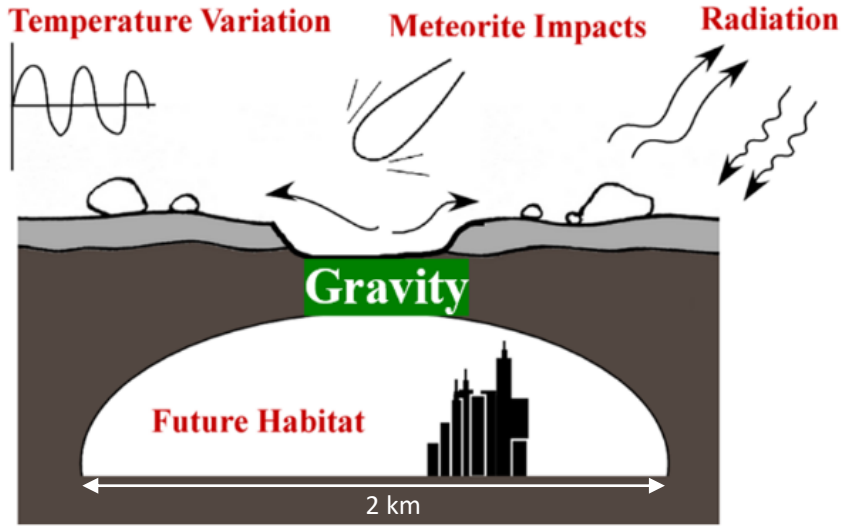
# Potential Solution

- GRAIL data shows lava tubes on the Moon created during volcanic eruptions
- Could potentially house future habitats
- Lunar lava tubes are estimated to be up to several kilometers wide

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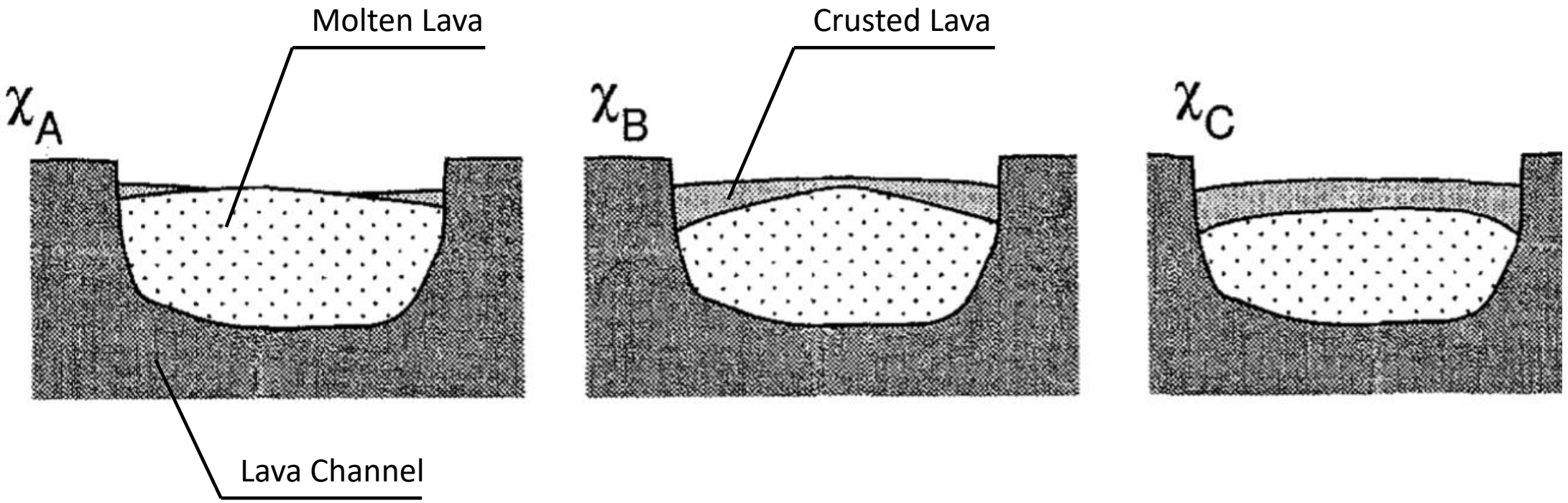
# Hawaiian Lava Tube Formation



