# Regional Prospecting of Lunar Polar Water Resources Using the Polar Volatile Mapper (PVM) Mission


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## Exploration Context & Science Rationale

The lunar south pole is a primary target for Artemis-era exploration and ISRU due to the presence of permanently shadowed regions (PSRs) that can preserve water ice over geologic timescales. These environments are believed to contain accessible volatile resources critical for life support, propellant production, and sustained surface operations.

•Volatiles confirmed:
LCROSS (ice detection), Chandrayaan-1 (hydration), LRO (cold traps, hydrogen)

•Current limitation:
Orbital datasets lack site-scale resolution and subsurface insight

•Mission gap:
VIPER → high fidelity, limited coverage
Loss of Lunar Trailblazer → reduced orbital mapping capability

PVM addresses this gap by enabling co-registered surface and subsurface measurements through targeted low-altitude orbital passes, supporting meter-scale resource mapping and ISRU site certification at the lunar south pole.

## Mission Concept

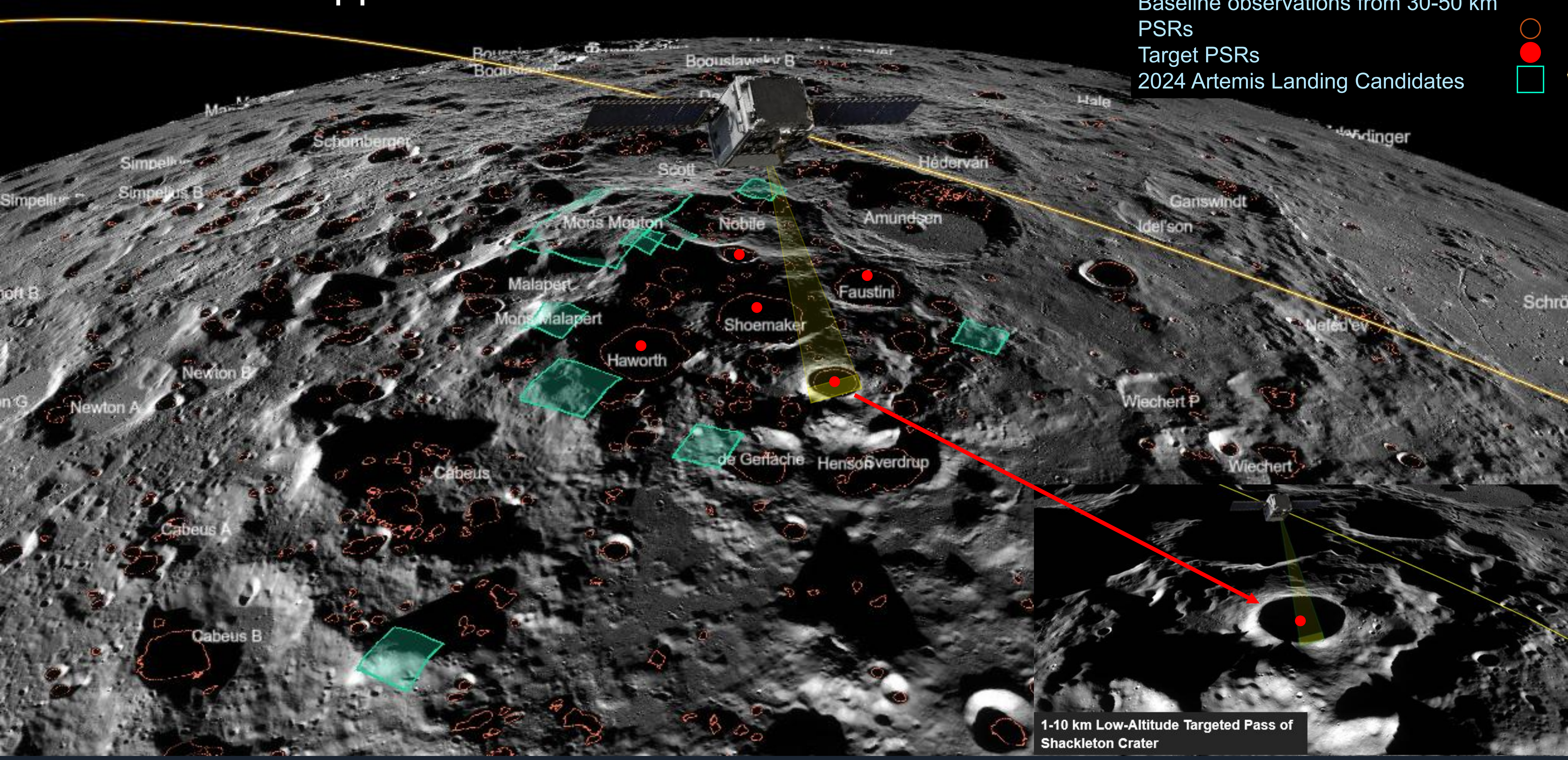
PVM is a **SmallSat-class lunar orbiter** optimized for polar resource mapping. Its key features:

