SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Systems and Infrastructures to Implement Future Building Blocks in Space Exploration and Development (2)

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LUNAR PROSPECTING USING THERMAL WADIS AND COMPACT ROVERS PART B: A COLLABORATIVE INFRASTRUCTURE FOR DETERMINING THE RESOURCE POTENTIAL OF THE MOON

Abstract

From lunar orbit, recent remote sensing spacecraft have measured spectral signatures highly correlated with the presence of water and other volatiles on the Moon, both in permanently-shadowed polar craters and elsewhere. Non-volatile lunar resources may represent significant additional value as feedstock for manufactured goods or elements of an operational human-presence infrastructure. Characterization of these potential lunar resources in terms of abundance concentrations, distribution, and economical harvestability is limited to Apollo-era samples returned from low-latitude lunar surface locations and expanding remote-sensing sources. The resource potential of the moon is therefore still speculative but of great interest since the volatile resources alone, processed into mission consumables for propellant, life support, and power systems, could significantly improve the cost and sustainability of not only lunar exploration but also human operations in cis-lunar space and beyond. Moreover, lunar resource characterization is closely aligned with scientific studies of the Earth-moon system formation and evolution. Science-based resource prospecting over substantial regions of the moon, including the feasibility of harvesting, invites a significant change in the paradigm of robotic lunar/planetary surface exploration: evolving beyond unique, self-sufficient, short-lived probes with limited range in favor of multiple dispersed prospecting platforms with nighttime shelter. Implemented with a system of systems that are compatible or interchangeable, a distributed resource prospecting paradigm offers opportunities for collaboration between organizations of different types and nationalities. This paper summarizes an evolving approach to lunar resource prospecting utilizing a basic lunar surface infrastructure of fixed node locations to provide energy storage and other services to compact robotic prospecting vehicles. The approach centers around the Thermal Wadi concept of solar thermal energy storage for nighttime survival of robotic prospectors. Externally providing services unneeded while performing prospecting tasks simplifies robotic prospectors: reducing their size, complexity, and their cost of development and realization. A fully utilized infrastructure node, having standard servicing interfaces and capacity to support multiple vehicles, increases the geographical reach and coverage for resource characterization. Additionally, amortizing development investments over multiple standardized vehicles and adopting artificial intelligence capabilities for cooperative robotic prospecting amplify the affordability and effectiveness of this approach. The paper discusses the characteristics and operational establishment of infrastructure nodes, specific implications of this ap-

proach to robotic prospecting devices, transportation and lunar delivery of integrated infrastructure nodes and compact robotic prospector teams, and an updated overview of the value of utilizing native lunar resources to further the goals of scientific exploration of the moon and beyond.