Analogue Gradiometry Testing for Lunar Lava Tube Exploration

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Introduction: After discovering more lava tubes on the Moon [1] and Mars [2], the option to build a possible subsurface habitat for the first human settlers on these respective planetary bodies, has 'resurfaced'[3]. Within a subsurface habitat, many of the challenges that are facing a habitat standing on the surface will be eliminated – such as temperature differences, micro-meteorite impacts, radiation protection, regolith contamination, etc.[4]

There are however two main problems before an actual extraterrestrial habitat can be constructed. The first is that thus far, no lava tubes anywhere else than on Earth have been explored. This is partly caused by technological difficulties, but also by the second problem: There are very few lava tubes discovered. Besides, the ones that have been discovered, are often collapsed, very big, or too deep [5].

It is therefore of great importance to expand our knowledge of (extraterrestrial) lava tubes and how to discover them.

Although human exploration will most likely result in the most accurate and the largest variety of datasets of lunar and Martian lava tubes, on the Moon or on Mars, human exploration is very costly. (Rechargeable) autonomous drones, equipped with a gradiometer/magnetometer, could thus be an essential aid in the discovery and mapping of new and existing lava tubes. To ensure the quality of these autonomous drone mappings, a simulation field test, conducted here on Earth (and compared to manually-acquired data), is necessary.

Research: The project will consist of a fieldwork at the HI-SEAS (Hawaii Space Exploration and Analogue Simulation) habitat in Hawaii, where there are several lava tubes in the near vicinity. The goal is to map these structures and collect rock samples from the field to see if there can be any correlations found between different ages, depths, and compositions of the lava flows and the accuracy of their detection.

This field work will be performed from the 18th of January 2020 to the 1st of February 2020, whilst in-simulation at the HI-SEAS facility, as a part of the EMMIHS-III crew. Afterwards, the gradiometric data will be analyzed, drone footage will be used to complete a map of the local surroundings, and the composition of the (rock) samples will be tested with XRF.

EMMIHS-III: The EMMIHS-III mission, of which this project will be one of the major individual researches, is a part of the EMMIHS missions campaign, set up as a collaboration between EuroMoonMars and the International Moonbase Alliance (IMA).

After the great success of last years' mission to HI-SEAS, where six scientists, engineers, journalists and photographers spent two weeks at the HI-SEAS station performing research relevant to both the Moon and Mars, the International Lunar Exploration Working Group (ILEWG) set out to continue their research with three more analogue missions at HI-SEAS.

In December 2019, and January-February 2020, the bringing together researchers from the European Space Agency, VU Amsterdam, the ILEWG and IMA.. The campaign aims to increase the awareness about the research and technology testing that can be performed in analogue environments, in order to help humans become multiplanetary species. Furthermore, the research and technological experiments conducted at HI-SEAS are going to be used to help build a Moonbase in Hawai'i, and ultimately to create an

actual Moonbase on the Moon, as part of IMA's major goals.

First results are expected to be in March 2020, just in time to be presented at the LPSC 51 in The Woodlands, Texas.

References:

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