**Hybrid orbit:** A 30–50 km polar baseline orbit for regional coverage, plus repeated **1–10 km "SLALOM" passes** over high-value craters (e.g. Shackleton, Cabeus, Shoemaker, Faustini). These low-altitude passes (conceptual sketch below) achieve meter-scale resolution while covering dozens of PSRs.

**Payload:** A compact high-resolution suite inspired by Trailblazer:

- **Visible–SWIR imaging spectrometer** maps OH/H2O spectral features.
- **Thermal infrared imager** measures surface and near-subsurface temperatures to identify cold traps.
- **Ground-Penetrating Radar (GPR):** a P-band radar providing subsurface profiles.
- **Context Camera:** a high-res optical camera for surface morphology and targeting.

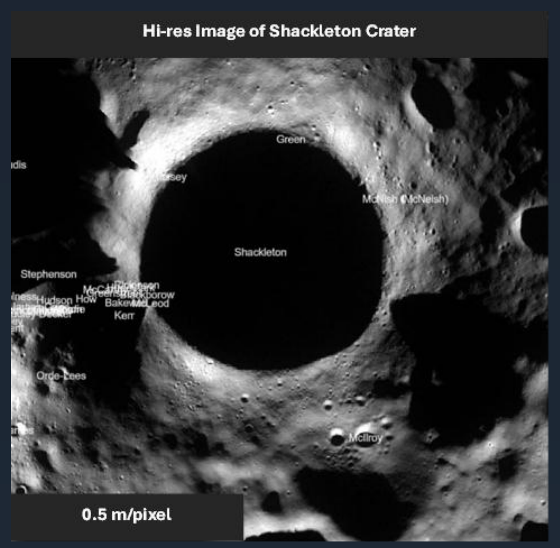
## Polar Volatile Mapper

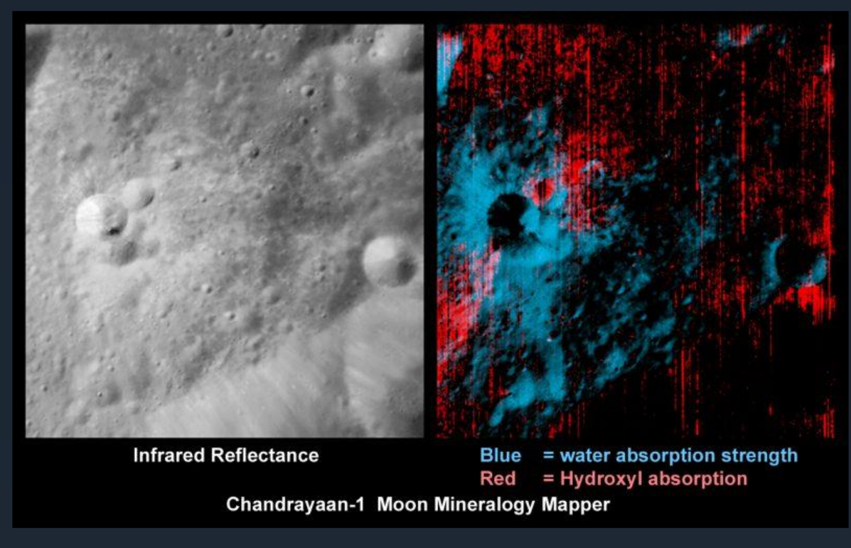


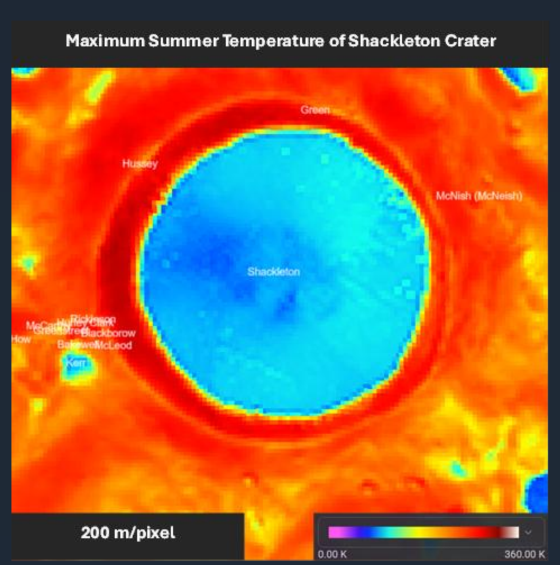

## Instruments & Performance

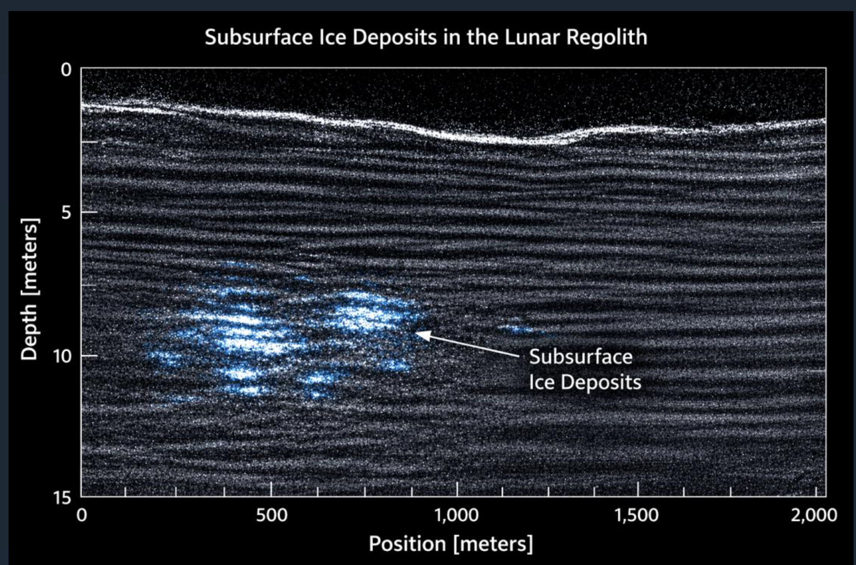
| Instrument | Measurement | Resolution (30–50 km) | Resolution (1–10 km) | Swath Width | Key Performance |
|---|---|---|---|---|---|
| **VSWIR Spectrometer** | Surface OH/$H_2O$, mineralogy | 30-80 m/pixel | **1-10 m/pixel** | 1-5 km | 0.4-3.6 µm, 10-20 nm spectral res, SNR >150 |
| **Thermal IR Mapper** | Temperature, thermal inertia | 50-100 m/pixel | **5-15 m/pixel** | 2-6 km | 7-14 µm, ±2-5 K accuracy |
| **Ground-Penetrating Radar** | Subsurface structure, ice | ~50-200 m (horizontal) | **10-100 m (horizontal)** | 1-5 km | **5-15 m depth,** 1-3 m vertical resolution |
| **Terrain Imager** | Surface morphology, context | 10-30 m/pixel | **0.5-5 m/pixel** | 3-10 km | Visible imaging, high-res context |

## Example Data Products




Top Left: High-res image of Shackleton crater from LRO Camera.
Bottom Left: Maximum Summer Temperature of Shackleton crater from LRO Diviner Instrument.
Top Right: Chandrayaan-1, M³-derived hydration map of the lunar south polar region.
Bottom Right: Notational radargram from PVM GPR instrument.

## References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Lunar surface images proivded by ACT Lunar Quick Maps


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