GEOLAB IN NASA'S FIRST GENERATION PRESSURIZED EXCURSION MODULE: OPERATIONAL CONCEPTS.

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Introduction: We are building a prototype laboratory for preliminary examination of geological samples to be integrated into a first generation Habitat Demonstration Unit-1/Pressurized Excursion Module (HDU1-PEM) in 2010. The laboratory—GeoLab—will be equipped with a glovebox for handling samples, and a suite of instruments for collecting preliminary data to help characterize those samples (see Calaway et al, 2010). The GeoLab and the HDU1-PEM will be tested for the first time as part of the 2010 Desert Research and Technology Studies (DRATS), NASA's annual field exercise designed to test analog mission technologies. The HDU1-PEM and GeoLab will participate in joint operations in northern Arizona with two Lunar Electric Rovers (LER) and the DRATS science team.

Historically, science participation in DRATS exercises has supported the technology demonstrations with geological traverse activities that are consistent with preliminary concepts for lunar surface science Extravehicular Activities (EVAs). Next year's HDU1-PEM demonstration is a starting point to guide the development of requirements for the Lunar Surface Systems Program and test initial operational concepts for an early lunar excursion habitat that would follow geological traverses along with the LER (Fig.1). For the GeoLab, these objectives are specifically applied to enable future geological surface science activities. The goal of our GeoLab is to enhance geological science returns with the infrastructure that supports preliminary examination, early analytical characterization of key samples, insight into special considerations for curation, and data for prioritization of lunar samples for return to Earth [1, 2].

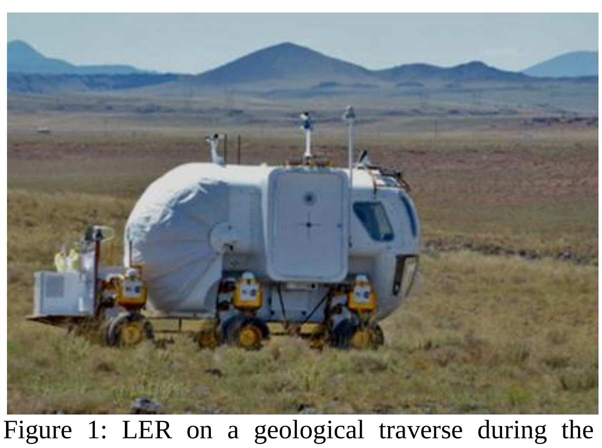

Figure 1: LER on a geological traverse during the DRATS 2009 exercise.

GeoLab Description: The GeoLab comprises a glovebox inside the HDU1-PEM, allowing for samples collected during LER traverses to be brought into the habitat in a protected environment for preliminary examination (Fig. 2). The glovebox will be attached to the habitat bulkhead and contain three sample pass-through antechambers that would allow direct transfer of samples from outside the PEM to inside the glovebox. We will evaluate the need for redundant chambers, and other uses for the glovebox antechambers, such as a staging area for additional tools or samples. The sides of the glovebox are designed with instrument ports and additional smaller ports for cable pass-through, imagery feeds and environmental monitoring. This first glovebox version will be equipped with basic tools for viewing, manipulating, and early analysis of samples. The GeoLab was also designed for testing additional analytical instruments in a field setting. Calaway, et al (2010) present a detailed description of the GeoLab design.

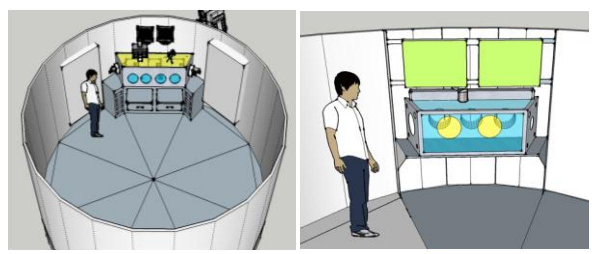

Figure 2: Schematic showing an inside view of the PEM with GeoLab integrated into one section. GeoLab includes a glovebox for handling and examining geological samples. Other outfitting facilities are not depicted in this figure.