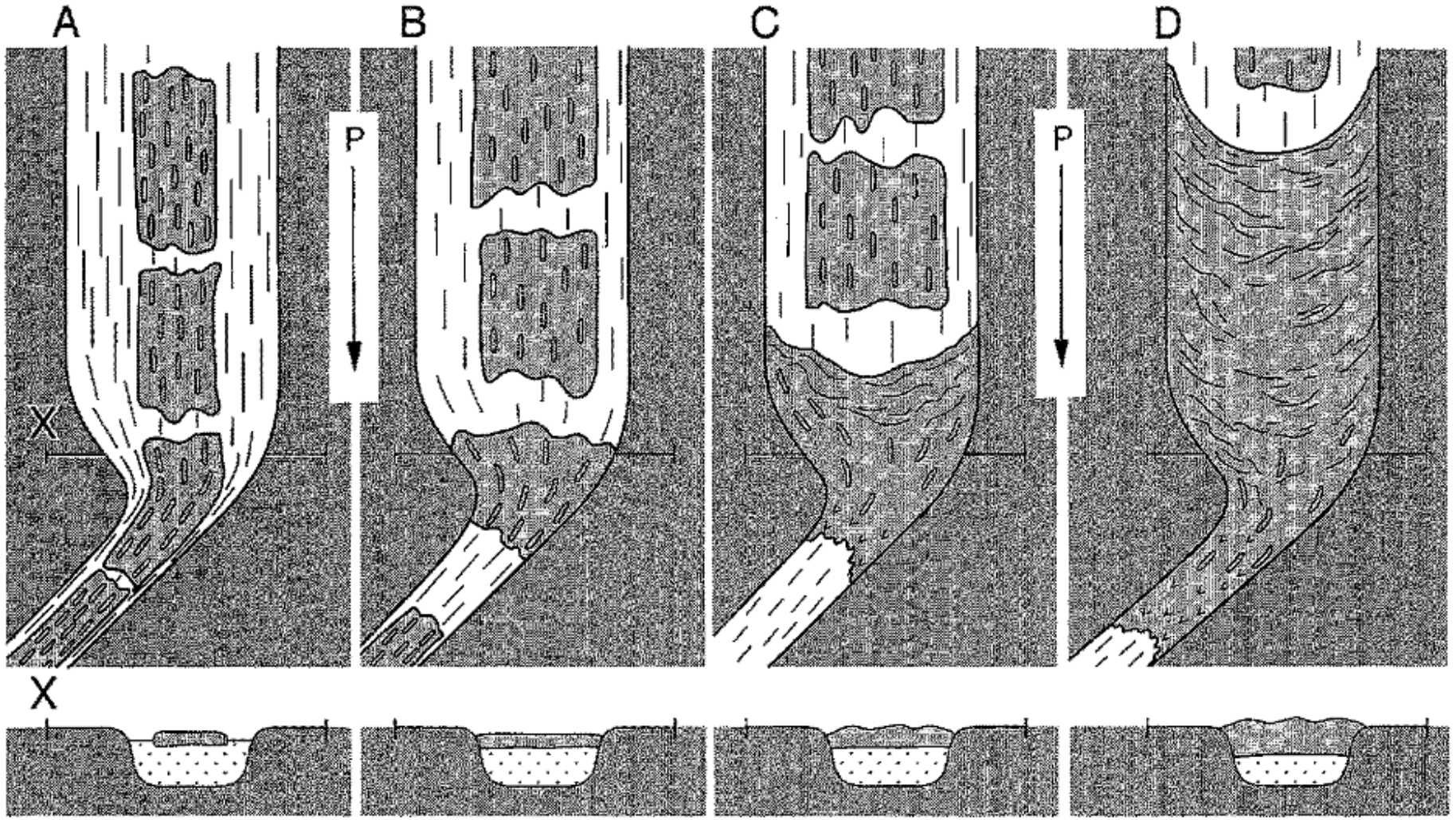

D. Peterson

# Hawaiian Lava Tube Formation


Hawai'i Volcanoes National Park

# Hawaiian Lava Tube Formation

Top View




Front View

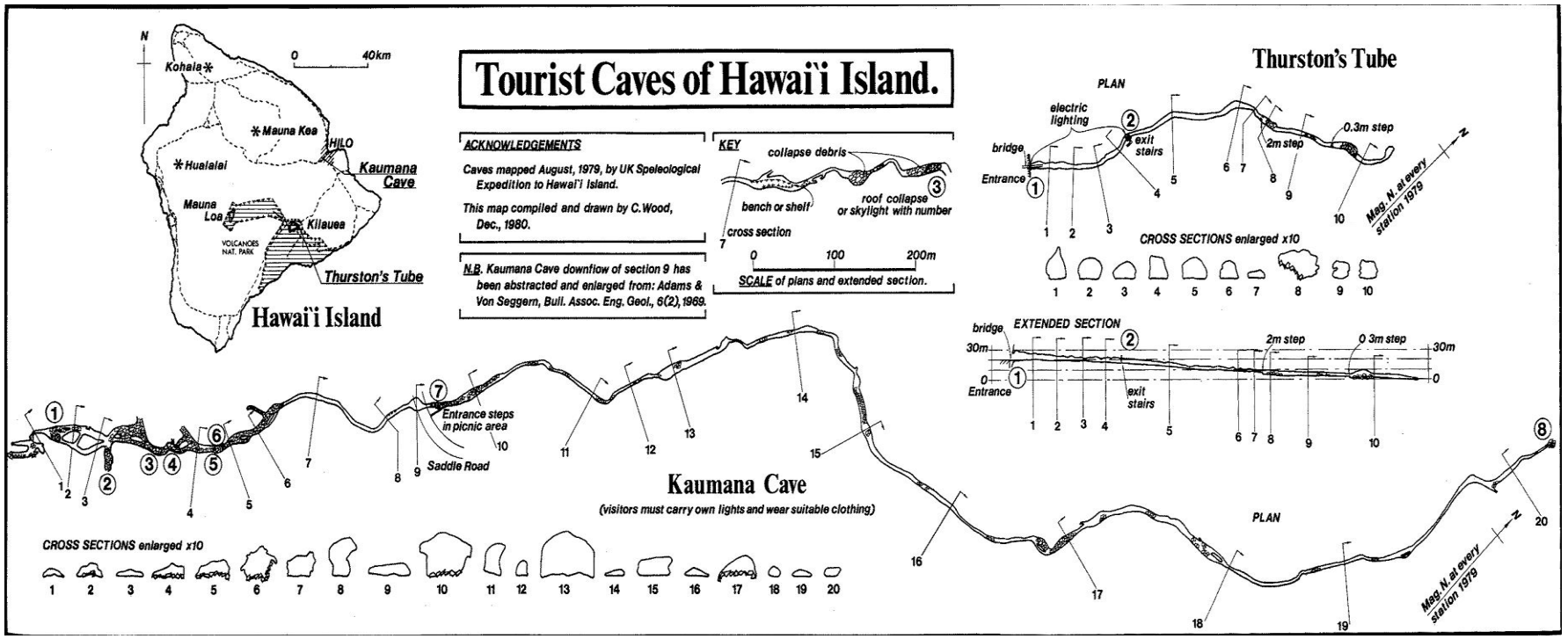
D. Peterson

# Hawaiian Lava Tube Formation


Hawai'i Volcanoes National Park

# Kaumana Cave and Morphology

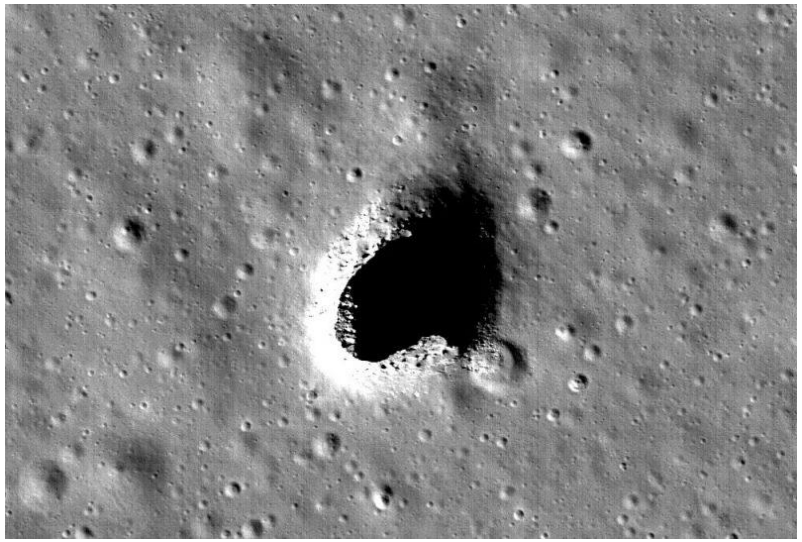
- Shape is determined by topography and changes in direction
- Terrestrial lava tubes have widths up to 30 meters




Arizona State University

# Marius Hills Lava Tube

- Demonstrates the presence of subsurface features on the Moon
- Supported by multiple methods using data from several probes



