Geophysical Exploration of the Dynamics and Evolution of the Solar System (GEODES)

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The Moon, near Earth asteroids, and the martian moons Phobos and Deimos are all Solar System Exploration Research Virtual Institute (SSERVI) target bodies as they present a wide variety of natural wonders and are potential hosts to resources that will one day enable human exploration of the Solar System. Our SSERVI project, Geophysical Exploration of the Dynamics and Evolution of the Solar System (GEODES) is exploring a suite of natural resources on these bodies through multidisciplinary geophysical investigations. Geophysical methods have been incredibly successful in identifying resources on Earth as they provide a means of characterizing and mapping the subsurface using data gathered on and above the surface. We focus our geophysical investigations on four essential resources that will enable future human space exploration: I) Lava tubes and void spaces, capable of hosting people and infrastructure; II) Ice deposits, subsurface bodies that can be used for volatile extraction; III) Regolith, which covers the surface of all target bodies, potentially serving as a building material but also presenting a hazard to human and robotic operations and health; and IV) Magma-tectonic Systems, which mobilize, concentrate, and trap volatiles, unique rocks, and ore minerals.

Our investigations use an "orbit to outcrop" approach by analyzing existing geophysical data, conducting geophysical exploration of field analog sites on Earth, and creating models that link these analog studies to SSERVI target bodies. Analog sites enable the development, ground-truthing, and integration of (a) exploration strategies, (b) multiple geophysical methods, and (c) modeling capabilities. The GEODES team is integrating field methods and results to create a scientific modeling framework that facilitates the joint inversion of data sets and will share these results with the community via cyber infrastructure, data management, and outreach. The unifying goal behind GEODES is to develop geophysical detection and exploration methods to characterize these natural resources and enable in situ resource utilization at SSERVI target bodies.