

HUMAN EXPLORATION OF THE MOON AND MARS SYMPOSIUM (A5)  
Strategies to Establish Lunar and Mars Colonies (1)

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LAVA TUBE EXPLORATION FOR SPACE COLONIZATION

**Abstract**

This paper proposes use of lava tubes as sites for human habitation. A lava tube environmental characterization and robotic exploration and evaluation are proposed to investigate the feasibility of exploiting, mapping, and ultimately emplacing habitats within lunar lava tubes.

Lava tubes solve problems of surface habitation on the moon and Mars while minimizing requirements for infrastructure mass and site preparation. Lunar lava tubes can catalyze the colonization of the moon and Mars. This will accelerate the colonization of space through the use of natural voids on planets, moons, and asteroids as sites for human habitation. The research purpose is to establish the feasibility of exploiting, mapping, and ultimately emplacing habitats within lunar lava tubes.

Lava tubes shield habitation from extreme temperature ranges, micrometeorites, dust and radiation at the lunar surface that present a serious threat to the health of human explorers and the lifetime of structures. The existence of lava tubes on Mars also presents the possibility of building on this concept for future Martian bases.

The feasibility of habitation and robotic exploration of lunar lava tubes must be evaluated. This is accomplished through modeling environmental conditions within lava tubes, initial configurations for exploration robotics, and preliminary mission planning. Technologies must be developed for lava tube exploration integrated with the world space community's vision for space exploration. This would lead to robotic missions and eventual human colonization of lava tubes on the moon and Mars.

Viable lava tubes have been identified from satellite imagery and their locations and distributions established, but it is not until they are explored that appropriate sites can be selected for human habitation. Factors such as expected tube size, debris accumulation, and roughness of terrain in and around the cave must be determined in order to predict the ease with which tubes can be harnessed for colonization. To this end, the interior of lava tubes must be explored. Robotic exploration presents a clear advantage to human exploration, as crewed missions would be expensive and far too dangerous for astronauts. Robotic configurations for exploration of lunar lava tubes must be developed to overcome the unique challenges of the lava tube environment, including power in the dark, communication from inside the tube, and mobility to enter and navigate the tube.