LUNAR PERISCOPE: A PROBE FOR EXPLORING REGOLITH AND ICE BY SUBSURFACE CLASSIFICATION OF ORGANICS, PAHS, AND ELEMENTS.

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Introduction: Artemis III will explore the south-polar region of the Moon. One of the mission's primary goals is to characterize polar volatile deposits [1–5]. In-situ and return sample investigations are required to thoroughly investigate the distribution, abundance, composition, state, origins, timing, and subsequent evolution of water and other volatiles in the inner Solar System. However, refrigeration, required for preserving volatile and organic compounds in drive tube cores, will not be ready for Artemis III.

The Probe for Exploring Regolith and Ice by Subsurface Classification of Organics, PAHs, and Elements (PERISCOPE) addresses these challenges by enabling in-situ surface and subsurface measurements (Figure 1). Its compact nature enables it to be carried on small landers or deployed by astronauts. PERISCOPE provides rapid, in-situ subsurface chemical and volatile abundance measurements of borehole walls—effectively measurements of a cored sample. In addition, PERISCOPE's ability to conduct fluorescence imaging of surface materials can inform real-time pointing of rover-based instruments and site selection for sample acquisition. Therefore, PERISCOPE provides analyses that can inform real-time exploration of the lunar surface and downstream measurements of returned core material.

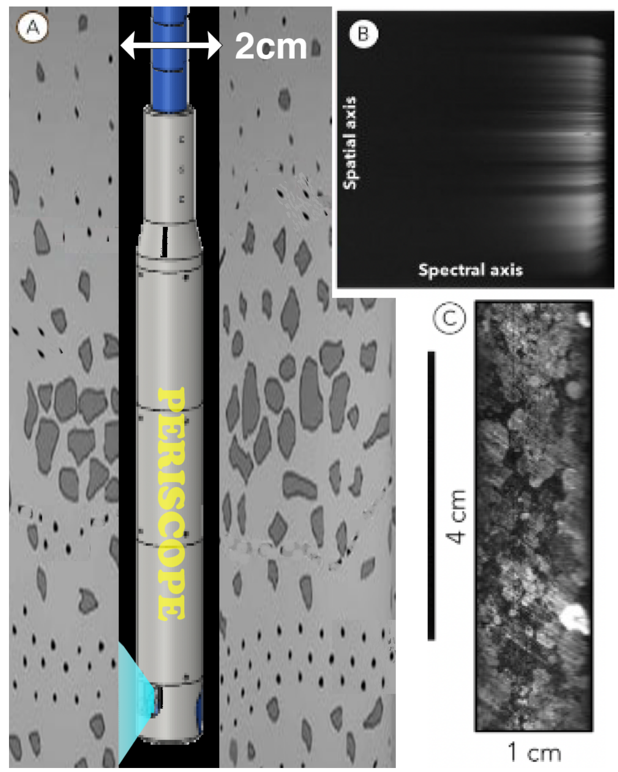

Figure 1. *(A) The PERISCOPE optical probe is lowered through a borehole; (B) Example of a full-frame hyper-spectral image; and (C) Resulting reconstructed hyper-spectral image obtained by integrating regions of 400 images similar to (B) that constitute the full dataset.*

Key Components: We are qualifying PERISCOPE to TRL 5 with SBIR funding. The probe's optical design enables surface and subsurface measurements in a compact package without moving parts. PERISCOPE features an active UV laser illumination source, a fluorescence imaging spectrometer, and a novel downhole optical probe. Ultraviolet light (257 nm) is generated by frequency doubling the 515 nm light from a 1 ns pulsed laser. An imaging spectrometer measures the resulting emission and records spatial and spectral information (Figure 1). The active illumination yields spatially resolved compositional mapping with 100 µm precision over cm-scale areas.

Discussion: UV-generated luminescence measured by the spectrometer yields the distribution of three priority regolith components: 1) water content (liquid, ice, and bound in minerals); 2) rare-earth elements; and 3) trace organic compounds like those detected by LCROSS (e.g., methane, ammonia, and ethylene [6]). PERISCOPE seeks to detect volatile substances in core material before they degas. Therefore, PERISCOPE is a powerful lunar surveying instrument for rapidly determining volatile ice content, REEs, and organics [7] in lunar surface and subsurface materials.

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