

**A MOON-MARS ANALOGUE VOLCANIC SITE AT LA REUNION
FOR PREPARING FUTURE GEOLOGICAL AND HUMAN EXPLORATION**

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ABSTRACT

Forty years after the Apollo missions, the international space community is considering a manned return to the Moon, and beyond, the human exploration of Mars. In preparation for these new developments, it will be useful to have analogue sites presenting some similarities with lunar and martian conditions, for the purpose of testing equipments and procedures. There have been so far simulations in Antarctica, and there is an operational research site in the desert of Utah, USA. There also exists a site that will be appropriate for further developments in Reunion Island, a French region of the European Union, with the so-called "Plain of Sands", a mineral landscape located in the volcano area of La Fournaise on the territory of the city of Sainte-Rose. Back in 2002, a TV documentary was made on this site, with the participation of several scientific experts, to present in a vivid manner what the future human exploration of Olympus Mons might be like. Reunion Island offers an excellent environment in terms of logistics and professional support, with territorial infrastructures featuring full European standards, and several direct flights from Paris, France, on every night, practically with no time lag difference with continental Europe. Since La Reunion is European territory, there are a minimum of administrative and security burdens, especially for the European citizens. The Sciences and Technology Unit at the University of La Reunion may bring future-oriented quality contributions, especially in the field of energies, but also, together with the National Park of La Reunion, in the fields of environment and public outreach. A powerful regional audiovisual industry can readily produce technical and promotional documents for the Sainte-Rose Analogue Site. Sainte-Rose already has experience about space activities. The city was one of the sponsors of Sputnik-40-Years, the first high-school satellite in the world. In 1997, Sainte-Rose hosted a world meeting of the Education Committee of the IAF, and in 2006 NASA installed in Sainte-Rose a temporary tracking station for the launch of the New Horizons Pluto probe. Today, the city of Sainte-Rose can readily offer to Moon and Mars researchers a permanent support base for an operational Moon Mars Analogue Site.

1 – INTRODUCTION : ANALOGUE SITES

Forty years have gone since the Apollo missions in the seventies. Today, the international space community, government administrations, research institutes and major international business groups are considering a manned return to the Moon, and beyond, the exploration of Planet Mars by humans (fig.1), not counting many automatic missions for preparation and support. In order to have these new developments to make progress, it will be very useful to have analogue sites that have similarities with the conditions prevailing on the Moon and on Mars, in order to test



equipments and procedures, considering the technology and the organisation questions as well. There have been simulations in Antarctica, and in the North of Canada, there is an operational research site in the desert of Utah in the United States, and American university researchers are considering the development of new sites in Hawaii. In Europe, simulations have been conducted by ILEWG, the International Lunar Exploration Working Group, on the volcanic land of the Eifel region (fig.2) [ref.1].



Fig.2 : Simulation of extra-vehicular activity for the inspection of the ExoGeoLab lander on the volcanic site of Eifel (ILEWG campaign)

According to Richard L veill , of the Canadian Space Agency, "Analogue sites are places on Earth that present some geological, environmental or biological conditions that are estimated to exist on some celestial bodies, today or in the past. The so-called "analogue" studies are necessary because they allow us to understand how some processes work on Earth and thus to interpret and to validate the data that are received from orbiters or from roving exploration robots. Analogue sites are also important places to work on the optimisation of scientific and technological requirements as well as working on the exploration strategies for manned or robotic exploration missions to the Moon or to Mars." [ref.2]. To validate technologies and procedures, analogue sites represent useful intermediate steps between laboratory environments where conditions are known, but limited by choices made by the experimenters, and the "real life" of future explorations, with its important share of unknown and discovery. Tests made on an analogue site may thus enlarge the spectrum of reacting capability for machines and for men as well.

2 - A REMARKABLE SITE : THE PITON DE LA FOURNAISE VOLCANO



Fig.3 : Reunion Island, in the Indian Ocean, a volcanic region of the European Union, just one night of flight away from Paris airports.

