

Advancing Experimental Research and Instrumentation in the Laboratory in Understanding the Moon



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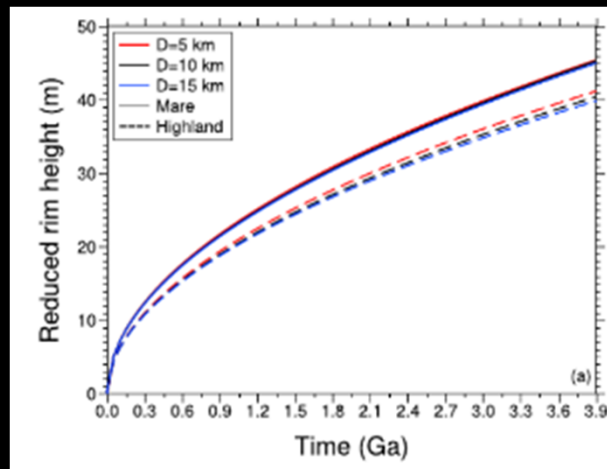
We recommend increased support for such laboratory research of the physical (rheological, thermal) and chemical (mineralogical, isotopic) properties of lunar material, especially being relevant to future space missions to the Moon and extend our knowledge of these lunar materials in experimental settings.

Why lab work?

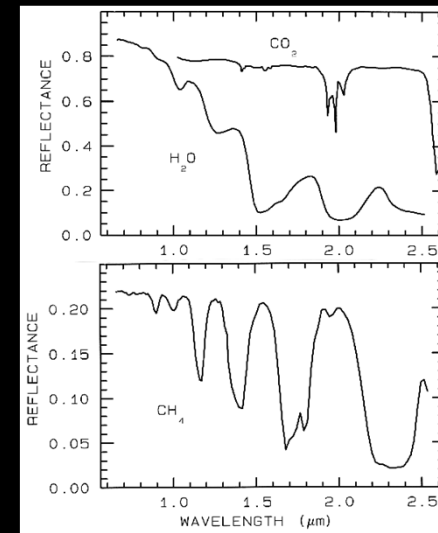


Ground-based, Fly-by, Orbiter Mission Data

Modeling Simulations



Experimental Research



Why lab work?

- Supplement ground-based, orbital, lander observations
- Enhance our understanding of samples brought back from the Apollo-era
- Advance our sampling technologies
- Models can only provide so much...

Lab objectives for lunar science

- Regolith studies / simulant synthesis
- Thermophysical properties & grain physics
- Spectroscopy
- Isotopic constraints
- Magnetic effects
- Irradiation effects
- Sample return handling
- Improvement of instrumentation (lab vs lunar)

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- Ground-based, Fly-by, Orbiter, Astronautic
 - UV/VIS/IR spectroscopy
 - Density
 - Radiometer
 - Radar
 - Sample return

