Percussive Hot Cone Penetrometer (PHCP) and Ground Penetrating Radar (GPR) for Geotechnical and Volatiles Mapping

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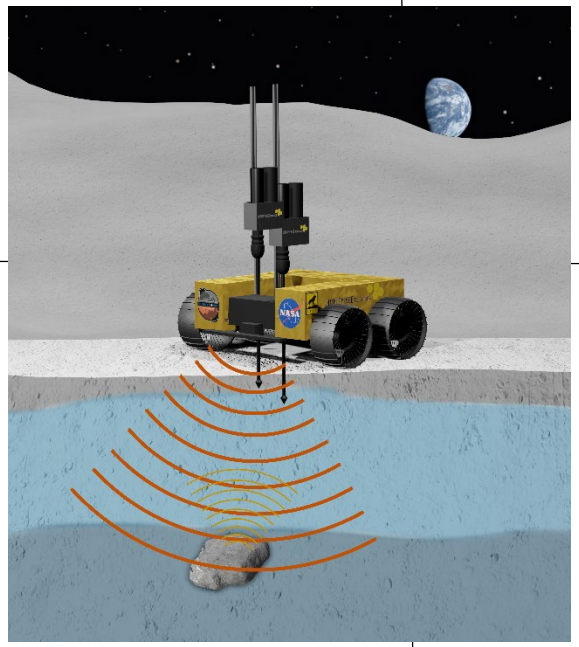
Development Objectives

Planned accomplishments: Using differential scanning calorimetry in two percussive cone penetrometers in combination with GPR to determine the type, concentration and vertical and lateral variation in volatiles in the lunar regolith by using thermal profiles and cycling. A dataset of thermal release profiles of cryogenically frozen regolith infused with volatiles will be a major objective.



Current state of the art in-situ measurements cannot uniquely determine what volatiles are present while determining geotechnical properties. No volatile release profile database exist currently.

The lowest component TRL is 3 and after testing we plan to be at TRL 5/6

Approach

Concept: Combine a percussive cone penetrometer with heaters and sensors, and GPR to determine spatial distribution of ice in subsurface, and geotechnical properties of the regolith.

Research:

- **Simulant prep & volatile thermal characterization**
- **Thermal cone instrumentation and thermal profiling**
- **Geotechnical property calibration and cone selection**
- **GPR calibration and ice, rock, layering detection**
- **Integrate final hardware. Perform TVAC and field tests**

Impact and Infusion

The proposed research will provide a dramatic improvement in the direct in-situ measurement of ice concentration with depth at accuracy of 0.1 wt% at 10 cm vertical intervals. GPR (once calibrated by in-situ measurements) would provide continuous measurement. This will directly inform follow-on missions to the lunar surface and design of the ice mining and extraction equipment

The PHCP will be deployed from TRIDENT-based hammering drill system (designed for VIPER). As such, PHCP could fly on VIPER 2.0 in 2024 or 2025. This mission would directly inform the goals of 2028 sustainable lunar presence with mining of polar water ice. Synergy with Astrobotic's SBIR funded GPR development effort would also be possible.