Interdisciplinary Collaboration on Borehole Core Testing for Extraterrestrial Material. F. K. Vonstad[1], [1]University College London (UCL), Frida.sjovoll.13@ucl.ac.uk, P. Ferreira[2], [2]University College London (UCL), P.Ferreira@ucl.ac.uk, D. Sully[3], [3]University College London (UCL), D.Sully@ucl.ac.uk,

Introduction:

Several Government Space agencies, including NASA and ESA, are conducting preliminary studies on the building of space-habitat systems for deep-space exploration (Lim et al, 2017:1413). Such studies include development of advanced technologies for planetary surface exploration, including an in-depth understanding on the use of local resources. Based on the plans from NASA to land humans on Mars in 2030, similarly from Europe (ESA), Canada (CSA), Russia, (ROSCOSMOS), India (ISRO) Japan (JAXA) and China (CNSA), a series of scientific developments needed for such expansion are emerging. In NASA's Strategic Plan (2018), Objective 3.1. "Develop and Transfer Revolutionary Technologies to Enable Exploration Capabilities for NASA and the Nation", the goal is to enable humans to live and work in space and on planetary surfaces and expanding capabilities through robotic exploration and discovery.

Isolated, confined, and extreme (ICE) environments are the most universally challenging places for mankind but can provide enormous scientific and economic benefits to those willing to take the challenge, as well as enables unique scientific exploration and discovery. To encourage exploration and discovery in such harsh environments, and to pave the way for human habitability on other planets, research expansion in the field of geological sciences is needed. Thus far, geological sciences involved with the investigation and dissemination of extra-terrestrial material is limited in scope and access. To help gain momentum from a geological standpoint, it is important to include further disciplinary requirements to testing and analysis, and to widen the scope of information gathered so that results may be informative to currently side-lined geological disciplines. There is a drive within academia and industry to create more interdisciplinary research, with suggestions that with innovation in terms of interdisciplinary collaboration, gaps in research can be bridged by combining knowledge and practice from several disciplines. Some of the needs noted can be met by applying an interdisciplinary testing framework to borehole samples acquired from robotic and future manned missions. This could be done by integrating the interdisciplinary testing framework, and methodology, developed by the Doctoral Researcher writing this proposal.

The interdisciplinary testing framework suggested for the research will be based upon a doctoral research project on interdisciplinary sampling and testing of borehole cores on construction sites. The framework is being tested on two major highway developments in Norway and in the UK and received full funding both from industry partner and the Science and Engineering Research Council in the UK. The work combines geotechnical engineering, geology and geological archaeology on sites, by proposing a testing framework between the disciplines that helps separate the individual disciplinary needs from a common testing scope on a borehole core. By researching how to extend this methodology to include the other disciplines, the amount of material needed will significantly decrease, and the information spread will be significant.

As will be made evident in the presentation, the benefits of integrating different strands of analysis to construct coherent and plausible arguments still outweigh the challenges of interdisciplinary research and warrants the effort. The focus of space research in terms of geology needs to gradually shift from the individual to the group.

The main objective of the reserach is to create a framework to apply to core tests recovered from other planets. The overall goal of the proposed research is to develop interdisciplinary testing procedures for borehole cores, and to find a framework which allows all disciplines involved to meet their analytical requirements in a collaborative practice. This will involve creating a novel sample framework, which addresses issues that needs solving which will allow people to thrive within ICE environments and create a wider understanding of the geology of extraterrestrial planetary bodies. What follows is a brief look at the major topics under consideration for the research.

Methodology:

The research is based on some topics suggested by readings and Space Agencies:

- Building structures
- Testing environment / characterizing material
- Historic geology
- Geochemical analysis
- Discovering species/life

According to (AIAA, 2009), extra-terrestrial habitations can be classified in three types: (i) Class I: pre-integrated hard-shell modules such as the International Space Station (AIAA, 2009), which are deployed in space with a limited extension capability; (ii) Class II: prefabricated on Earth and surface-assembled modules, e.g. inflatable structures (NASA,2014); and (iii) Class III: ISRU-derived structures which can be integrated with the other Class I and II modules to expand the habitat (Rousek et al., 2012) (Lim et al, 2017:1414). The use of martian soil, or regolith, in combination with design and investigation techniques of civil engineering will be critical in the construction of extra-terrestrial habitations (Farrier, 2000:46). The use of this material comes in many forms, such as cuttings for embankment, insultation and protection, as well as options such as the Martian Concrete (Wan et al, 2016:222). To be able to create such habitations, it relies on the ability locally source and manufacture construction materials.

To gain knowledge needed to answer some of these questions the areas require, the following disciplines are suggested to be incorporated in the testing framework:

- Astrobiology
- Geotechnical engineering
- Geochemical analysis
- Geology

These specific disciplines are mentioned due to their relevance to the above goals detailed, and how they can respond to them. This does not limit the scope to these, but a suggestion of where to start the work.

Conclusions:

The development of collaborative interdisciplinary approaches to testing cores can help widen the useability of material gathered, spread dissemination further between fields, reduce cost for tests, make the cores used more efficient, and speed up the process of gathering basic geological information needed for space expansion. The research will help gather the geological fields with an interest in extraterrestrial material, and provide a wider geological image of other planets and enhance understanding, prepare for premanent settlements, characterize materials for commercial use and gain further knowledge of the geological history of other planets.

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