**Gamma radiation and Radon exhalation in Uruguayan building materials**

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Natural radiation accounts for approximately 80% of global average exposure, with radon inhalation being the largest contributor. ²²²Rn is classified as the second leading cause of lung cancer. While international agencies have set guidelines to limit annual exposure to below 1 mSv from building materials, Uruguay lacks specific national regulations, aside from recently introduced recommendations for indoor radon concentrations.

Samples from five categories of building materials—cements and cementitious mixtures, granites, bricks and concrete blocks, ceramic and porcelain tiles, and gypsum—were collected from local suppliers, representing both domestic and imported products. After drying and milling, the samples were tested using gamma spectrometry and radon exhalation techniques. The activity concentrations of ²²⁶Ra, ²³²Th, and ⁴⁰K were measured with a high-purity germanium detector, while the exhalation of ²²²Rn was assessed using the sealed can technique and CR-39 solid-state nuclear track detectors.

Radiological risks were evaluated using the activity concentration index (I) and the alpha index (Iα). Additionally, dose simulations for granite were performed using the RESRAD-BUILD model developed by Argonne National Laboratory, which accounted for external exposure, radon inhalation, dust inhalation, and ingestion under various occupancy scenarios.

Granites showed the highest concentrations of all three radionuclides (mean values: ²²⁶Ra = 79.4 Bq/kg, ²³²Th = 123.9 Bq/kg, and ⁴⁰K = 1058 Bq/kg), while gypsum and fiber cement showed the lowest. Despite these variations, all values remained below the clearance levels recommended by the IAEA and the European Commission (1 Bq/g for uranium and thorium series, 10 Bq/g for ⁴⁰K).

The activity concentration index (I) exceeded 1 only in granite samples, which is permissible for surface materials such as countertops under international standards. All other materials had indices well below the recommended limits.

Radon exposure rates and exhalation values were highly variable. Granite once again exhibited the highest mean radon emission (590 kBq·h/m³), while most other samples fell below detection thresholds. One granite sample marginally exceeded the national recommended radon concentration for indoor air (300 Bq/m³). This sample was further analyzed through dose simulations for four scenarios - one-room residence, part-time occupancy (0.6), One-room residence, full-time occupancy (1.0) – One-room workspace (0.33) and standard residence (0.67)-. In all scenarios, the simulated annual doses remained well below the 1 mSv/year threshold established by international safety recommendations.

This work concludes that the studied building materials available in Uruguay are radiologically safe for use in both residential and public construction. All measured radionuclide concentrations were below the established clearance limits, and dose simulations confirmed that exposure levels—even in worst-case scenarios—do not pose significant health risks.

The research provides a scientific basis for the safe use of commonly marketed construction materials in Uruguay and underscores the need for further studies on indoor radon levels to support public health policy and regulation.

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