**RESOURCE PROSPECTOR, THE DECADAL SURVEY AND THE SCIENTIFIC CONTEXT FOR THE EXPLORATION OF THE MOON.** R. C. Elphic[1], A. Colaprete[1], and D. R. Andrews[1], [1]NASA Ames Research Center, Moffett Field, CA 94035 USA.

**Introduction:** The Inner Planets Panel of the *Planetary Exploration Decadal Survey* [1] defined several science questions related to the origins, emplacement, and sequestration of lunar polar volatiles:

1. What is the lateral and vertical distribution of the volatile deposits?
2. What is the chemical composition and variability of polar volatiles?
3. What is the isotopic composition of the volatiles?
4. What is the physical form of the volatiles?
5. What is the rate of the current volatile deposition?

A mission concept study, the *Lunar Polar Volatiles Explorer (LPVE),* defined a ~$1B New Frontiers mission to address these questions.

The NAS/NRC report, *"Scientific Context for the Exploration of the Moon"* [2] identified he lunar poles as special environments with important implications. It put forth the following goals:

- Science Goal 4a—Determine the compositional state (elemental, isotopic, mineralogic) and compositional distribution (lateral and depth) of the volatile component in lunar polar regions.
- Science Goal 4b—Determine the source(s) for lunar polar volatiles.
- Science Goal 4c—Understand the transport, retention, alteration, and loss processes that operate on volatile materials at permanently shaded lunar regions.
- Science Goal 4d—Understand the physical properties of the extremely cold (and possibly volatile rich) polar regolith.
- Science Goal 4e—Determine what the cold polar regolith reveals about the ancient solar environment.

**Resource Prospector:** In 2014, HEOMD Advanced Exploration Systems initiated a Phase A study of Resource Prospector, a lunar polar mission that would address many of the open science and engineering questions surrounding lunar polar volatile deposits. Resource Prospector would, like LPVE, use a mobility system to explore the physical form, composition, spatial distribution scales, and likely origins of polar volatiles. The primary mission requirements focus on characterizing lunar polar volatiles as an ISRU resource. But the RP objectives also address Decadal and SCEM questions and goals, as shown in the following two tables:

| Decadal Science Questions | Resource Prospector Capability |
|---|---|
| 1. What is the lateral and vertical distribution of the volatile deposits? | Lateral: Neutron spectroscopy of water-equivalent hydrogen concentration in top 1-m of regolith throughout entire traverse; Imaging and NIR spectra of surface while roving. |
| | Vertical: Neutron spectroscopy of water-equivalent hydrogen concentration in top 1-m of regolith; NIR spectra of drill cuttings, GC/MS of samples from different depths |
| 2. What is the chemical composition and variability of polar volatiles? | Chemical: Imaging and NIR spectra of surface and subsurface materials (drill cuttings), GC/MS of volatile vapor from samples, including isotopic analysis. |
| | Variability: NIR spectra and GC/MS analysis of drill samples acquired at multiple locations separated by 10 - 100's meters. |
| 3. What is the isotopic composition of the volatiles? | GC/MS of volatiles driven off of samples provides isotopic analysis. |
| 4. What is the physical form of the volatiles? | Imaging and NIR spectra of surface and subsurface materials (drill cuttings), GC/MS of volatile vapor from samples. |
| 5. What is the rate of the current volatile deposition? | No direct measurements |

| SCEM Goals | Resource Prospector Capabilities |
|---|---|
| Science Goal 4a-Determine the compositional state (elemental, isotopic, mineralogic) and compositional distribution (lateral and depth) of the volatile component in lunar polar regions. | GC/MS analysis of surface and subsurface volatiles reveals chemical and isotopic composition; NIR spectra reveal mineralogy; Neutron spectroscopy provides lateral and approximate depth distribution; NIR spectra of extracted drill cuttings provides vertical distribution, as does GC/MS analysis of samples from depth. |
| Science Goal 4b-Determine the source(s) for lunar polar volatiles. | Chemical and isotopic composition reveal sources; imagery of physical state and NIR spectra inform emplacement mechanism. |
| Science Goal 4c - Understand the transport, retention, alteration, and loss processes that operate on volatile materials at permanently shaded lunar regions. | Drilling/sampling within PSRs: Chemical and isotopic composition reveal likely sources; imagery of physical state and NIR spectra inform emplacement mechanism. |
| Science Goal 4d-Understand the physical properties of the extremely cold (and possibly volatile rich) polar regolith. | Rover slip vs slope, drill penetration force and augering torque with depth, and imaged rover wheel/surface interaction provide geotechnical info. |
| Science Goal 4e-Determine what the cold polar regolith reveals about the ancient solar environment. | Not directly addressed by RP. |

**References:**

[1] https://solarsystem.nasa.gov/docs/131171.pdf (Visions & Voyages).

[2] https://www.nap.edu/catalog/11954/the-scientific-context-for-exploration-of-the-moon.