Standard rock

For at least two generations, the depth of underground muon experiments has been reduced to depth in "standard rock." This is by definition the overburden of the Cayuga Rock Salt Mine near Ithaca, New York, where K. Greisen and collaborators made seminal observations of muons at substantial depths[1]. Ref. 1 says only "Most of the ground consists of shales of various types, with average density 2.65 g/cm^2 and average atomic number 11." Menon and Murthy later extended the definition: $\langle Z^2/A\rangle = 5.5$, $\langle Z/A\rangle = 0.5$, and and $\rho = 2.65$ g/cm^2[2]. It was thus not-quite-sodium. Lohmann[3] further assumed the mean excitation energy and density effect parameters were those of calcium carbonate, with no adjustments for the slight density difference. We use their definition for this most important material.

(Extracted from D.E. Groom, N.V. Mokhov, and S.I. Striganov, "Muon stopping-power and range tables, 10 MeV–100 TeV," Atomic Data and Nuclear Data Tables 78, 183-356 (2001).)

[1] P. H. Barrett, L. M. Bollinger, G. Cocconi, Y. Eisenberg, and K. Greisen, Rev. Mod. Phys. **24**, 133 (1952).

[2] M. G. K. Menon and P. V. Ramana Murthy, in *Progress In Elementary Particle and Cosmic Ray Physics*, (North Holland, Amsterdam, 1967), Vol. 9, 161–243.

[3] W. Lohmann, R. Kopp, and R. Voss, "Energy Loss of Muons in the Energy Range 1–10000 GeV," CERN Report 85–03 (1985).