

ASTROPARTICLE TECHNIQUES: COLOMBIA ACTIVE VOLCANO CANDIDATES FOR MUON TELESCOPE OBSERVATION SITES

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We discuss a methodology to identify observation points for muography of active Colombian volcanoes; we found that only Cerro Machín can be studied.

The MUTE (Muon Telescope) is a project to design, construct and operate a hybrid detector (2 scintillator panels + a water Cherenkov detector) to measure integrated flow of muons crossing a rock mass (≈ 100 m) in Colombian active volcanoes.

Muography measures the attenuation of cosmic muon flux making it possible to build images of volcanic inner structure at the top of the edifice. It uses the same basic principles of standard medical radiography (Marteau et al. 2012; Tanaka 2014).

As the particles measured at ground are produced by the interaction of cosmic rays with atmospheric elements, their modulation needs to be carefully corrected by considering those factors that could affect the integrated flux at Earth surface, mainly geomagnetic conditions, atmospheric reaction and detector response (Asorey et al. 2015). From this simulation chain we estimate the background muon flux, as a function of its arrival direction and energy, incident on geological structures.

Muons cross matter and lose energy described by $-\frac{dE}{dq} = a(E) + b(E)E$, where $a(E)$ and $b(E)$ are functions of the material and $\rho(L)$ is the density integrated along trajectories. If we choose homogeneous standard rock, (i.e $Z/A \geq 0.5$ and density 2.65 g cm^{-3}), the distances traveled by muons and its integrated flux density, depending on their energy and arrival directions, are determined, considering volcano topographies and their surroundings, (See Figure 1).

After having analyzed four Colombian volcanoes –Nevado del Ruiz, Galeras, Cerro Machín and Cerro Negro-Chiles– we have determined that only Cerro Machín is feasible to be studied by muon tomography from two points: $4^\circ 29' 39.53'' \text{ N}$, $75^\circ 23' 17.04'' \text{ W}$, and

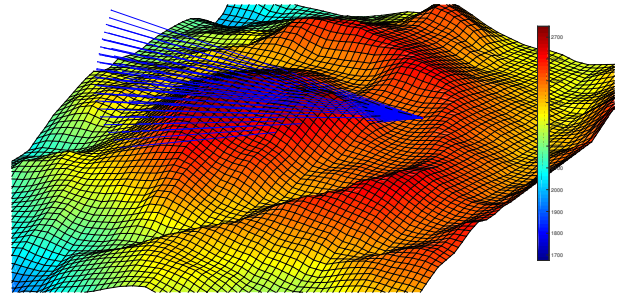


Fig. 1. Cerro Machín with one of its raytracing.

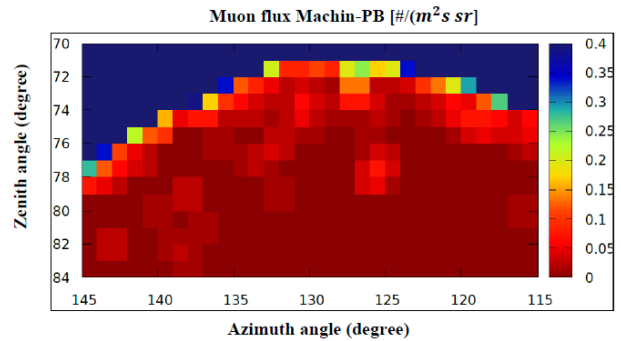


Fig. 2. Muon flux at $4^\circ 29' 31.14'' \text{ N}$, $75^\circ 22' 48.31'' \text{ W}$, Cerro Machín.

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