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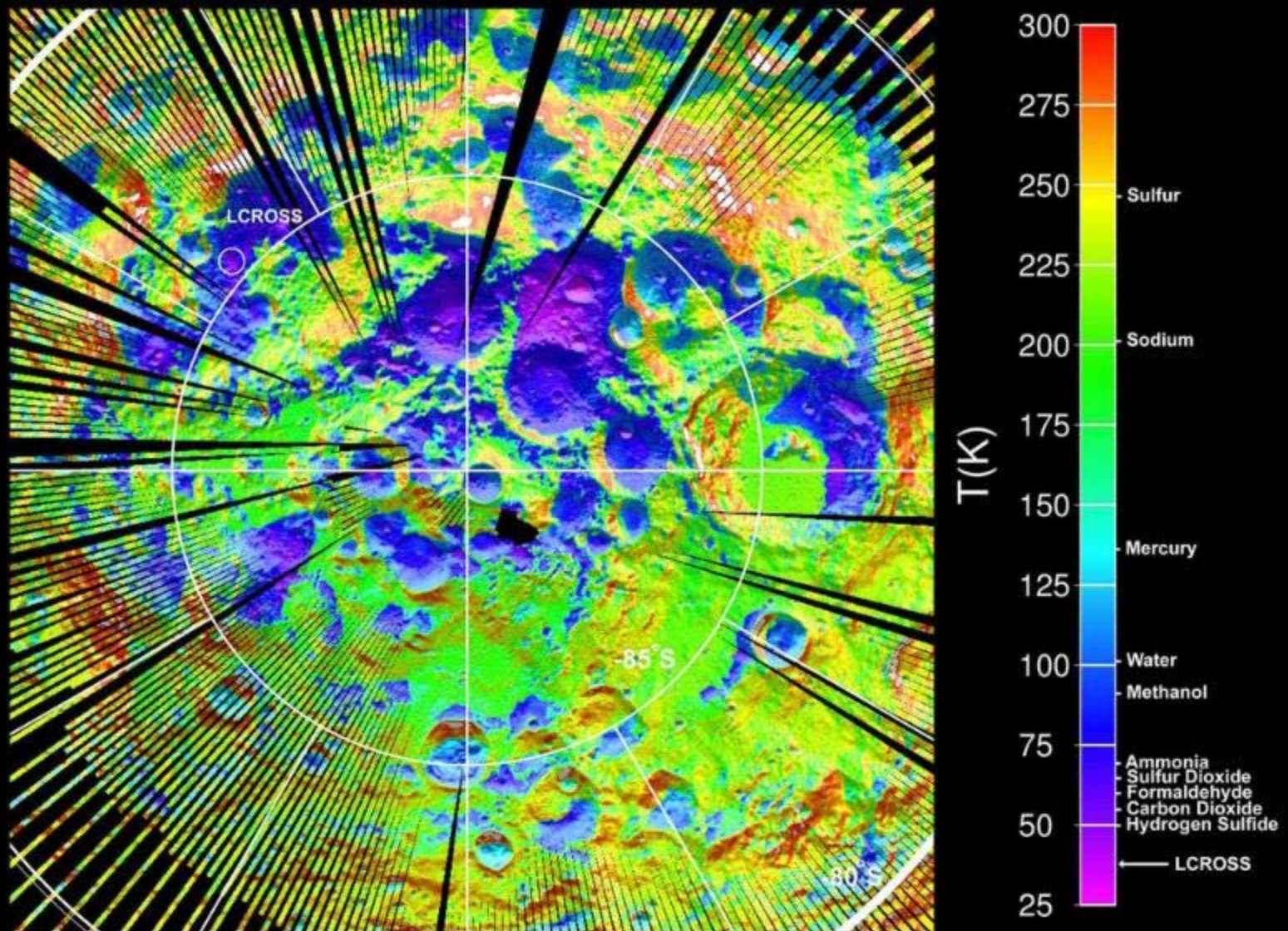
- **Modeling**

- Thermal evolution
- Regolith layering
- Buoyancy of material
- Mineral endmember weathering/evolution over longer timescales
- Volatile interactions
- Spectral radiative transfer

Example: *What are the regolith properties?*

- **Laboratory**

- Thermophysical (density, heat capacity, conductivity, latent heat)
- Dielectric
- Acoustic
- Particle size distribution/evolution
- Optical maturity
- Spectroscopy



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- Lunar magma ocean
 - Isochron dating, laser ablation spec of samples, High T/P crystallization, UV/VIS/IR of lunar anorthosites/KREEP basalts/terrestrial analogs
- Impact cratering
 - Impactor experiments, compressional/shear stresses, thermal relaxations, impacts of stratified units

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- Lunar swirls
 - Geochemistry and mineralogy
 - Ion sputtering
- Lunar interior
 - Compressional/shear stresses
 - Acoustic velocities of different materials
 - Low-T seismometers

Key challenges

- Time & funding
- Lab preparation of lunar samples
- Careful recreation of lunar regolith simulants
- Instrument construction, calibration, analysis
- Simulating vacuum environment
- Simulating shorter geologic timescales
- Reproducibility!

Recommendations

- Improvement of coordination between laboratories and improvement of networking and understanding lunar material science
- Establishment of a laboratory-sharing database (e.g., Planetary Data System)
- Support the role of experimental research as a key component for lunar exploration
- Increased inclusion and representation from the laboratory research community within respective professional societies and assessment groups
- Increased provisional funding inside mission proposals to support supplementary/complimentary laboratory work dedicated to support mission-critical instrumentation