

Multi-Lunar Day Polar Missions with a Solar-Only Rover. A. Colaprete¹, R. C. Elphic¹, M. Shirley¹, M. Siegler²,
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Introduction: Resource Prospector (RP) was a lunar HEOMD/Advanced Exploration Systems volatiles prospecting mission developed for potential flight in the early 2020s. The mission includes a rover-borne payload that (1) can locate surface and near-subsurface volatiles, (2) excavate and analyze samples of the volatile-bearing regolith, and (3) demonstrate the form, extractability and usefulness of the materials. The primary mission goal for RP is to evaluate the In-Situ Resource Utilization (ISRU) potential of the lunar poles, to determine their utility within future NASA and commercial spaceflight architectures. While the current RP rover design did not require a system that could survive lunar nights, it has been demonstrated that the current design could conduct multi-lunar day missions by taking advantage of areas that receive prolonged periods of sunlight (short lunar nights).

Mission Goals and Rover System Design: While it is now understood that lunar water and other volatiles have a much greater extent of distribution, possible forms, and concentrations than previously believed, it is essential to fully understand how viable these volatiles are as a resource to support human exploration of the solar system. Specifically, the distribution and form needs to be understood at a “human” scale. That is, the “ore body” must be better understood at the scales it would be worked as a mining operation before it can be evaluated as a potential architectural element within any evolvable lunar or Mars campaign. To this end the primary mission goals for RP are to (1) provide ground truth for models and orbital data sets, including temperatures at small scales, subsurface temperatures and regolith densities, surface hydration and hazards (rocks and slopes), (2) correlate surface environments and volatiles with orbital data sets to allow for better prediction of resource potential using orbital data sets, and (3) address key hypotheses regarding polar volatile sources and sinks, retention and distribution, key to developing economic models and identifying excavation sites

The RP rover system was designed to be as simple as possible (low cost and risk) while still meeting these requirements. Detailed analysis of traverses, including rover models that include power, data and mobility models, has found that a solar powered rover with Direct to Earth (DTE) communications could meet all mission goals within one Lunar day (mission length 10-12 Earth days). Therefore, the simplest design utilizes only solar power with no radiogenic heating (e.g., Radioisotope Thermoelectric Generators or RHUs) or other non-solar power systems.

Polar Solar “Oases”: Numerous studies have identified regions near the lunar poles that have sustained periods of solar illumination. In some places these periods of sustained sunlight extend across several lunations, while others have very short (24-48 hours) nights. A study was conducted to evaluate if the RP rover system could take advantage of these “oases” to survive the lunar night. While the Earth would set, as seen by the rover, every approximately 2-weeks, these “oases” could provide sufficient power, and have lunar-nights short enough, for the rover system to survive.

Results: The study focused in the area surrounding the north pole crater Hermite-A (primarily due to the fidelity of existing traverse planner data sets in this area). Several possible locations in the area showed short nighttime periods (<48hours). Two examples were studied in detail, including power modeling, both surviving a single polar night, extending the total mission duration to over 46 Earth days. These examples saw considerable increase in overall science return, increasing the number of drill sites from 16 to as many as 40. It was concluded that these traverse types were available at both the north and south pole, and likely can extend to 2.5 to 3 lunations while not making any modification to the existing RP rover system design. However, relatively minor augmentation/changes to the RP rover design, including the use of passive thermal switches and a modest number of RHUs, would likely greatly expand the number of locations and mission durations. This talk will summarize the approach for identifying these areas and review the two examples cited above.

Example of a North Pole Multi-Lunar Day Traverse
(map layer is net sunlight)

