LEAG COMMUNITY SUPPORT FOR LUNAR RESOURCE EVALUATION AND UTILIZATION.

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Introduction: Lunar resources are internationally recognized as an essential aspect of facilitating continuous and sustainable human exploration on the lunar surface and throughout the solar system (e.g., [1]). In addition, the establishment of a cislunar economy, permanent lunar surface presence, and the use of space resources are national policy goals for the United States [2]. The significance of lunar resources has also been captured in numerous Lunar Exploration Analysis Group (LEAG) documents. These include reports from Specific Action Teams (SATs: where subject-matter community experts, tasked by NASA or LEAG leadership, examine a specific issue). However, the United States Lunar Exploration Roadmap (US-LER [3]) is the primary community-based guiding document that defines how lunar resources integrate into a path to address commercial, industrial, and scientific objectives for lunar and solar system exploration.

US-LER: The US-LER [3], a living document, represents a "cohesive plan for using the Moon and its resources" to explore cislunar space and other solar system locations. Resources are most significantly highlighted in the *Feed Forward* (i.e., use the Moon as a foundation to explore other targets) and *Sustainability* (i.e., extended human presence) themes, but are also included in the *Science* theme (e.g., volatile sources, transport, and deposition). The US-LER documents the need for specific investigations to be conducted according to time-phasing to maximize science and exploration return, plus commercial involvement.

VSAT & VSATII: The Lunar Volatiles SAT (VSAT, [4]) identified lunar polar regions that could be used to "understand the size, distribution, form, and resource potential of deposits of water ice and other volatiles," and was requested in support of international activities (e.g., Global Exploration Roadmap – GER [5]). Of note, the VSAT acknowledged the need for measuring geotechnical and thermal properties of regolith as a corollary to the volatile abundance. As a follow-up to VSAT, and the earlier GAP-SAT [6], LEAG and the International Space Exploration Coordination Group (ISECG) held a joint SAT to review NASA and international missions to address the viability of lunar volatiles as a resource at the south pole (VSATII, [7]). This report effectively demonstrated international support for assessing and utilizing lunar volatiles as resources and urged broad coordination and cooperation of volatile characterization, data-sharing, and the need for sample return and analysis.

NEXT-SAT: The Next Steps on the Moon SAT (NEXT-SAT, [8]) was chartered to assess potential missions to address new lunar science questions (i.e., lunar volatile budget). The report reiterates that lunar science is solar system science and that understanding the Moon's resource potential will influence our understanding of the broader solar system. Efficient resource assessment would ideally include missions with mobility to traverse diverse geologic terrain (e.g., pyroclastics) and more than one permanently shadowed region. This will be partially addressed by the Volatiles Investigating Polar Exploration Rover (VIPER) mission and will be supplemented by several upcoming lunar orbital assets (e.g., Lunar IceCube, LunaH-Map, Lunar Flashlight, KPLO Shadowcam, and Lunar Trailblazer).

VVM-SAT: The Volatile Viability Measurement SAT [9] was formed in response to findings from the LEAG Commercial Advisory Board, to examine "near-term measurements… to establish commercial viability of lunar polar resources," and built upon the findings of previous reports (e.g., ASM-SAT [10], VSAT). The report noted that science and exploration are synergistic and recommended the formation of a group to examine specific measurements to enable ISRU to support sustainable exploration and economic development.

Relevance to Lunar and Solar System Exploration: The need for lunar resources has been clearly demonstrated. Gaining a better understanding of the distribution and form of resources (and technologies needed for utilization and production) are critical for furthering NASA's lunar exploration goals, and are directly relevant to many other reports including: Scientific Context for Exploration of the Moon [11]; decadal survey reports [12-13]; GER Supplement [14]; and reports for the Artemis program [15-17].

References: [1] ISECG ISRU Gap Assess. Rpt (2021). [2] Federal Register, The National Space Policy. [3] https://www.lpi.usra.edu/leag/roadmap/ [4] LEAG Volatiles SAT Rpt (2014). [5] ISECG, GER, 3rd edition (2018). [6] LEAG Strategic Knowledge Gaps for the "Moon First" Human Exploration Scenario SAT Rpt (2012) [7] LEAG-ISECG Volatiles SAT 2 Rpt (2017). [8] LEAG Next Steps on the Moon SAT Rpt (2017). [9] LEAG Volatile Viability Measurement SAT Rpt (2019). [10] LEAG Advancing Science of the Moon SAT Rpt (2018). [11] NRC Rpt #11954 (2007). [12] NRC Visions and Voyages (2011). [13] NRC Origins, Worlds, and Life (2022) [14] ISECG GER Supp. (2020). [15] NASA, Artemis Plan (2020). [16] NASA Artemis III SDT Rpt (2020). [17] NASA Artemis Accords (2020).