A MUON TELESCOPE FOR ASSESSING ROCK INTEGRITY ON THE TOP OF A GIANT CLIFF – LA REUNION ISLAND

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La Reunion Island, located East of Madagascar, is composed of three shield volcanoes among with la Fournaise which is still active. The volcanic cirques, subjected to large-scale rock-falls (>10,000 m^3), regularly, impose crisis management on public authorities. Rock-falls, which sometimes cause a retreat of several meters at the top of the walls, can occur every 5 to 10 years on average. However, it seems that the effects of climate change (cyclonic events, drought, fire...) increase this occurrence.

On the top of the wall (or Rempart), the decompression cracks are concentrated on a strip often equivalent to 10% of the height of the cliff that can be higher than 1,000 m. These cracks, sometimes more than a meter wide, delimit the rock scales likely to be crumbled. The origin of these cracks, which are almost vertical on the surface, is linked to the natural decompression of the massif by the vacuum. The geometry of these cracks at depth is not well known, but it is likely that they acquire a slightly concave shape, bringing them closer to the wall and cutting out large scales at the crest of the Rempart. The volume of rock falling highly depends on the depth of these cracks.

Our experiment is focused on the Maïdo Rempart overlooking the western part of the Cirque of Mafate where the formations of the ancient volcanic outcrop in 1,000 m high scarps. We have installed a Muons telescope at “l’Ilet de Roche-Plate”, a small village located at the foot of active scree cones at the foot of the Maïdo Rempart. This innovative experiment follows a fire that occurred on the top of the Rempart at the end of 2020, which led to an increase in falling blocks and a potential acceleration in the opening of cracks.

A diagnosis and a monitoring were requested by the local authorities to the national geological survey, the BRGM. One of the issues is to better delimit the volume of "fractured" rocks and if possible, to identify the depth of the decompression cracks that delimit the scales likely to fall. Given the gigantic morphology of the geological feature, the solutions available to geoscientists are few.

Muography was chosen because it allows to access the density variation in time and space, in a passive way, by collecting in the telescope the muons which crossed the rock. A telescope based on scintillators technology has been installed for up to 6 months at the footwall of the Maïdo Rempart. The rainy season was chosen as the acquisition window to be able to follow the density variations that occur in the massif during rainy events. It is composed of 3 parallel ~1m^2 active detection planes recording the positions and the precise time of the particle’s hits. The detector readout has been developed on the early concept of connected “smart sensors”. It allows an optimized selection of the particles hits to perform their tracking. A post-processing analysis will translate the recorded tracking properties into a detailed image of the target within the acceptance of the detector, in our case the top part of the Maïdo Rempart.