

SALM Sainte-Rose and Lava Tubes : Exploring Underground on the Moon and Mars

By Guy PIGNOLET

Site Analogue Lune Mars, Sainte-Rose, Reunion, France, European Union

Lava Tubes are very important targets of future Lunar and Martian exploration. SALM Sainte-Rose (“SALM” is the French acronym for “Moon Mars Analogue Site”) has been set up for assistance to international research teams. It is an intermediate step between lab simulations and the real planetary exploration. Piton de La Fournaise, one of the largest volcanoes on Earth, 7-km high, features many lava tubes under its slopes. Because they are an essential part of the building process of volcanoes, exploring lava tubes is an important aspect of developing our knowledge of Moon and Mars volcanic structures. Robotic systems will have to be designed, but researchers are faced with many technical challenges : how to locate the robots underground, how to communicate with them, how to deal with pits and how to move across masses of fallen rocks ? SALM Sainte-Rose will offer opportunities to test solutions in a real environment, with organizational assistance and scientific support.

Key Words: Moon, Mars, Analogue Site, Reunion Island, Lava Tubes

1. Introduction

SALM Sainte-Rose (“SALM” is a French acronym meaning “Moon Mars Analogue Site”) has been set up in 2010 in cooperation with ILEWG, the International Lunar Exploration Working Group, for assistance to the international European and World research teams that seek to test equipment and procedures in preparation for future planetary missions.

SALM Sainte-Rose is located on Piton de La Fournaise, one of the largest volcanoes on Earth, 7-km high, on Reunion Island, a remote region in the far South of the French Republic and of the European Union, at about a 10-hour flight distance from main land.

Piton de la Fournaise, a significant volcanic Moon and Mars Analogue Site on Planet Earth, features many lava tubes under its slopes, and SALM Sainte-Rose appears as a valuable intermediate step between laboratory simulations and the real planetary exploration, since lava tubes are very important targets of future Lunar and Martian exploration.

2. Lava Tubes are typical volcanic features

Because lava tubes are an essential part of the building process of volcanoes, exploring them is an important aspect of developing our knowledge and understanding of the volcanic structures which exist on the Moon and on Planet Mars.

Lava tubes are environments of great interest, and they offer access to specific and remarkable structures that are often created during volcanic eruptive phases. They occur when the upper surface of a flowing lava channel becomes solid as it cools at the contact of the atmosphere. It then forms a sort of lid over the river of lava that continues to flow underneath until the exhaustion of the eruption at the origin of the tunnel which then empties and leaves a lava tube.



Reunion Island is an overseas region of the European Union

Lava tubes constitute archives of the different phases of the processes that occurred at the time of the eruptive flow. During the recent 2004 eruption of Piton de la Fournaise in Reunion Island, many new lava tubes were formed, often extending down to sea level. The longest tube chartered develops over a length of 2700 m with a total denivellation of 345 m. The topography and the development of the creation of several sections have been well documented.

Exploring the cavities of lava tubes at SALM Sainte-Rose may help in developing tools for the interpretation of the processes that may be found also on the Moon and Mars.



Typical lava river before formation of lava tube



Many lava tubes are large enough for human exploration



Lava rivers during the 2007 eruption with formation of lava tube



Lower part remained an open ditch

3. Exploration of Lava Tubes

Some lava tubes are large enough that people may stand easily, and there are also very large caves. But lava tubes may be complex and treacherous for the safety of the explorers. There may be multiple channels and multiple connected levels. Solidified lava offers good resistance but there may be cracks and part of the structure may fall if mechanically challenged as is often evidenced by rock piles. It is difficult to assess the thickness of the lava floors, and there is always a possibility of collapsing.



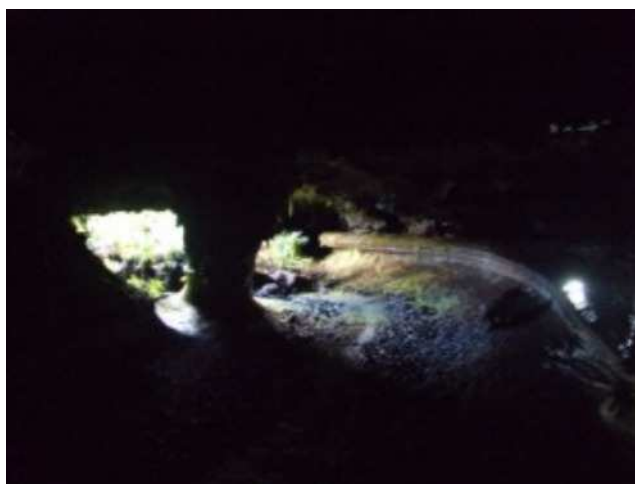
The inside of lava tubes may be sometimes chaotic



An entrance of a lava tube



The structures of lava tubes may be quite complex



A large cave with a pillar : a possible habitat ?

On the Moon and Mars, but also on Planet Earth, robotic systems will have to be designed to explore conveniently and safely the lava tubes, but researchers are faced with many technical challenges due to the specific nature of lava tubes.

Underground, where electromagnetic waves may have difficulties to transmit over a distance, how is it possible to locate and track the exploring robots, and how is it possible to communicate with them to send commands and receive data ?

How is it possible to crawl over the uneven surfaces that are likely to be found, how to deal with pits and to climb up or down between different levels, how to move across chaotic masses of fallen rocks ?

All these are quite difficult challenges that the engineers will have to meet when designing equipment that will explore underground the Moon and Mars, and analogue sites like SALM Sainte-Rose are convenient places to try out solutions.

4. SALM is Assistance for Moon and Mars Explorers

In Reunion Island, SALM Sainte-Rose offers an opportunity to make tests in a real environment, with remarkable academic and logistical regional support in connexion with the University of La Reunion and the City of Sainte-Rose.

In addition to its potential for scientific and technological assistance, SALM Sainte-Rose runs educational activities with exhibitions and a weekly public outreach forum every Friday evening, called the “Martian Cafe”, where Moon and Mars researchers from the whole world are invited to give casual presentations from their own home or offices through Skype teleconferencing.

Also, the preservation of the planetary environment should be a major concern for researchers, on the Earth, the Moon, Mars and on other planets of the solar system - including underground in lava tubes - and the expertise of the National Park of La Reunion, recently recognised as World Heritage by Unesco, may be useful to meet this other challenge as well.



SALM Sainte-Rose, located on the volcanic analogue site

Acknowledgements

The author wishes to address his special thanks to Lucette Ferlicot, Patrice Huet, François Martel-Asselin, Roby Soriano, Didier Cailhol and many others for their images and advice.

Reference and Contact

- 1) SALM Sainte-Rose : <http://www.science-sainte-rose.net/salm>
- 2) Main contact for SALM : Guy.Pignolet@science-sainte-rose.net