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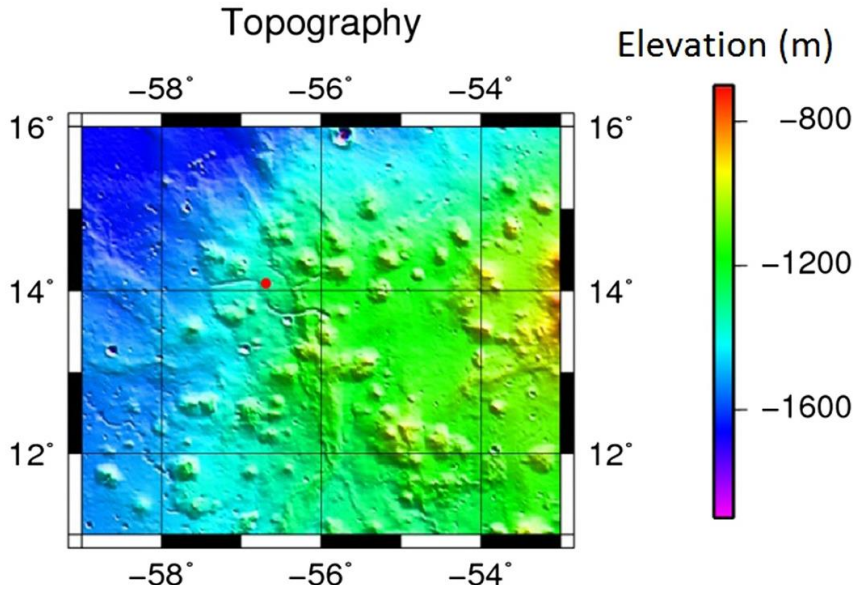
