NEW APPROACHES TO LUNAR ICE DETECTION AND MAPPING: STUDY OVERVIEW AND RESULTS OF THE FIRST WORKSHOP.

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Introduction: The Keck Institute for Space Studies (KISS) is hosting a one-year study titled, "New Approaches to Lunar Ice Detection and Mapping", as part of its ongoing mission of bringing together a broad spectrum of scientists and engineers for sustained interaction to develop new space mission concepts and technology. The primary objective of this study is to explore innovative, low-cost mission concepts for detecting and mapping "operationally useful" ice deposits on the Moon. In this presentation, we will provide an overview of the study and describe results of the July 22-25 workshop, which was the first of two such workshops to be held in 2013.

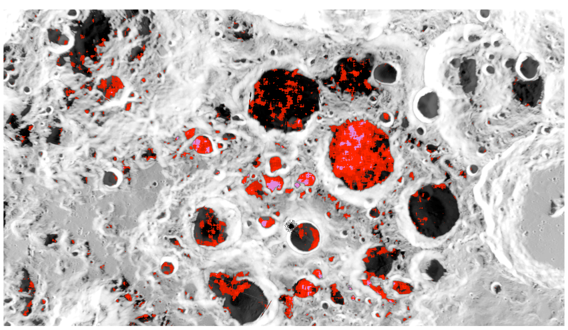

Figure 1. This south polar map of lunar annual maximum surface temperatures from Diviner [9] (grayscale) also shows the distribution of high apparent H_2O UV band depth from the LAMP instrument [13] constrained to regions with $T_{max} < 110$ K (reds and pinks). Although interesting patterns and contiguous features are revealed, their interpretation is ambiguous due to variable correspondence with other datasets.

Study Overview: As in previous KISS studies [1], the goal is to conduct in-depth discussions and develop new mission concepts with the potential for revolutionary scientific advancements or technological innovations. The question of whether volatile reservoirs exist on the Moon has a longstanding importance in planetary science [2,3] and space exploration [4]. Initial measurements from Earth and lunar orbit hinted at the presence of cold-trapped water ice in polar craters [5,6], but its abundance and distribution remained uncertain. New and complementary datasets from recent lunar missions, including the Lunar Reconnaissance Orbiter, LCROSS, and Chandrayaan-1, present further evidence for volatile enhancement in the polar regions [7,8,9]. However, agreement has not been achieved among the various datasets (e.g. temperature, neutron spectroscopy, radar, UV and near-IR albedo) in terms of the form, abundance, and distribution of volatiles on the Moon (Fig. 1) [10,11]. Furthermore, multiple competing theories regarding the origins, redistribution, and ultimate state of lunar volatiles have yet to be definitively tested [12]. We therefore initiated this study with the goals of: (1) assessing uncertainties in the nature of surface and subsurface ice deposits based on existing datsets and theory, (2) identifying the key measurement(s) needed to definitively detect lunar ice deposits, and (3) developing innovative, low-cost mission concepts to map these deposits at a spatial scale useful for sample extraction and in-situ resource utilization. Figure 2 shows an example of the type of flow

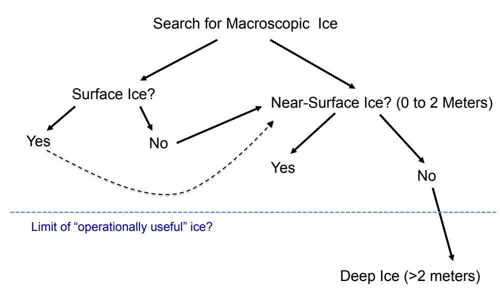

Figure 2. Example flow chart representing the search for "macroscopic" lunar ice deposits. The dashed arrow indicates a possible search for near-surface ice following detection of surface ice.

chart that could be followed to address the question of whether macroscopic ice deposits exist on the Moon.

Study Participants: The invitation-only workshop involves 30 core participants hailing from 16 separate institutions, including 5 NASA centers and 7 universities. Three study Co-leads (P. Hayne, D. Paige, and A. Ingersoll) direct the technical aspects of the study, along with the Distinguished Visiting Scientist (W. Feldman). Within this relatively small group, experitise spanning a range of disciplines including planetary science, lunar exploration, engineering and technology allows creative thinking, in-depth discussions, and analysis of a wide range of possible measurements and mission architectures.

Study Format: The study period consists of two workshops (July and November), a public one-day short course, and intensive collaboration among subgroups during the inter-workshop period. Presentations from the short course are promptly made publicly available on the KISS web site [1], as are many of the materials developed during the closed workshop. Following the second workshop in November, participants will produce a final report, which will also be posted on the KISS web site for reference and use by the lunar science and exploration community. After submission of the final report, a proposal for up to two years of follow-on technology development may be submitted to KISS, in competition with other studies.

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