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Self-attenuation factors in gamma-ray spectrometry of NORM samples

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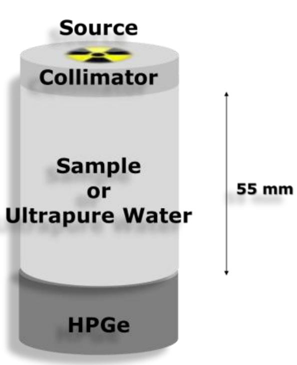
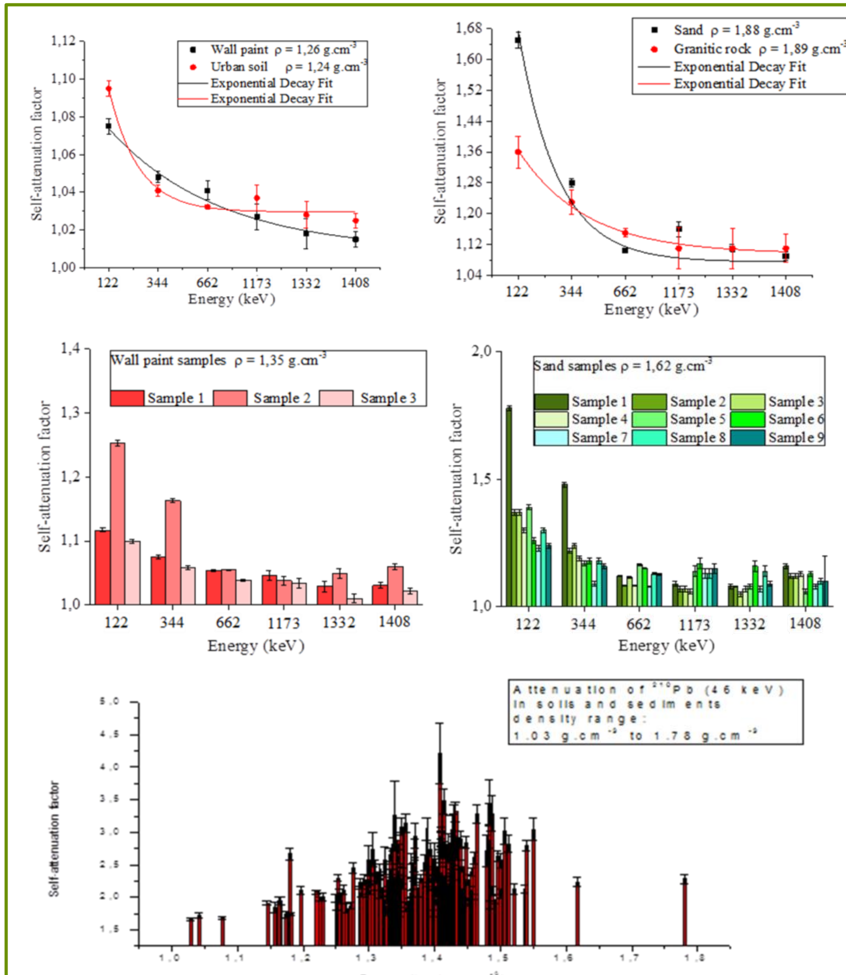
Table: Samples analyzed over the last 7 years at Environmental Radiometric Laboratory, IPEN – Sao Paulo

Sample type	Density (g.cm^{-3})	Total
Granitic Rocks	1.57 - 2.02	50
Sand	1.26 - 2.35	132
Urban Soil	1.07 - 1.32	10
Wall Paint	0.97 - 1.46	50
Soils / Sedimemts	1.-3 – 1.80	165



Cutshall Technique

$$f_i = \frac{\ln\left(\frac{S_i}{W_i}\right)}{\left(\frac{S_i}{W_i} - 1\right)}$$



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Self-attenuation factors in gamma-ray spectrometry of NORM samples

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Introduction

High-resolution gamma-ray spectrometry is currently the most widely used analytical technique for radionuclides qualitative and quantitative determination. Quantification of elements relies on the correct analysis of the spectra, depending strongly on the efficiency calibration of the measurement apparatus, most often performed with aqueous standard multi-radionuclides solutions. For efficiency calibration curves obtained with aqueous standard multi-radionuclides solutions and NORM samples such as sand, soil, rocks and wall paints with apparent typical densities higher than water, self-attenuation correction factors were experimentally determined for hundreds different samples by Cutshall transmission technique.

Method

The **Cutshall technique** consists basically on measuring the transmission of gamma-rays through both the sample of interest and an ultrapure water sample in the same geometry, with gamma transitions in the range of interest.

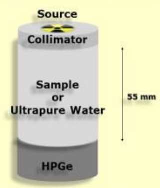

FIG.1. Illustrative scheme of the experimental setup.

$$f_i = \frac{\ln\left(\frac{S_i}{W_i}\right)}{\left(\frac{S_i}{W_i}-1\right)}$$

f_i: self-attenuation factor for a particular *i-th* gamma transition

S_i: beam intensity transmitted through the sample for a particular *i-th* gamma transition

W_i: beam intensity transmitted through the ultrapure water sample for a particular *i-th* gamma transition.

Sample type	Density (g.cm^{-3})	Total
Granitic Rocks	1.57 - 2.02	50
Sand	1.26 - 2.35	132
Urban Soil	1.07 - 1.32	10
Wall Paint	0.97 - 1.46	50
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Results

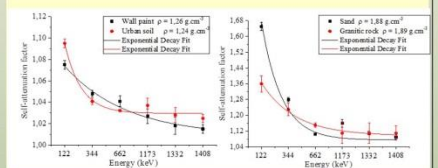

FIG. 2. Self-attenuation curves for (a) wall paint and urban soil and (b) sand and granitic rocks.

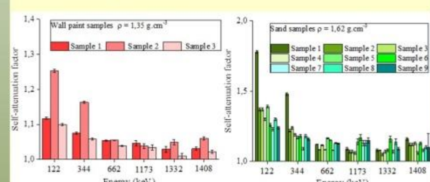

FIG. 3. Self-attenuation factors for different samples, but same density. (a) wall paints, (b) sands.

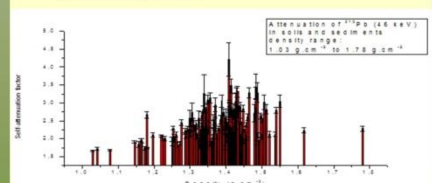

FIG. 4. Self-attenuation factors of ^{210}Pb for sediment and soil samples with different densities.

Conclusions

The results for self-attenuation correction factors of NORM samples with high apparent densities like sand, soil, rocks and wall paints measured by high resolution gamma-ray spectrometry, confirm that, apart from density, attenuation strongly depends on the sample chemical composition, so correction factors must be determined for each studied sample. Yet, the correction must be performed not only for NORM samples, but for all samples with high densities, when the efficiency curve was obtained with aqueous standard multi-radionuclides solutions.

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Fernanda Cavalcante

Thank you!