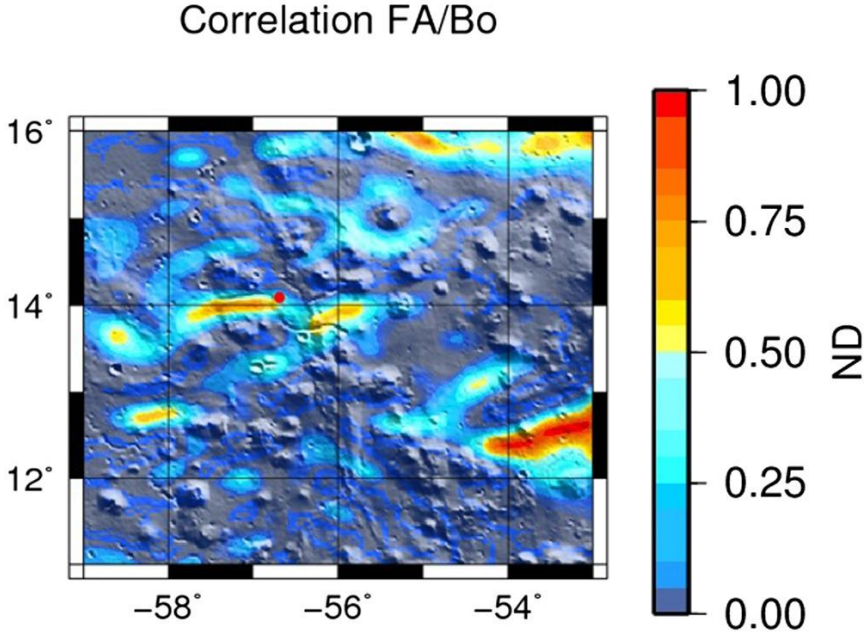
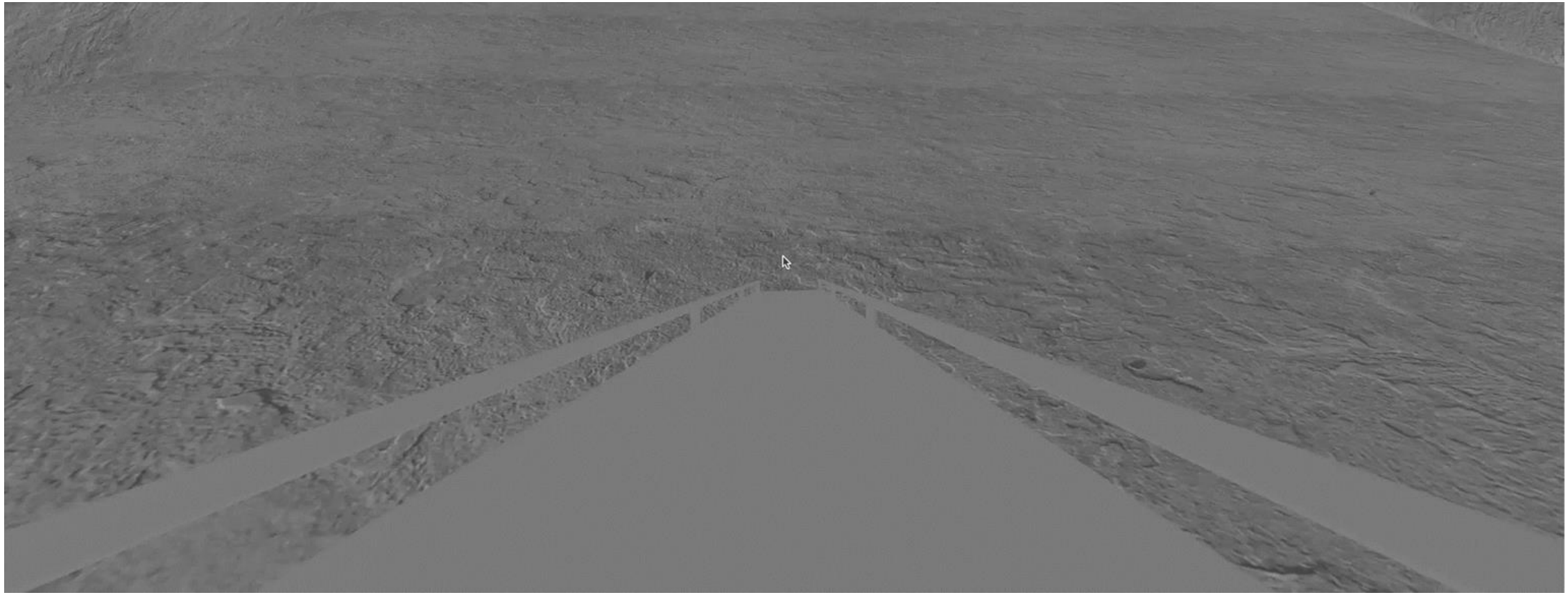



Chappaz et al.

