

IAF SPACE EXPLORATION SYMPOSIUM (A3)
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ARES STATION: A UNIQUE PERMANENT PLUG-AND-PLAY SUBSURFACE ANALOG STATION
FOR EXPLORING HABITABILITY AND OPERATIONAL CAPABILITIES ON MARS.

Abstract

Establishing habitats underground in Moon or Martian caves, specifically lava tubes, would efficiently address many of the risks derived from such environments. Indeed, for human habitations, the lack of a magnetic field, thin atmosphere, and extreme temperature cycles would additionally pose a big hazard for both humans and equipment. Underground habitats would provide a benign controlled temperature environment, a natural protection against meteorite impacts, radiation protection, and flexibility in using lightweight building materials.

The benefits of using natural caverns such as lava tubes on either the Moon or Mars as receptacles for habitation structures or as protective shelters have been around for almost four decades. Past research on human Mars missions, including most of the analogue studies, has focused mainly on surface operations (excl. ESA Cooperative Adventure for Valuing and Exercising). Thus, more research and data are needed to address the specific requirements and challenges of subsurface habitability and operational performance. For that reason, Astroland has developed and operates the first permanent cave analog in the extreme environment of a cave near Santander, Spain, which has a max height of 60 m and a length of over 1.5 km.

This main habitat (Alpha base) is fully equipped to enable testing of End-to-End mission concepts: e.g., research laboratories, made-to-measure astrolander suits and technical clothing, hydroponics lab, autonomous power, water waste management, 3D printer, survival kits, food supplies specifically adapted per crew member, kitchen, leisure and gym areas, plus the provision to expand modules. Completely isolated from external interferences, the cave Ares Station hosts Astroland's own analog habitat with a capacity for 8 crew members.

To simulate the different operational conditions that the teams might face, we can introduce different time delays in the communications to represent the actual distance between Mars and Earth (4 to 24 minutes depending on the planet's relative position). After over 15 missions Astroland's concept and infrastructure have achieved the maturity level to support long-duration research analogue missions to test and validate technology and operations roadmaps and establish a research hub for international cooperation. In addition to serving as a research platform on underground habitats, the Ares station provides a fantastic biological testing platform, as it hosts aerophilic cyanobacteria which are examples of adaptation to extreme environments conditioned by the lack of light in a nutrient-poor environment. Ares Station is unique in its design, location and biological research possibilities in analogue space missions.