SPATIAL ANALYSIS OF LAVA TUBES FOR THE PURPOSE OF EXTRA-TERRESTRIAL HABITATION.

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Introduction: Recent developments in the space industry have led to a growing interest in new manned space missions to the Moon. This time, space agencies and companies plan on building sustainable bases on the Moon. However, this will not only require new architectural design concepts, but also it will need to provide solutions for the hostile conditions on the Moon to enable this innovative research approach. To accomplish the different requirements necessary for a permanent extra-terrestrial human settlement, a possible solution could be the construction of habitats inside of lava tubes. [1] This attempt has been analyzed during a two-week lunar simulation (EMMIHS-II, series of field simulations developed by ILEWG EuroMoonMars Programme) at the Hawai´i Space Exploration Analog and Simulations (HI-SEAS) habitat, to provide comparable lava tubes on Earth as an environmental guideline for space architects and to investigate the habitability of such spaces for the purpose of extra-terrestrial habitation.

Figure 1. Entrance of a lava tube. Skylight located at the Mauna Loa volcano on Hawai´i [2].

A major milestone in the planning and implementation of habitats in lava tubes could be the discovery of more than 200 lunar skylights. A potential candidate skylight was reported at Philolaus crater (72.1°N, 32.5°W), with a distance of 550 km from the North pole. With the potential variety of tunnel systems, the connection to water resources in ice form could be guaranteed, which are essential for the successful establishment of a base on the Moon. [3] With a further increased protection against radiation, meteorites and lunar dust by placing the habitat in lava tubes [4], the essential advantages of such a location for astronauts and the architecture itself are given.

With these developments, discoveries and the choice of location, the importance of considering such spaces will be discussed within this paper. Based on the results, approaches for the implementation of such architectural design concepts will be proposed.

Methodology: The scientific data produced for this research was obtained during several simulated extravehicular activities (EVA) at the HI-SEAS Mars/ Moon Research Facility.

During these EVAs, investigations of the different dimensions (length, width and height) of the lava tubes were carried out and documented. By evaluating the measurements and various lava tubes, the three most suitable ones were selected as references for comparable lava tubes on the Moon and compared in their environmental conditions, usability for architectural purposes and different dimensions.

Figure 2. Documentation of the different dimensions within the lava tube during a simulated EVA. [5].

The results of this paper should create an environmental guideline to counteract future questions in the architectural design process and to ensure realistic dimensions in the habitat development. To establish a comprehensive guideline for space architects, a simultaneous definition of the structural requirements will be provided.

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