# Extraterrestrial Habitat Virtual Reality



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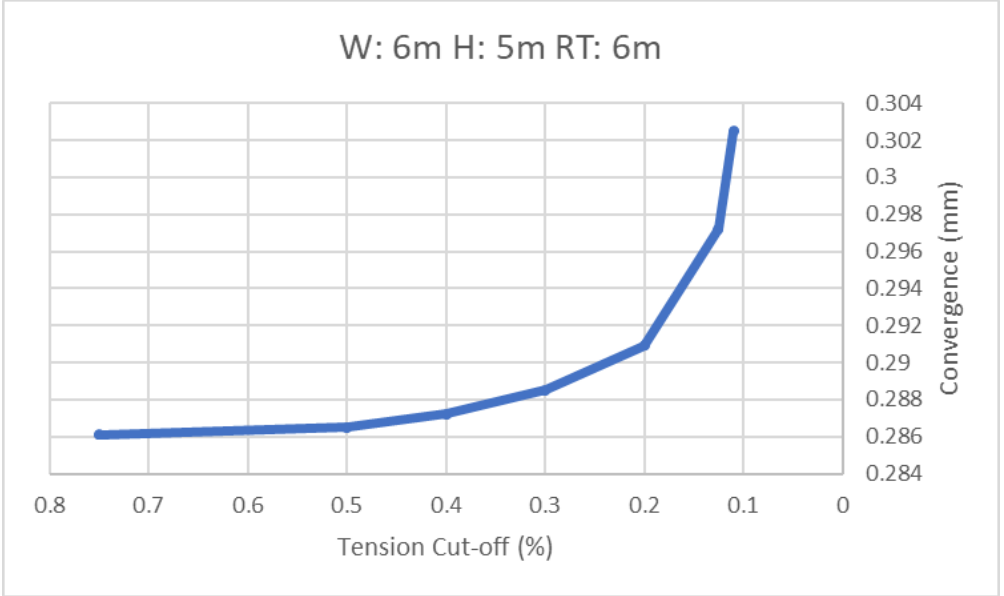
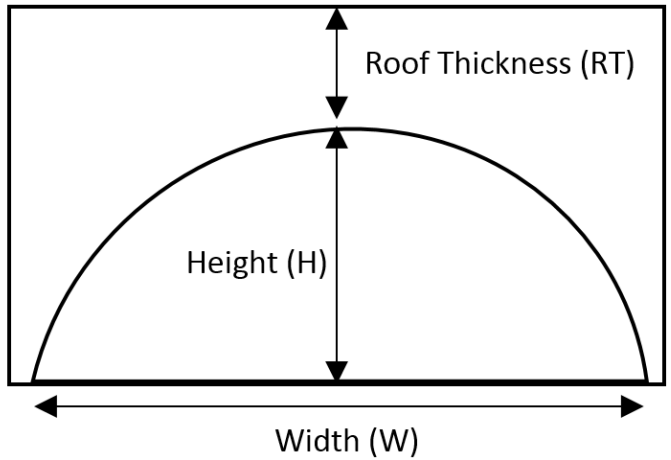
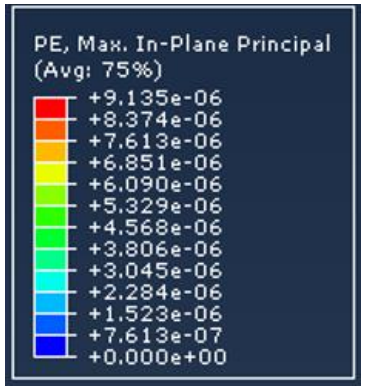
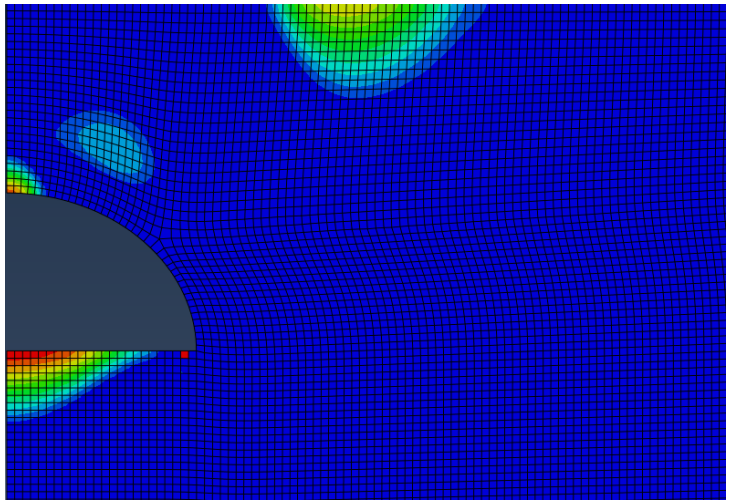
# Hawaiian Lava Tubes

