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LAVA-T: LAVA TUBE ACCESS VIA AERIAL TETHER - THE LUNAR UNDERGROUND

Abstract

Lunar exploration and eventual long-term habitation depend upon humans' ability to better understand the origin and geologic nature of the Moon, while also devising innovative strategies to survive the extreme temperatures, micrometeorites, and most significantly, radiation exposure. When data from the GRAIL (Gravity Recovery and Interior Laboratory) Mission was used to confirm the presence of subsurface lava tubes on the Moon in 2016, it was as though the Cosmos had gifted humanity with naturally-occurring shelters. In 2017, a group of scientists from Purdue University studied the structural stability of lunar lava tubes, suggesting that these geologic structures would be stable at widths of up to 5 kilometers. Thus, the science to date has primed and demonstrated a clear need for a future exploration mission that is focused on further characterizing the nature of lava tubes.

Additionally, the fortuitous discovery of the "skylight" pit in the historically significant Mare Tranquillitatis region, potentially contain unperturbed solar records unlike anything that we have been able to observe on Earth. The scientific data collected would be critical to understanding the Sun-Earth relationship and developing a robust Earth climate change model. One of our best chances of combatting climate change is to better understand the macro solar environment in which our planet resides. The lunar surface, and particularly, lunar lava pits, represent our most easily accessed celestial body for conducting comparative climate science research.

Building upon the previous Moon Diver mission concept, the Lunar Underground Mission would work around the steep, sloped skylight entry by using a lander and rover pair as anchors on either side of the skylight opening. The rover would drive carrying a cable attached the cargo lander around the lip of the skylight and then pull it taut once in position. From there, a small robot (akin to the Moon Diver or a spider robot would be lowered safely into the skylight until it reached the surface of the crater pit.

For this concept, local seismographs would assess stability and stress test the environment prior to habitation. Additionally, LIDAR (Light Detection and Ranging) and GPR (Ground Penetrating Radar) would be used in tandem to create a unified 3D model of the existing network of lunar lava tubes. The LAVA-T Mission concept is a combined crewed and CLPS rover expedition into a carefully selected lunar lava tube for the purposes of geologic survey, mapping, emergency shelter, and eventual long-term habitation.