Geophysical Research Abstracts
Vol. 21, EGU2019-17503-1, 2019
EGU General Assembly 2019

Concept and field reconnaissance for a Semi-Permanent Moon-Analogue Habitat Inside a Lava Tube in Iceland

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Finding the best terrestrial moon-analogue mission sites is of utmost importance in the preparation for future, manned, lunar missions. During these moon-analogue field tests, many problems that the astronauts will encounter during the actual mission will be discovered. The current moon-analogue bases can only represent a part of the conditions to be found around the most likely first semi-permanent living quarters on the moon. Bringing large structures to the moon will take up a prohibitively large amount of energy and time, and with that, money. Using existing structures on the lunar surface, might thus be the most logical and durable solution.
Looking into utilizing already existing features on the moon, one can think of three main ways to construct a livable habitat. ISRU-housing, ice habitats and lava tube habitats. ISRU-housing, by making concrete, sintering regolith, or covering inflatable housing, can be a great way to insulate and design large spaces on the Moon [1], but often requires (heavy) machinery and the use of regolith may harm the astronauts [2]. Utilizing the ice extracted from repositories on the lunar South pole, with the close proximity of water and 'peaks of eternal light', alleviates the problem of having to use heavy machinery and avoids potentially dangerous regolith. The lunar ice resources however, are preserved in polar craters with abundances of few % and temperatures of -220 oC; this will bring large isolation problems, as also shown by the IGLUNA project [3]. A third option would be to build living quarters inside the lava tubes, as recently discovered on the borders of the mares and the highland regions. On the Moon, lava tubes will have an average temperature of about -20 oC, which suggests that relatively little heating is needed to make a comfortable living space inside a lava tube and, as they can be many meters deep, they will protect the inhabitants from harmful radiation, temperature changes, and micrometeorites.
In September 2018, a team from ILEWG EuroMoonMars programme [4] has visited three lava tubes on Iceland; Raufarholshellir, Surtshellir, and Stefanshellir. Raufarholshellir is the most touristic lava cave of Iceland, which makes it more suitable for public outreach, but less suited for researching the psychological aspects of the isolation. Stefanshellir and Surtshellir are almost connected, but Stefanshellir goes deeper into the lava field and has a more maze-like structure, making Stefanshellir the most attractive choice for a lunar analogue base.
One of the main objectives of a longer duration Iceland moon-analogue mission as part of ILEWG EuroMoonMars Iceland campaign 2019 will be: Is it possible to harvest enough energy, safely store it and use it to make a local, pressurized environment that is suited for living? Other objectives that can be reached within an Iceland moon-analogue base are ISRU-based, such as extracting water from dehydrating rocks [5], 3D printing building material, or soil fertility studies.

[1] B.Dunbar, E.Mahoney(2018) https://nasa.gov/isru
[2] T.E.Bell(2006), Air and Space magazine
[3] T.Benavides, O.Kirchoff et al.,(2018), https://www.spacecenter.ch/igluna/
[4] B.Foing et al https://www.hou.usra.edu/meetings/leag2017/pdf/5073.pdf
[5] T.John,(2014), AGU, 2014AGUFM.H31P..02J