GEOPHYSICAL EXPLORATION OF THE DYNAMICS AND EVOLUTION OF THE SOLAR SYSTEM (GEODES). N. Schmerr[1], J. Richardson[1,4], R. Ghent[2], M. Siegler[3], K. Young[4], M. Wasser[4], P. Whelley[1,4], D. Buczkowski[5], L. Carter[6], C. Connor[7], L. Connor[7], J. Bleacher[4], M. Fouch[8], D. Baker[4], T. Hurford[4], L. Jozwiak[5], S. Kruse[7], V. Lekic[1], A. Naids[10], R. Porter[11], L. Montesi[1], D. C. Richardson[1], E. Rumpf[12], N. Schorghofer[3], J. Sunshine[1], S. Goossens[4,18], N. Whelley[1,4], D. Wyrick[9], W. Zhu[1], S. Jazayeri[7], E. Bell[1], J. DeMartini[1], E. Williams[1], D. Coan[10], D. Akin[1], B. Cohen[4], E. Mazarico[4], C. Neal[13], M. Panning[14], N. Petro[4], B. Strauss[4], R. Weber[15], T. Glotch[16], A. Hendrix[3], A. Parker[17], and S. Wright[3], [1]Univ. of Maryland, College Park, MD, USA (nschmerr@umd.edu), [2]Univ. of Toronto, Toronto, Canada, [3]Planetary Science Institute, Tucson, USA, [4]Goddard Space Flight Center, Greenbelt, USA, [5]Johns Hopkins Applied Physics Laboratory, Laurel, USA, [6]Univ. of Arizona, Tucson, USA, [7]Univ. of South Florida, Tampa, USA, [8]Samara/Data, Washington DC, USA, [9]Southwest Research Institute, San Antonio, USA, [10]NASA Johnson Space Center, Houston, USA, [11]Northern Arizona Univ., Flagstaff, USA, [12]USGS, Flagstaff, USA, [13]Univ. of Notre Dame, Notre Dame, USA, [14]Jet Propulsion Laboratory, Pasadena, USA, [15]NASA Marshall Space Flight Center, Huntsville, USA, [16]Stony Brook Univ., Stony Brook, USA, [17]Southwest Research Institute, Boulder, USA. [18]Univ. of Maryland Baltimore County, USA.

Introduction: Our SSERVI project, Geophysical Exploration of the Dynamics and Evolution of the Solar System (GEODES) is exploring a suite of natural resources on the Moon, near-Earth asteroids, and the martian moons Phobos and Deimos through multi-disciplinary geophysical investigations. Geophysical methods have been incredibly successful in identifying resources on Earth as they provide a means of characterizing and mapping the sub-surface using data gathered on and above the target structures. Our planned GEODES investigations will focus on four essential resources that enable future human space exploration and *in situ* resource utilization (IRSU): I) Lava tubes and void spaces, capable of hosting people and infra-structure; II) Subsurface ice deposits, 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.

Approach: GEODES aims to integrate multiple geophysical methods together to characterize natural resources and enable ISRU at SSERVI target bodies. The interpretation of geophysical methods is often non-unique or uncertain; interpretation is enhanced by combining diverse methods that are sensitive to complementary material properties. The combination of integrated observations and process-based theoretical modeling allows GEODES to link insights from Earth-based geophysical analogs to the environments present beyond Earth, and also to develop best practices for future geophysics exploration of ISRU targets (**Fig. 1**).

Analog Sites: Our team has identified three field sites that provide access and opportunities to: 1) validate models of near-surface structure in analog geologic settings (*e.g.*, lava flows, lava tubes, cinder cones), 2) test data collection methods in order to develop instrument and mission architecture recommendations, 3) determine the optimal scales of measurements to characterize resources, and 4) identify the observational overlap between outcrop-scale and orbital geophysical measurements. Upcoming 2020-2025 GEODES field expeditions will be to Lava Beds National Monument, northern California, the San Francisco Volcanic Field (SFVF), Flagstaff, Arizona, and the East Snake River Plain, southern Idaho, and targets in Hawaii and Iceland.

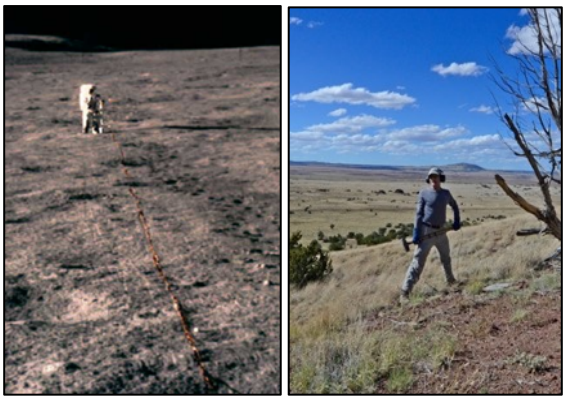

Figure 1. Left: Apollo 14 astronaut Edgar Mitchell operates the Thumper for the Active Seismic Experiment. Right: Astronaut Don Pettit prepares for an active source seismic shot in the SFVF that replicates the geometry of the lunar experiment. Image Credits. NASA, J. Richardson

Future Outlook: The Moon serves as a comprehensive testbed for extraterrestrial geophysics. Interest and opportunities for the next generation of geophysical experiments on the Moon are at an all-time high, including forthcoming NASA partnerships with commercial missions deploying equipment on the lunar surface, and the New Frontiers competition in which the Lunar Geophysical Network is a strong candidate. Extending lessons learned from the Moon to near-Earth asteroids and the moons of Mars is also of interest, as astronaut exploration of these bodies will provide a pathway forward for a human presence on Mars.