Advancing to Lunar Lava Tube Sensing: A New Radar Perspective of Philolaus Skylight Candidates

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Rationale

A new radar perspective enables plausible identification of water/ice associated with lunar lava tube and skylight candidates of the Philolaus crater.

- Polar selenographic location urges the need for further exploration into the floor through dedicated rover mission.
- LRO NAC images provide evident clues of skylight candidates, suggestive of possible lava tube in the nearby location [1]-[3].
- Incorporating S-band MiniRF data to understand the behavior of an electromagnetic wave with the regolith.
- Higher penetration of the radar wave allows delineating subsurface features, not observable in optical images.

Philolaus Skylights

Propinquity to the North pole.

Crisscrossing sinuous rilles over the impact melt deposits on the floor.

Among youngest lunar lava flows.

Uncollapsed sections of rilles exhibit rimless circular depressions (or pits) called lava tube skylights [4]. [5].

Potential source of volatiles within subsurface cavities, an entrance to the lunar attic.

Proposed Framework

MiniRF CTRL data are converted to the Stokes parameters after extracting horizontal and vertical polarization channels. The scattering mechanisms are retrieved through m-Chi decomposition of the received Jones matrix. The data analysis part involves analyzing volumetric scattering powers in conjunction with CPR measurements for the search of water/ice. NAC images are utilized for closely observing the terrain, avoiding any misinterpretations.

3D visualization of m-Chi decomposition (left) and CPR image (right). Mixed scattering mechanisms retrieved from populated microcraters on the floor. Enhanced volume scattering power observed from regions near prospective skylights. Black arrows in the SC and OC image track the plausible buried nonlinear inclusion, while white arrow locates the skylights. Evidence of water/ice in the proximal regions of skylights attributes to higher proportions of dipole-like features. This exhibits dominant volume scattering pattern and CPR value greater than 1. Source of water/ice is, however, not confirmed yet.

Findings

Confirmation of plausible water/ice near prospective skylight candidates.

Identification of buried lava tube (as nonlinear feature) in the vicinity of skylights from m-Chi decomposition image.

Enhanced volumetric scattering powers and CPR values from the lava pits, attributing to the mixture of dipole-like particles with regolith.

Future scope involves deriving petrophysical properties of the Philolaus crater floor using physics-based backscattering inversion models.

Spectroscopic data for assessing the contribution of space weathering processes to the detected water/ice signatures.

Shows the potential of radar imaging in lava tube sensing for subsequent detection of subsurface features associated with buried volatiles.

Acknowledgements & References

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