Effect of Induced Seismicity of Indirect Meteorite Impacts on the Stability of Lunar Lava Tubes

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Lunar lava tubes can provide immediate protection against surface hazards

Hazards for Lunar Habitation

Evidence of Lava Tubes

• Lunar Reconnaissance Orbiter (LRO) and SELEnological and EngiNeering Explorer (SELENE) images of skylights near the volcanic areas and sinuous rills (Robinson et al., 2017)

• Gravity Recovery And Interior Laboratory (GRAIL) mass deficit region (hot colors) near the skylight (Chappaz et al., 2017)

• Lunar Radar Sounder (LRS) echo pattern (hot colors) near the skylight (Kaku et al., 2017)

• SELENE-Kaguya/LRO-LOLA morphometric analysis of collapses (skylights and pit chains) (Sauro et al., 2018)

Structural Stability of Lava Tubes

• Static analysis:
  Effect of size, roof thickness, and material strength

  • Model set-up in ABAQUS
  • Convergence criterion, difference in radial displacements of crown and invert

• Dynamic analysis:
  Effect of impact-induced seismic events

  • Predictions of lunar meteorites (main source of seismicity)

  • Modeling induced seismicity using iSALE (Melosh et al., 1992)

  • Motion history from iSALE at 15.75 m distance from meteorite impact

  • x-velocity (m/s)
  • y-velocity (m/s)
  • x-acceleration (g)
  • y-acceleration (g)

Structural Stability of Lava Tubes

Future Direction

Analyzing the structural stability of lunar lava tubes under the effect of impact-induced seismic events:

• Using finite element method software ABAQUS

• Lava tube dimension (width: 1000 m, height: 333 m, roof thickness: 100 m)

• Basalt material properties and GSI 70

• Importing velocity history from iSALE as the boundary condition in the left lateral boundary of the ABAQUS model

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