GeoLab Test Objectives: The DRATS 2010 mission plan includes two LERs that will traverse across the Black Point Lava Flow and SP Mountain area of northern Arizona for 14 days. During the traverses, the crews will be collecting geological samples as part of their simulated exploration activities (Fig. 3). At a mid-point in the mission, and after several days of geological traverses, the LERs will dock with the HDU1-PEM to conduct a series of operations and tests in the PEM. The docked period is followed by more LER traverses. During the docked phase, a set of test samples collected from the traverses will be processed through the GeoLab. In addition to basic hardware tests using the glovebox and analytical equipment, we will test the GeoLab in the analog environment in order to evaluate the efficacy of performing preliminary examination, sample handling, and prioritization of the test samples. Specifically, we will develop and test sample inventory methods for efficient sample identification and retrieval from the field collections; operations associated with handling multiple samples in the glovebox; operations associated with preliminary examination of samples; requirements for communications and interactions with back-room scientists associated with processing samples in the GeoLab; data, descriptions and operations required for sample prioritization; and sample handling and curation protocols for moon-based or earth-bound storage. Some of these tests may be contrasted with field-based (from the LER traverses) analyses. We will leverage resources with DRATS science team deployed as "back-room" scientists supporting the LER traverses. Using the data collected from traverses, the involvement and knowledge of the science team, and the communications protocols and infrastructure via the science back-room (Fig. 4), our laboratory tests can simulate simple scenarios for obtaining additional data on samples collected during traverses. We will use these field tests to develop and assess preliminary crew and science support "back-room" procedures, to better understand critical data required to support informed decisions about planned traverses, sample priorities and sample return [1, 2]. Additional testing will be conducted at the NASA Johnson Space Center after the HDU1-PEM returns from the DRATS field exercise.

Figure 3: Crew member collecting a geological sample during a traverse during the 2009 DRATS analog exercise. Samples are photographed with a camera on the crew's EVA suit, described and stored in a labeled sample bag for later disposition, analysis or storage for Earth return.

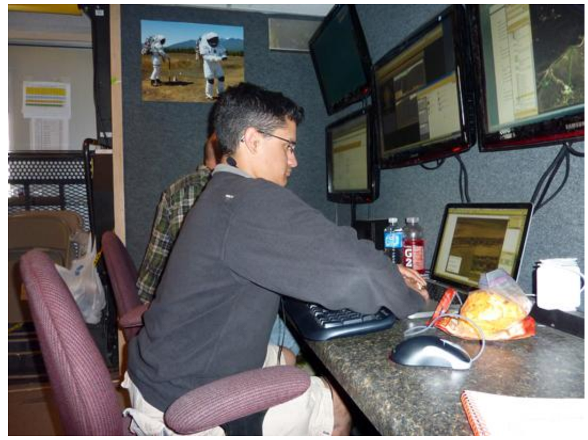

Figure 4: Scientist in the DRATS Science "back room" monitoring traverse activity and recording geological data associated with traverses and sampling. The Science Support Team would also work with crews operating the GeoLab.

Anticipated outcomes: All of the operations are considered to be a first step at understanding both the value and operational constraints associated with human-tended geological operations in a laboratory setting on the Moon. GeoLab operations in a field environment will contribute to the development of advanced laboratory concepts (both laboratory and field tools) and the sample handling protocols required for efficient field campaigns and initial curation efforts that control contamination and preserve pristine samples collected during exploration missions. Assessment of the laboratory operations will drive the definition of requirements and the advancement of new technologies for handling and examining extraterrestrial samples, and transporting them back to Earth.

GeoLab capabilities and the derived operational concepts will also provide a venue for participation by the science team in surface mission planning for future exploration missions. Through GeoLab deployment and operations, we will gain a practical understanding of the field operations and performance of a specific habitat laboratory facility so that we can confidently work with mission planners to optimize astronaut activities on the lunar surface. We anticipate learning valuable lessons working in an operational environment and collaborating with science, mission operations, engineering and robotic teams.

References: [1] Treiman, A.H. (1993) Curation of Geological Materials at a Lunar Outpost, JSC-26194 and Office of the Curator Publication #187. [2] Shearer, C. et al. (2009) Review of Sample Acquisition and Curation During Lunar Surface Activities, LEAG and CAPTEM White paper, in press.[3] Calaway et al, GeoLab 2010 Hardware in NASA's Pressurized Excursion Module, this volume.