On Reunion Island (fig.3) (fig.4), a French remote region of the European Union, there are on the volcanic mountain of Piton de la Fournaise several sites that are proper for simulating experiments on the Moon or on Mars, especially in the "Plain of Sands" a zone of mineral landscape located on the territory of the city of Sainte-Rose.

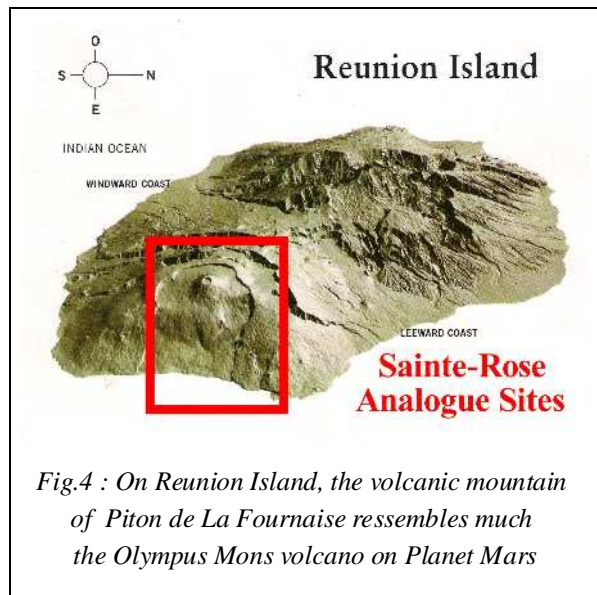


Fig.4 : On Reunion Island, the volcanic mountain of Piton de La Fournaise resembles much the Olympus Mons volcano on Planet Mars

In 2002, a TV documentary fiction was made on this site (fig.5) [ref.3], with the participation of planetary geologist Charles Frankel and other scientific experts, to present in a vivid manner what a future exploration of Olympus Mons volcano by humans might look like.



Fig.5 : Images from "Ascent of Mars Mountain " a movie shot in the Plain of Sands in La Reunion

The movie begins with an approach of Planet Mars that uses 3D images made from the data collected by the Viking spacecraft, and a few moments later, with a hardly noticeable transition, it continues for a final approach shot in the Plain of Sands in La Reunion. " We had been looking everywhere in the world, in the United States, in Jordan, and we had found nothing like this, says with enthusiasm producer Gregg Lanning who made the movie Ascent-of-Mars-Mountain (On-a-marché-sur-Mars). Plain of Sands is Mars" [ref.4]. This is a fact that many tourists and visitors make readily the comparison with lunar or martian landscapes.

From a geological and structural point of view, Piton de la Fournaise, 7-km high, one of the largest volcanoes on Planet Earth, resembles much the volcanoes of Mars, and especially Olympus Mons.

3 - AN ENVIRONNEMENT OF EXCELLENT LOGISTICS

For the teams of Moon and Mars experimenters, Reunion Island offers an excellent environment in terms of logistics. Several direct flights link Paris and the rest of Europe with La Reunion every night, practically without any time lag. On the island, they can find their usual infrastructures with a road network and a professional environment of fully European standards, including in matters of communications. Furthermore, since La Reunion is a French region, a European territory, access is possible with a minimum of administrative and security constraints, especially

for researchers who are citizens of the European Union and members of the European Space Agency ESA, even though La Reunion is open to the whole world. The city of Sainte-Rose is small by the size of its population, nevertheless it has great ambitions in terms of energy and projects for the future, with the largest photovoltaic farm in France and regional projects to harness the thermal energy of the ocean (OTEC). The city has full capability to support the logistics for the development of an analogue site, especially considering transportation, with a highway that makes Sainte-Rose less than one hour far from the Saint-Denis international airport. Communications feature high-speed internet connexions and microwave beams to the volcano area.

