GEOLAB'S FIRST FIELD TRIALS, 2010 DESERT RATS: EVALUATING TOOLS FOR EARLY SAMPLE CHARACTERIZATION. C. A. Evans[1], M. S. Bell[2] ,M. J. Calaway[2], Trevor Graff[2], Kelsey Young[3], and the Desert RATS Science Team, [1]Astromaterials Acquisition and Curation Division, NASA Johnson Space Center , Mail Code KT, 2101 NASA Parkway, Houston, TX 77058, cindy.evans-1@nasa.gov; [2]Jacobs Technology (ESCG) at NASA JSC; [3] School of Earth and Space Exploration, Arizona State University, Tempe AZ

Introduction: As part of an accelerated prototyping project to support science operations tests for future exploration missions, we designed and built a geological laboratory, GeoLab, that was integrated into NASA's first generation Habitat Demonstration Unit-1/Pressurized Excursion Module (HDU1-PEM). GeoLab (Fig. 1) includes a pressurized glovebox for transferring and handling samples collected on geological traverses, and a suite of instruments for collecting preliminary data to help characterize those samples [1, 2]. The GeoLab and the HDU1-PEM were tested for the first time as part of the 2010 Desert Research and Technology Studies (DRATS), NASA's analog field exercise for testing mission technologies. The HDU1-PEM and GeoLab participated in two weeks of joint operations in northern Arizona with two crewed rovers (Fig. 2) and the DRATS science team.

Figure 1: GeoLab integrated into the HDU1-PEM. The suite of instruments included a handheld XRF analyzer (far left), stereo microscope (center, above glovebox), network cameras, and touchscreen computers. Ports in the back of the Glovebox are pass-through chambers for sample transfer from the outside.

The 2010 HDU1-PEM demonstration was initially conceived 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 rovers (Figure 2). GeoLab objectives targeted general support of future planetary surface geoscience activities by providing an infrastructure for preliminary examination of samples, early analytical characterization of key samples, providing in-situ insight into special considerations for curation, and utilizing data for prioritization of samples for return to Earth [3,4].

Figure 2: The HDU1-PEM with two rovers docked. The three circular ports directly below "Habitat Demonstration Unit" are the antechamber doors that provide access directly into the GeoLab Glovebox.

GeoLab Operations: The 2010 GeoLab operations included testing basic functions of the Glovebox and associated instruments with a variety of operators (Figure 3), and supporting the DRATS science team with additional data on samples that were collected during the rover traverses. The 2010 Desert RATS field campaign included two separate week-long exercises: 6 days of dual rover traverses [5] and a final day in the HDU1-PEM, including 4 hours of GeoLab operations. When the crews examined samples in the GeoLab, they were testing four major objectives:

1) How does the GeoLab function as a workspace, including glovebox and instrument operations?

2) How well do the crew and science team work together; what benefits are achieved by crew-scientist interactions during the integrated GeoLab tests?

3) Can the data collected in the GeoLab inform the science team about the geologic units and the geologic history of the traverse area?

4) Can the data collected in the GeoLab help the science team prioritize samples for decisions regarding future return to earth?

Initial Results: The GeoLab 2010 operations are a first step at understanding both the value and operational constraints associated with human-tended geological operations in a laboratory setting on a planetary surface. We are still analyzing the full set of data, including the quick-look accuracy and utility, with special attention paid to the attributes and drawbacks of the XRF data. Initial assessments suggest that:

1) The Geolab glovebox provided a high fidelity field laboratory, and it performed well. With a trained crew, samples could be examined relatively quickly, and data entered into the database for further consideration by the science team. The Geolab operations are described in more detail by Calaway et al [6]

2) Geolab operations benefited from science team participation. The science team saved valuable crew time by performing certain tasks (for example, camera control), and interacted with the crew for decisions regarding data collection.

