2023 Technology Showcase for Future NASA Planetary Science Missions
PERISCOPE: Technology for organic detection in the near subsurface

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PERISCOPE Innovation, Maturity, and Development: PERISCOPE is an instrument for in situ detection, characterization, and spatial mapping of aromatic organic compounds in the subsurface using ultraviolet (UV) spectroscopy. PERISCOPE's downhole probe can be sized in accordance with high-TRL planetary drills, and the instrument development is pursuing low-SWaP commensurate with New Frontiers, Discovery, and SIMPLEx missions.

PERISCOPE has been funded through NASA SBIR (Contract No. 80NSSC20C0456) Phase I (completed) and Phase II (planned to conclude mid-2023). The instrument reached TRL4 at the completion of Phase I, and key subsystems are currently being developed to TRL 5 under Phase II, targeting environmental testing under Mars-relevant conditions. Preliminary lab testing has characterized detection limits of organics relevant to astrobiology. PERISCOPE has been successfully deployed to the Gilkey Glacier, AK, validating capabilities including 1) in situ borehole scanning of the ice; 2) UV florescence hotspot detection; 3) real-time rapid data processing and analysis.

Key PERISCOPE Technologies:

1. **UV-NIR Optical probe.** A novel UV-NIR optical probe directs illumination light onto a sample surface (e.g. the wall of a borehole) in a narrow line. The probe may be fiber coupled to the spectrometer, enabling meter-scale separation between the probe and spacecraft body.
2. **Hyperspectral UV imaging spectrometer.** PERISCOPE includes a compact hyperspectral UV-VIS-NIR imaging spectrometer for hyperspectral UV-VIS-NIR (276 nm to 850 nm) mapping of the borehole interior or across a sample surface.
3. **UV fluorescence and VIS-NIR imaging.** PERISCOPE detects organics in situ using UV spectroscopy. UV fluorescence instruments can be sensitive to trace concentrations of many aromatic organics[1], including PAHs[2], aromatic amino acids, and microorganisms[3]. The technique can be rapid and non-invasive[4]. PERISCOPE includes a broadband LED, used to obtain VIS/NIR hyperspectral maps over the same region scanned with the ultraviolet capability, providing a visible context image of the borehole wall, co-locating organic material within its context.

Relevance to 2023 Tech Showcase mission concepts: PERISCOPE is most relevant to missions which include 1) organic detection or astrobiological science objectives, 2) near-subsurface drilling to meter-scale depths, and 3) missions to rocky or icy environments. Key subsystems (spectrometer and optical probe) are low-SWaP and suitable for small-scale missions. Detection of aromatic organic compounds, including PAHs and aromatic amino acids, may complement other organic or geochemical detection

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[2] E. Eshelman, et al. Detecting aromatic compounds on planetary surfaces using ultraviolet time-resolved fluorescence spectroscopy. Planetary and Space Science, 151:1-10, 2018.
[3] L. Beegle et al., "SHERLOC: Scanning habitable environments with Raman & luminescence for organics & chemicals," in 2015 IEEE Aerospace Conference, 2015.
[4] R. Bhartia et al., "Label-Free Bacterial Imaging with Deep-UV-Laser-Induced Native Fluorescence," Applied and Environmental Microbiology, vol. 76, no. 21, pp. 7231–7237, Sep. 2010.

payloads. PERISCOPE may perform a surveying role when performing in situ scanning, informing sample selection and identifying locations with probable organic content. Mission concepts meeting one or more of these criteria include Mars Icebreaker, Mars Life Explorer (MLE), and Abzu: A Mission to Uncover the Origin of Ancient Organics on Mars.

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