Non-destructive Testing in Lava Tubes on the First Space Analog Mission in Portugal

Overview

- Scientist-astronaut Ana Pires led Portugal's first space analog mission to assess geotechnical rock mass and underground geomechanical stability and characterize lava tubes similar to those found on the moon.
- The Schmidt Hammer and Equotip portable hardness tester were used to assess the rock hardness of the lava tube rock wall during the engineering geology mapping and geotechnical assessment.
- The team successfully collected valuable data despite the extreme conditions, significantly highlighting Portugal's potential in space exploration.

Scientist-astronaut Ana Pires is a researcher at INESC TEC's Centre for Robotics and Autonomous Systems and has been using Screening Eagle's Proceq equipment for over twenty years. From the ground-breaking missions here on earth at "Mars" Terrestrial Analog sites and in marine environments to the all-women microgravity mission to perform research in "space", Ana proves there are no limits…

For this mission, which stimulated a Lunar environment, Ana Pires (Geosciences and Geotechnics), Rui Moura (Geophysics), and Helder I. Chaminé (Geo-Mapping and Geomechanics) were the Geo-team of Crew Zero.

Challenge

Lava tubes have been identified on Mars and the Moon. Aside from being good places for humans to protect themselves from radiation, micrometeorites, and extreme temperature variations, lava tubes may be the starting point for building labs and habitats on the Moon and Mars. That's why performing underground engineering geology mapping and testing the geotechnical rock mass behavior and geomechanical stability of the lava tubes here on Earth is crucial.

There are several lava tubes worldwide, and this project proves that Portugal holds excellent potential for this type of research. The extreme conditions for the research were highly challenging. There is an isolated shelter from the exterior on the site's surface where the team can store equipment and food and use the bathroom.

Underground, inside the lava tubes, the team has tents to sleep in and headlamps and lighting to conduct their research. Most of the time, the team spends inside the lava tube researching, mapping, and collecting rock and soil samples. Seven researchers were inside the cave conducting various experiments, including Ana's geotechnical characterization and geomechanical evaluation testing on rock mass.



A glimpse inside the lava tube living space of the first lunar analog mission in Portugal.

Solution

Equotip portable hardness testers and Schmidt Classic Hammers (types L, LR) were the chosen tech solutions for this project. They have been the trusted geo-partners for Ana's working life in all extreme environments. Ana uses both technologies to correlate the values and understand the rock behavior better. During the mission, the team had three remote outreach and educational activities sessions, explaining what they were doing live in real time.

The Equotip portable hardness tester was used to understand if these structures are safe to build, do construction, and do architecture inside. Geotechnologies like Proceq offer a rugged solution to measure rock hardness. The Equotip and Schmidt Hammer complement the rock hardness assessment and help assess the geomechanical behavior of rock mass and the underground geotechnical mapping. This helps humanity better understand the future if these caves are safe for humans to live inside. Important work!



Ana Pires taking measurements with the Equotip portable hardness tester

Results

The team spent almost 24 hours daily for 6 nights and 7 days underground in the lava tubes, showing great potential for using these natural stretches for space training activities.

Everything went well, and they received support from the local speleological association (‘Associação Os Montanheiros’), which offered all the safety and backing they needed.

The results of this mission were more than geotechnical assessment and more than science. It was also an extraordinary project because two women led this first mission. Ana was the commander of this mission, and Yvette Gonzalez, an indigenous-origin Executive Officer (XO), brought diversity where it had not been before while leading a mission that had also never been done in Portugal.

This unique and vital mission shows the potential benefits of construction or habitation inside lava tubes. It also shows the incredible potential of the non-destructive testing equipment, Schmidt hammer and Equotip, when used in extreme conditions.



Ana Pires takes hardness measurements inside the lava tube with the Equotip portable hardness tester.

The team collected vast amounts of data over the seven days they spent inside the lava tubes. Now, they are mapping, processing, analyzing, and assessing the data to draw conclusions and learn lessons about the lava tube's geomechanical behavior and stability.

"It was an extreme mission, but at the same time and as a woman, leading the first lunar space analog mission in Portugal was amazing!" – Ana Pires, INESCTEC.

Stay tuned for further updates on Ana's unique missions with Schmidt and Equotip, here on Earth and in space!

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