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Hawaiian Lava Tubes with Extraterrestrial Habitat Applications

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ABSTRACT

One of the next major steps in space exploration, as noted by agencies such as NASA and SpaceX, is the creation of extraterrestrial habitats. Most current extraterrestrial habitat designs focus on above-surface solutions and do not consider all the hazards that can impact this habitat. However, the existence of lava tubes on the moon, supported by data from Gravity Recovery and Interior Laboratory (GRAIL), SELenological and ENgineering Explorer (SELENE), and NASA's Lunar Reconnaissance Orbiter (LRO), could impact extraterrestrial habitat designs. To support life, a prospective habitat must be safe from the harsh conditions of space, including meteorite impacts, radiation, and fluctuating temperatures. Lunar lava tubes, cave-like structures created during volcanic eruptions, can house a prospective habitat. This paper provides an understanding of lava tube morphology and formation methods on Earth which gives insight into extraterrestrial lava tubes, specifically their structure, stability, and formation methods. By studying lava tubes in Hawaii, a better understanding of these qualities is formed. This knowledge provides for a more accurate model in which stability is further investigated. Several factors are investigated in this model, including size and geometry. Using a case study of the Kaumana Cave and Thurston's lava tube in Hawaii, it is found that stable terrestrial lava tubes share many similarities with extraterrestrial lava tubes. This shows the stability of lava tubes a few kilometers wide on the Moon. By knowing more about the stability of lunar lava tubes found through this research, future extraterrestrial habitat engineering designs will be impacted.

KEYWORDS

Extraterrestrial habitats, morphology and formation, stability of lava tubes, Moon, GRAIL, LRO, skylight.