External and internal annual effective doses for Paraná state granites used as internal coating building materials by high resolution gamma-ray spectrometry

A.O. Ferreira, B.R.S.Pecequilo and M.F.Maduar

Environmental Radiometric Laboratory, IPEN (Institute of Nuclear and Energy Research), Sao Paulo, 05508-000, Brazil

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Presenting author email: mmaduar@ipen.br

The entire terrestrial crust, including rocks and soils, contains different amounts of natural radioactive nuclides, mainly primordial radionuclides as the single radioactive isotope of potassium ^{40}K and radionuclides from the uranium ^{238}U and ^{232}Th series. As a consequence, geological materials used as building materials act as a source of radiation and in massive houses made of brick, concrete or stone the absorbed dose rate depends mainly of the activity concentration of natural radionuclides in those building materials.

A complete evaluation of the annual effective dose in a construction should consider both the external and internal contributions of the constituent materials.

In this work, the potential radiological hazard for 37 commercially-used granites, used as coating building materials, extracted in outcrops from the crystalline basement of Paraná state Brazil, mainly of Curitiba Metropolitan Region, was assessed through the ^{226}Ra (^{238}U serie), ^{232}Th and ^{40}K activities concentrations, determined by high-resolution gamma-ray spectrometry.

The external contribution was evaluated by using the ^{226}Ra, ^{232}Th and ^{40}K activities concentrations in all employed materials, weighted by their fraction in the construction and also considering the background radiation of the studied location.

The internal contribution due to indoor radon inhalation was evaluated through the ^{226}Ra activities concentrations.

In order to determine the annual effective dose, the radon exhalation rate was determined by a simplified mathematical equation for construction materials (UNSCEAR, 2000).

The increment of dose by external gamma rays and the internal dose due radon inhalation were simulated as suggested by the European Commission of Radiological Protection (EC, 1999) for a model room with all internal walls of dimensions 4 m x 5 m x 2.8 m coated with the studied rocks having 3 cm thickness and 2600 kg.m^{-3}density, for an annual exposure time of 7000 hours, a dose conversion factor of 0.7 Sv.Gy^{-1} and a background radiation of 50 nGy.h^{-1}.

The results for external and internal annual effective dose estimated from the absorbed dose rate radon exhalation rate, are shown in Fig. 1. The estimated values from the contribution of inhaled radon, varied from (21 ± 2) μSv.y^{-1} up to (432 ±14) μSv.y^{-1}. The total annual effective dose, considering the sum of these two contributions, ranged from (42 ± 2) μSv.y^{-1} up to (655 ± 15) μSv.y^{-1}, below the recommended EC value of 1 mSv.y^{-1} (EC,1999).

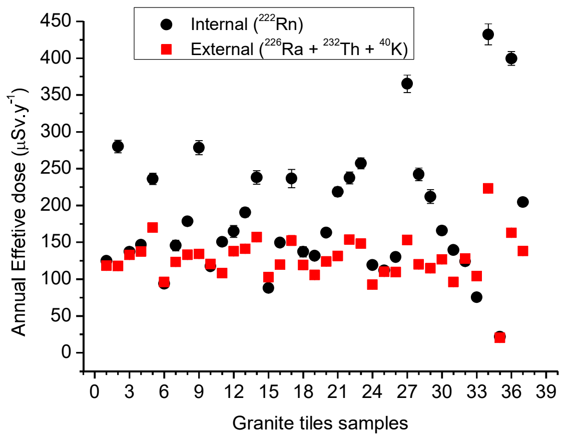

Figure 1. Internal and external annual effective doses for Paraná granites used as coating building materials.

The calculated values are below the ICRP 60 recommended limit for general public of 1 mSv.y^{-1}, but one should keep in mind that only the dose increment due to coating materials in the described scenarios was evaluated, and, for a complete assessment, the contribution of all construction materials must be considered.

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References

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