3) The detailed data collected in the GeoLab added to the body of evidence applied to understanding the regional geology. Even though initial assessments of the geochemical data include many uncertainties, the full body of data collected on each sample suggest that similar-looking rock units could be distinguished, providing data useful for geologic interpretation of the area (Figure 4). Of note, data collected on alteration surfaces of samples provided additional detail and information that was difficult to obtain in the field. We assume these data would also be useful to the science team for decisions regarding sample prioritization.

Figure 3: GeoLab operations. All data could be viewed in near-real time by a remote Science team

Future Plans: We have several areas of work that we will continue over the next year. We are developing best operating practices for the XRF as a field/lab instrument, and assessing how we interpret (and attach caveats to) the XRF data for whole rock geochemical fingerprinting. Not surprisingly, the GeoLab XRF data must be interpreted within the context of the field occurrence and detailed visual descriptions (especially texture, homogeneity, surface roughness and alteration, and more), and microscopic imagery. In parallel to analysis of our Desert RATS data, we are characterizing the performance of the XRF spectrometer by conducting tests with rocks of known composition and a variety of surfaces (smooth sawed faces and naturally broken faces), and building working calibration curves for the major rock-forming elements [7]. We will use these data for analyzing the results of our DRATS samples. We plan to test the configurability of GeoLab in the 2011 DRATS field tests by integrating an additional analytical instrument, and we will be upgrading and simplifying the instrument interfaces for remote operations. We will continue to collaborate with both the science and operations teams for integrated tests, to take full advantage of the operational environment provided by the field deployment.

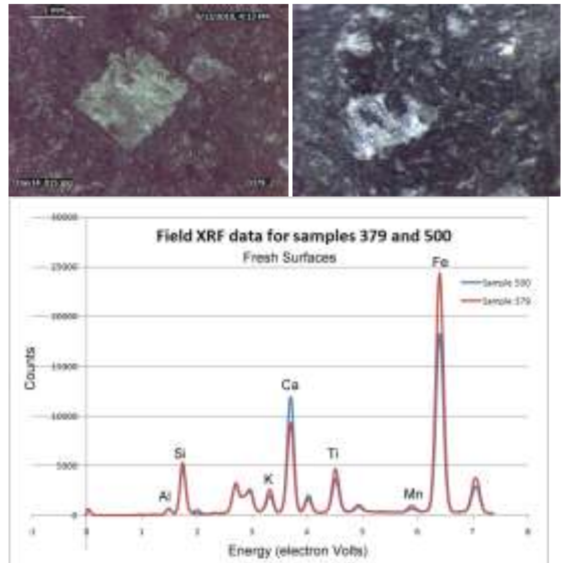

Figure 4. GeoLab data collected on all samples included microscopic images (texture and phenocryst assemblage) and XRF spectra for rapid geochemical fingerprinting. Data for samples 379 (left) and 500 (right) suggest compositional differences between the older flow unit (500) and an older cinder cone (379).

Continued testing of GeoLab operations in a field environment will contribute to the development of habitat-based laboratory concepts. We plan to assess the scientific and operational value of additional analytical capabilities in GeoLab, and, in the future, compare results to similar analyses using field instruments operated by crew, or instruments mounted on robots. We aim to apply our work toward defining preliminary examination and 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 support the advancement of new technologies for handling and examining extraterrestrial samples, and transporting them back to Earth.

References: [1] Evans et al. (2010) *LPSC XLI*, Abst. #1480. [2] Calaway et al. (2010) *LPSC XLI*, Abst. #1908. [3]Treiman, A.H. (1993) NASA Publication JSC-26194,. [4] Shearer, C. et al. (2010) Review of Sample Acquisition and Curation During Lunar Surface Activities, CAPTEM and LEAG Analysis Report. [5] Eppler et al. (2011) *LPSC XLII*, this volume [6] Calaway et al. (2011) [7] Young, et al. (2011), *LPSC XLII*, this volume.