4 - A REMARKABLE ACADEMIC ENVIRONNEMENT

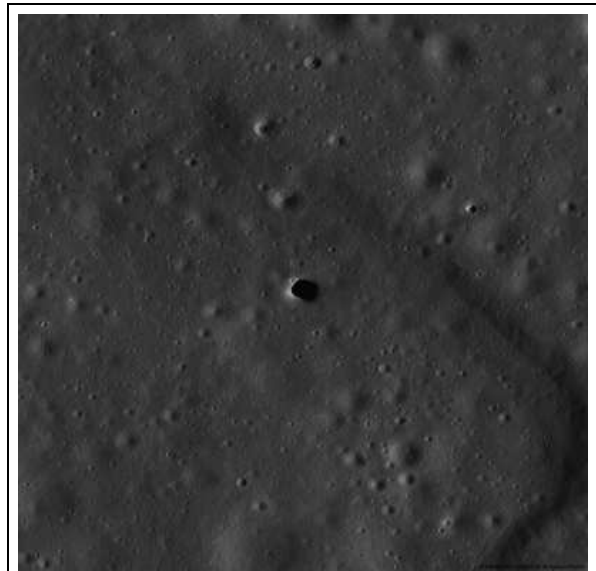


Fig.6 : Lava tubes that are similar to those existing under the slopes of Piton de la Fournaise have been discovered on the Moon by Japanese probe Kaguya and re-observed by the American probe LRO

The Sciences and Technology Unit at the University of La Reunion, and the technology institutes on the island feature researchers and quality laboratories that are oriented to the future, especially in the domains of

energies. The University of La Reunion was first in Europe to demonstrate a system of wireless power transportation (WPT) by microwaves, a technology that will be essential for future space power systems.

As a partner of the Sainte-Rose Moon Mars Analogue Site, the University of La Reunion brings its support and its teams, particularly in the fields of vulcanology, energies and technology, especially in the domain of robotics, where it may bring important contributions.

A specially interesting subject for study could be the lava tubes that run under the slopes of Piton de la Fournaise. Similar tubes have recently been spotted (fig.6) [ref.5] in the volcanic Marius Hills region of the Moon by the Kaguya probe (JAXA) and later by the LRO probe (Lunar Reconnaissance Orbiter) of NASA. The MRO probe (Mars Reconnaissance Orbiter) has made similar discoveries on Mars volcanoes.

5 - INTEGRATION WITH THE NATIONAL PARK

The Plain of Sands is located within the National Park of La Reunion that is especially dedicated to questions of environment and public outreach. The presence of the Moon Mars Analogue Site is an element of valorisation and prestige for the National Park. Its teams may contribute their specific experience in terms of protection of the environment, that will be an important aspect of future missions for the exploration of the Moon and Planet Mars.

Apart from the experimentation campaigns, the habitat modules and the equipments used for simulations may be at other times relocated near the logistic base in the heart of the village of Piton Sainte-Rose, near the entrance of the so-called touristic "Lava Road", with goals aiming at the information and the education of the general public.

The EuroMars Project (fig.7) [ref.6], developed by the French section of the Mars Society, is an example of a structure that may play a dual role, both experimental, with space researchers, and educational, with the general public, in partnership with the National Park of La Reunion.

6 - THE AUDIOVISUAL RESSOURCE

In La Reunion the audiovisual business is a strong sector of activity. It offers readily available resources to document and promote the activities of the Moon Mars Analogue Site, with all the qualified equipment and teams to cover two essential aspects :

- making technical images to record the on-going research activities and experiments and allow their exploitation within the best conditions,



Fig.7 : The example of the "Flashline" station set up by the EuroMars research group in Devon Island in the north of Canada

- covering the whole project for the purpose of keeping traces and making documentaries that may be exploited to communicate with the general public and with the various institutions in order to raise recognition and support for Moon and Mars projects.

