TELEMETRIC BIOLOGY: EVALUATING IN SITU RESOURCES FOR BIOLOGICAL PAYLOADS IN A LUNAR LANDER. Anna-Lisa Paul[1] and Robert J. Ferl[1,2], [1]University of Florida, Hort Sciences/Program in Plant Molecular and Cellular Biology, and [2]Biotechnology. Gainesville, FL 32611. alp@ufl.edu , robferl@ufl.edu.

Introduction: The concept of a biological payload for a lunar lander supports the conviction that we will need to effectively utilize local resources for support. Understanding challenges prior to mounting a long term mission will enhance the readiness level of returning humans for extended work on the moon.

Plants posses a set of characteristics that make them ideally suited to extraterrestrial biological payloads. As seeds, plants can lie dormant for years, and then be developmentally activated in favorable environment. There is also little difference in basic metabolic and genetic processes of both plants and humans, yet plants have evolved to adapt to their environment in situ, which has fostered a complex and dynamic mechanism to deal with environmental change unparalleled in higher eukaryotes. Plants can be easily bioengineered, and the mechanisms by which plants mount a response to a novel environment can be monitored telemetrically through the use of plants equipped with Fluorescent gene reporters.

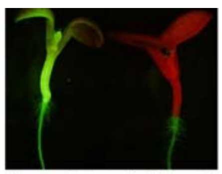
Figure 1. Two Arabidopsis GFP biosensors

The use of engineered Arabidopsis plants as biosensors has been widely used to assay the nature of stress responses. The incorporation of Green Fluorescence Protein (GFP) as a biosensor molecule makes it possible to evaluate patterns of gene expression telemetrically as processed fluorescence images (Fig. 1). The combination of biological engineering, high fidelity visual data collection and telemetry has created a means by which biologically relevant information can be obtained in a planetary lander in situ.

Tools and Analog Environments: A lander experiment of this nature is comprised of three components – biology, telemetric data collection and in situ resources. We have addressed the first two components with analog site studies by deploying the TAGES GFP imaging system within the Arthur Clarke Mars Greenhouse (ACMG) an autonomously operated greenhouse located within the Haughton Mars Project in the Canadian High Arctic [1]. Results demonstrate the applicability of the fundamental GFP biosensor technology for telemetric data collection from challenging deployment environments [2]. Thus, the basic efficacy of using plant biosensors in a capacity similar to deployment on a Lunar Lander has been demonstrated.

Evaluating local resources – regolith: It is not known how plants would fare in pure lunar regolith. Although plants have been exposed to lunar materials, it has always been in trace amounts due to its scarcity. [reviewed in [3]. A lander experiment capable of sampling surface material and depositing it into an internal growth chamber can evaluate the biological impact of regolith in lunar gravity and radiation environment.

As a first step, there are terrestrial analogs that can be evaluated to guide lander development. Additional to prepared simulants (e.g. JSC1a) are natural terrestrial analogs. The impact crater on Devon Island in the High Canadian Arctic contains geological features analogous to some lunar and martian impact sites [4].

Arabidopsis plants were grown in JSC1a Lunar simulant as well as in a variety of substrates from in and around Haughton Crater on Devon Island. All substrates were evaluated for their ability to support plant growth with and without mitigation. Figure 2 shows a small selection of the experiments conducted in native breccias and JSC1a with Arabidopsis. The results are preliminary, but show clearly that the native breccias and soils of Devon Island are complex and require a variety of mitigation steps to render them able to support plant growth. It is likely that the same would be true of native materials collected from any planetary surface. Telemetric data collection in the form of images can reveal the impact such substrates have on growth and habit, and well as reveal metabolic data in the form of GFP fluorescence of the biosensor gene.

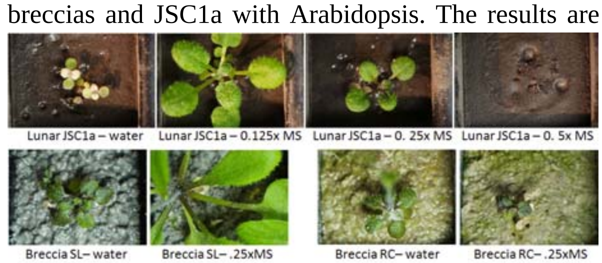

Figure 2. Growth tests with regolith simulants and analogs. All plants within each row are the same age, and photos taken to the same scale. The top row shows lunar simulant JSC1a; The second row compares two different sites from Devon Island.

References:

[1] Giroux, R. et al. (2006). *Advances in Space Research 38*, 1248-1259. [2] Paul A-L., et al. (2008) *Sensors, 8*, 2762-68 [3] Ming, D.W. and Henninger D.L. (1989) eds. *Lunar Based Agriculture: Soils for Plant Growth* [4] Lee, P. *Ad Astra* **2002**, *May-June*, 12. Authors acknowledge P.I.'s Alain Berinstain and Pascal Lee for HMP support with these experiments.