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LUNAR CAVES: LOOKING BELOW THE SURFACE OF THE MOON FOR PLANETARY SCIENCE AND HUMAN EXPLORATION

Abstract

The exploration and characterization of large stable voids under the lunar surface could change the way we approach planetary exploration, providing new promising possibilities for scientific research and human habitat design. In recent times, the availability of high resolution images of the surface the Moon has allowed the identification of more than 300 potential "cave-entrances". Most of them are isolated features but several are associated with sinuous rilles, suggesting the presence of huge lava tubes on the Moon. The most spectacular examples of pit entrances are situated in the volcanic plains of Marius Hills and Tranquillitatis, or within impact melts of some of the major craters like Copernicus and Aristarchus. Few potential subsurface access points are located at high latitudes toward the north and south pole, with more that could be discovered in the future. At these latitudes caves could present promising environmental conditions for the preservation of volatiles. Recent morphometric and geophysical studies have shown that lava tubes on the Moon are expected to reach dimensions up to two orders of magnitude larger than those on Earth on the Moon, potentially exceeding one billion cubic meters in volume. Accessing and analysing these subsurface environments will require addressing new technological challenges, but may also provide unexpected scientific discoveries. In the last decade, space agencies such as ESA, NASA and JAXA have become increasingly interested in planetary caves, resulting in new mission proposals and technological studies. With humans planning a return to the Moon through NASA's Artemis programme in 2024, robotic missions to lunar cave systems should become a priority. Such missions would allow these systems to be evaluated as locations for establishing protected human settlements, and provide opportunities for scientific exploration to better understand lunar volcanism and impact processes. This contribution outlines the most recent advances in lunar caves research, and discusses how the exploration of the subsurface of the Moon could represent a key milestone for space exploration in the next decades.