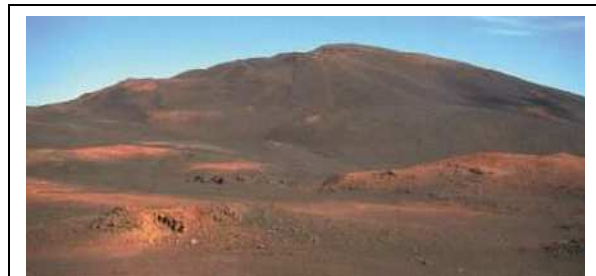


Fig.8 : The Moon / Mars landscape of the Plain of Sands. The site used for filming the fiction documentary "Ascent of Mars Mountain"

The local Reunionnese audiovisual professional teams have the end-to-end capability to make films on different projects, to make clips on various aspects, to produce educational and/or promotional DVDs, etc.

and to build extended image libraries.

In La Reunion, more than one hundred professionals (cameramen, sound specialists, stage directors, editors, etc.) work in the domains of filming, post-production, editing and final production of movies. Many production businesses turn out dozens of hours of production yearly for broadcast TV or for companies (documentaries, news, clips, short movies, institutional image building, advertising, etc.). Year after year, much competence has developed in La Reunion in the various domains of making images. There is a regional Image Institute (ILOI) that trains students up to Master level, and a School of Fine Arts. There are regional and international film festivals. Several TV broadcasters operate on the island, including RFO Reunion, a regional branch of the national public group France TV, Antenne Reunion, a private group, and Noot TV, by satellite. For the past ten years, the regional government has given specific public subsidies to support audiovisual production, and this has led to a large development of local production.

The activities of a Moon Mars Analogue Site in Sainte-Rose represent a new challenge for the numerous regional talents and expertise.

7 - CONCLUSION : THE MOON MARS ANALOGUE SITE IN SAINTE-ROSE

The city of Sainte-Rose already has a long experience in space-related activities. It was a partner of the Sputnik-40-Years high-school satellite and hosted the organisation of an international seminar of the Education Committee of the IAF in 1997.

Recently, in 2006, NASA installed in Sainte-Rose a temporary tracking station for the launching of the New Horizons interplanetary probe to Pluto.

Today, the City of Sainte-Rose may immediately make available a facility for the international Moon and Mars researchers to organise a permanent administrative and technical base. The city may also provide the logistics for transportation and communication to make the Moon Mars Analogue Site operational.

A first visit of the ILEWG researchers may take place at the end of the year 2010 for a reconnaissance of the possible analogue testing sites, for a discovery of the Reunionese potential, and for initial meetings with the academic, technical and institutional partners.

After the International Astronautical Congress IAC-2011 that is going to take place in neighbouring city of Cape Town in South Africa, the community of future users of the Analogue Site may come to La Reunion to discover the site and to proceed to a first campaign of experimentation and simulations.



Fig.8 : The buildings of a former police station, half-engulfed in lava during the 1977 eruption, will host the permanent base for the Moon Mars Analogue Site in Sainte-Rose.

Guy Pignolet, a citizen of Sainte-Rose, is a retired engineer formerly in charge of future studies with the French Space Agency Cnes and a former chairman of the Education Committee of the International Federation of Astronautics. He has been appointed by the City of Sainte-Rose to manage the development of the Moon Mars Analogue Site in Sainte-Rose, in cooperation with the ILEWG International Lunar Exploration Working Group, together with all the community of partners and users of the analogue site.

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We thank Mr. Bruno Mamindy-Pajany, the Mayor of Sainte-Rose and all the members of the City Council for their continued support that made possible the Moon Mars Analogue Site project in Sainte-Rose. We also wish to thank our colleagues at the Sciences and Technology Unit of the University of La Reunion and more especially Prof. Bernard Offmann. We also thank Jean-Marie Pernelle, of the audiovisual production organisation En Quête Prod. We wish to thank especially planetary geologist Charles Frankel [refs.7,8,9], who is responsible for the EuroMars project, for his documentation and advice.

For more information concerning the Moon Mars Analogue Site in Sainte-Rose, contact may be made in writing or by email with the space advisor for the City of Sainte-Rose :

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