- Tension Cut-off
  - Tensile Stress / Compressive Stress
- Geological Strength Index (GSI)
  - Value 0 – 100 to measure strength
  - Stable Tension Cut-off of 3% for GSI of 70
- Convergence
  - Difference between displacement in top and bottom of lava tube



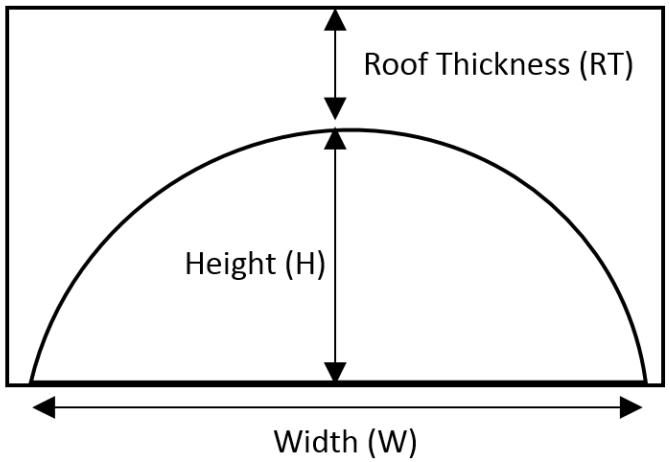



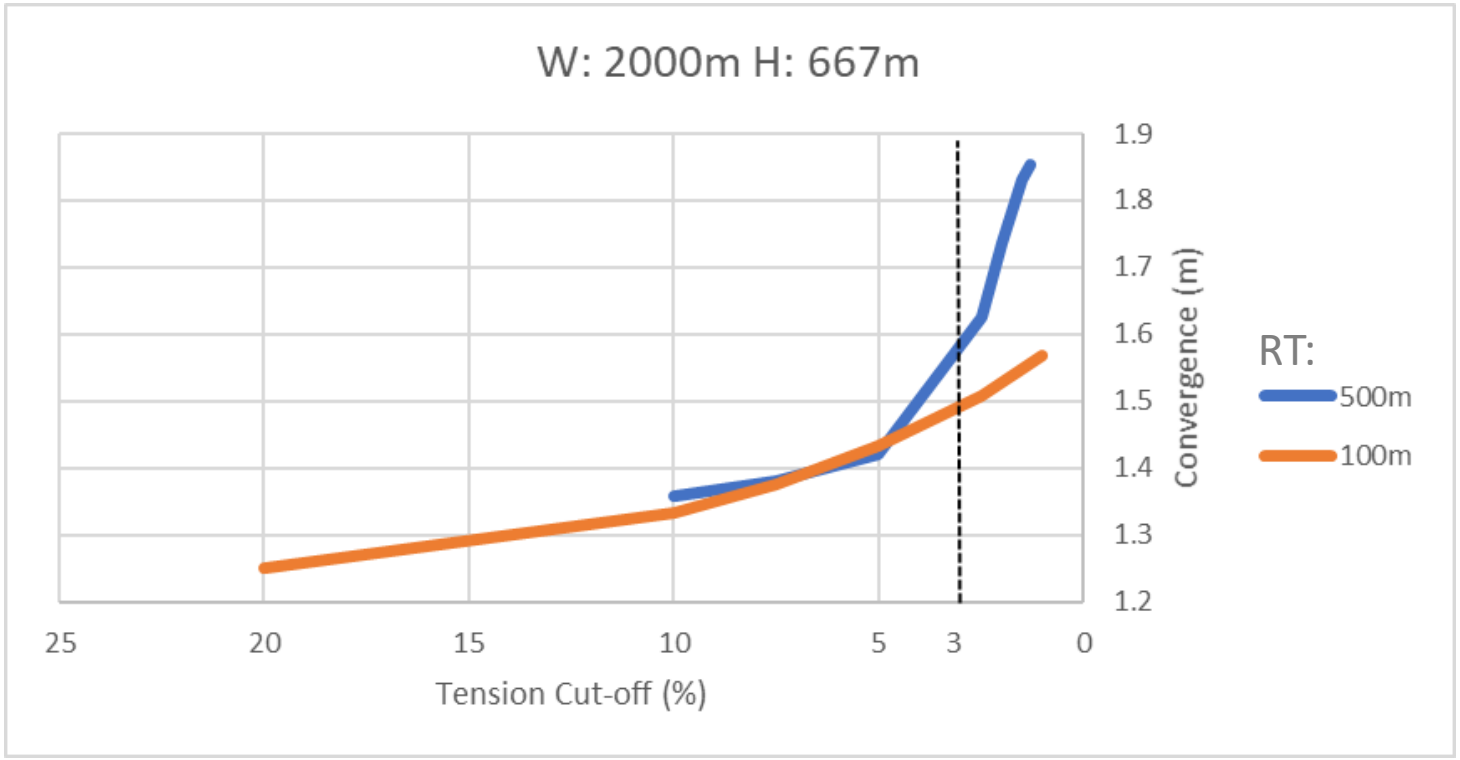



# Lunar Lava Tubes

- Geological Strength Index (GSI)
  - Stable Tension Cut-off of 3% for GSI of 70



# Conclusions

- Lava tubes could potentially house an extraterrestrial habitat
- Hawaiian lava tubes help in understanding their lunar counterparts
- Lunar lava tubes can be stable up to several kilometers wide

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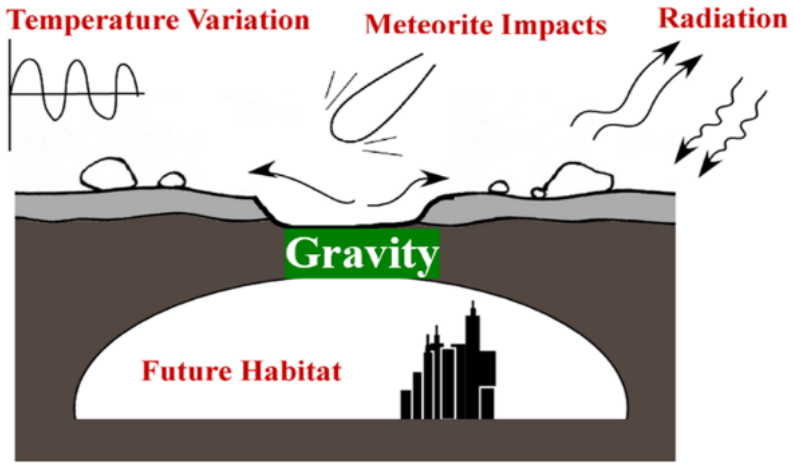
# Future Work

- Exploring lunar lava tubes via probes or manned missions
- Further investigating morphology and formation
- Determining impact of hazards on lava tubes

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# Thank you!

Purdue.edu/reth
justj@purdue.edu

RETH

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- Bunnell, Dave. “Classic Lava Tube Passage.” *TwistedSifter,* 2006.
- Peterson, D. W., et al. (1994). Development of lava tubes in the light of observations at Mauna Ulu, Kilauea Volcano, Hawaii. *Bulletin of Volcanology*, *56*(5), 343-360.

# Lava Tube Stability [Backup]

- Stability classifications
  - Stable: No yielding
  - Quasi-stable: < 50% yielding
  - Unstable: > 50% yielding