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# LUNAR LAVA TUBE INFRASTRUCTURE AND INNOVATIVE TECHNOLOGIES TESTING THROUGH SPELEOLOGY ANALOG MISSION: THE SAPIENZA GEA PROJECT

## Abstract

Future human space exploration missions aim to return man, and the first woman, to the Moon, establishing permanent exploration of our natural satellite. In this context, the study of the psycho-physical responses of men and women, and also in-depth testing of mission experiments, habitats and supporting hardware can be greatly facilitated through the execution of analog missions. Analog missions aim to replicate certain conditions and situations that astronauts could face during their mission, by performing activities in a relevant environment. Isolation, social interaction, poor exposure to sunlight, alteration of the circadian rhythm are some of the aspects to be taken into account. These missions can also provide valuable opportunities for students to gain hands-on experience in human spaceflight and space exploration engineering. GEA (Analog Exploration Group) is a cave analog mission project developed by Sapienza University of Rome (S5Lab research group) together with the Italian Alpine Club (CAI). The main objective of the project is to provide students with the opportunity to experience first-hand analog mission in an underground environment. The 72-hour mission includes several activities such as environmental monitoring and mapping, resources monitoring, experiments on autonomous cultivation of vegetables and electricity generation through organic waste recycling. The students, through specific training, are involved in all aspects of the mission, from design of the experiments to in-cave testing, with participation in the actual astronautics activities. GEA has been established in 2022 and the first two training courses have been completed in caves in Italy for 16 students and researchers. The so-far performed activities include the development of experiments related to autonomous plant cultivation, Microbial Fuel Cells development in relevant environment, psychological tests for the participants, realization of habitats and testing of the designed Mission Control Center (MCC). The team has realized shorter testing missions of 24 hours to verify the well-functioning of all the designed systems. Stakeholders and partners from different institutions in Italy and abroad are being involved to extend the impact of the mission to various technical fields. After a brief introduction this article will describe the organization of the project, the activities and the experiments carried out during the mission. The results and the achievement, both scientific and related to the psychological and physiological aspects of the crew will be presented. Finally, the implementation plan executed for developing national and international collaboration, both with public and private organizations, regarding experiments, student activities and outreach will be discussed.