Geophysical Research Abstracts
Vol. 20, EGU2018-6667, 2018
EGU General Assembly 2018

The effect of rock composition on muon tomography measurements

Alessandro Lechmann (1), David Mair (1), Akitaka Ariga (2), Antonio Ereditato (2), Ryuichi Nishiyama (2), Paola Scampoli (2,3), Tomoko Ariga (2), Ciro Pistillo (2), Mykhailo Vladymyrov (2), and Fritz Schlunegger (1)

(1) University of Bern, Institute of Geological Sciences, Bern, Switzerland (alessandro.lechmann@gmail.com), (2) University of Bern, Laboratory for High Energy Physics, Bern, Switzerland, (3) Dipartimento di Fisica "E. Pancini", Università di Napoli Federico II, Napoli, Italy

Present day muon tomography experiments are often built in such a way that muons penetrate several layers of various materials up to a few hundreds of meters before they are recorded by a detector. Based on these measurements, geophysicists aim at an improved understanding of subsurface structures (i.e. material boundaries) or spatial variations of a physical material parameter (i.e. mass density). Due to the lack of a systematic investigation of the stopping power of muons for different rock types, these materials have been summarised under the somewhat unclear term “standard rock” which is supposed to be applicable for all kinds of rocks. The standard rock is essentially a blend of calcium carbonate and sodium parameters that mimic the energy loss behaviour of a granitic rock. In such experimental setups the standard rock approximation can be safely applied.

This first order approximation is indeed reasonable for the account of noise around underground physical experiments that are designed to record other particles than muons. However, we show that if the desired signal are muons, this simplification can potentially produce serious errors, which in turn map directly into the tomographic result. This inaccuracy persists, with a smaller magnitude, even if the density difference has been accounted for. Consequently, this can be traced back to a discrepancy in rock composition.

As geophysical surveys are not restricted to any specific lithology, we investigated the effect of alternative, commonly occurring rock compositions (both sedimentary and igneous) and consequentially prefer to replace the standard rock approach with a more realistic rock model.

Laboratory measurements of density (He-Pycnometer), crystallographic (X-ray diffractometer) as well as mineralogical information (thin-section analysis & X-ray fluorescence) can be used to properly describe a rock, including a meaningful error on these quantities. Finally, a three-dimensional, integrated geological model can be built that encompasses the above parameters and structural field observations and that serves as the initial model for the tomography.

Simulation results show discrepancies of up to 20% between standard rock data and different rock types, which are consistent with for analogous GEANT4 simulations of the same experimental setup.