Poster Presentation

CONCENTRATIONS OF ^{226}Ra, ^{232}Th AND ^{40}K IN BRAZILIAN WALL PAINT

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Abstract

Geological materials used as building materials are a source of radiation exposure due to the presence of radionuclides of natural origin. Wall paint is one of the building materials to be considered for radiological evaluation as it generally contains titanium dioxide pigment obtained from minerals such as ilmenite and rutile which contain ^{238}U and ^{232}Th series radionuclides and ^{40}K. In this work, radionuclide concentrations were determined in 50 commercial Brazilian white latex wall paints using high resolution gamma-ray spectrometry. The following activity concentrations were measured: 1.41–38.7 Bq/kg (^{226}Ra), 0.9–101.2 Bq/kg (^{232}Th) and 5.9–256 Bq/kg (^{40}K). These results demonstrate that the wall paints studied in this work are safe for use.

1. INTRODUCTION

Radionuclides of natural origin with half-lives of the same order as that of the age of the Earth (i.e. radionuclides in the ^{238}U and ^{232}Th series and ^{40}K) are a ubiquitous source of human exposure [1, 2]. Workplaces and homes have implications for exposure because significant periods of time are spent inside them — it is not uncommon for some individuals to spend 80% of their time in homes and virtually every building material contains measurable concentrations of ^{226}Ra, ^{232}Th and ^{40}K. Knowledge of the radionuclide concentrations in building materials is needed for any assessment of population exposure. Several studies have been conducted worldwide to evaluate radioactivity in building materials such as rock, granite, marble and sand [3–7] but it would appear that no studies have been performed to determine activity concentrations in internal or external wall paints.

The basic raw materials for the production of almost all types of paint are resin, pigment, solvent and additives. The pigment gives the paint its colour, solvents make it easier to apply the resin and promote drying, while additives are used as fillers, antifungal agents, etc. The most common pigment material, titanium dioxide, provides whiteness and opacity. Titanium dioxide is a simple inorganic compound obtained from ilmenite and (to a lesser extent) rutile in heavy-mineral sand and accounts for 92% of the worldwide demand for titanium minerals [8]. Since ilmenite sand contains up to 500 ppm thorium and lesser amounts of uranium [9], it is easy to suspect that wall paints, like other construction materials, could contain significant levels of radioactivity [10]. Several studies have been conducted to evaluate the occupational exposure of titanium production workers [10–13] but public exposure from wall paints used in buildings seems not to have been investigated. In Brazil, the relative uses of titanium dioxide are 85.5% for paint, 8.6% for the steel industry, 6.4% for iron alloys, 1.6% for electrodes and 0.8% for floors and tiles [14]. Brazil is one of the world's top five markets for coatings, and manufactures paints for a variety of applications. There are hundreds of large, medium and small manufacturers spread throughout the country. The top ten manufacturers account for 75% of total sales [15].

2. EXPERIMENTAL

Samples of 50 brands of wall paint from various manufacturers were each sealed tightly in a 100 mL HDPE flat bottomed cylindrical flask with a screw cap and bubble spigot and stored for approximately 4 weeks in order to ensure radioactive secular equilibrium [16]. All samples were measured for 150 000 s with a coaxial extended range high purity germanium detector of 25% relative efficiency, with conventional electronics and an EG&G ORTEC Spectrum Master 919 4-k multi-channel analyser. The spectra were analysed using WinnerGamma software [17]. Background radiation was determined by measuring an ultra-pure water sample and the detector efficiency curve was determined with a multi-element standard aqueous radioactive solution sample, both in the same geometry of the samples. The activity concentration of ^{40}K was calculated from its single gamma energy peak of 1461 keV. The activity concentration of ^{226}Ra was determined by the weighted mean of the concentrations derived from the ^{214}Pb and ^{214}Bi gamma peaks and the activity concentration of ^{232}Th was determined by the weighted mean of the concentrations derived from the ^{212}Pb, ^{212}Bi and ^{228}Ac gamma peaks [16]. All activity concentrations were determined with self-attenuation corrections [18]. The apparent densities of the samples varied from 0.97 ± 0.03 to 1.46 ± 0.04 g/cm^3.

3. RESULTS AND DISCUSSION

The activity concentrations for all the radionuclides considered are shown in Fig. 1 for each paint sample. The activity concentrations of ^{232}Th were generally higher than those of ^{226}Ra. The correlation between ^{232}Th and ^{226}Ra in the samples is shown in Fig. 2 for each paint sample. Sample E08 (the outlier point in Fig. 2) shows a different behaviour from all the other samples, suggesting that its ^{226}Ra activity concentration is influenced by a constituent other than titanium dioxide.

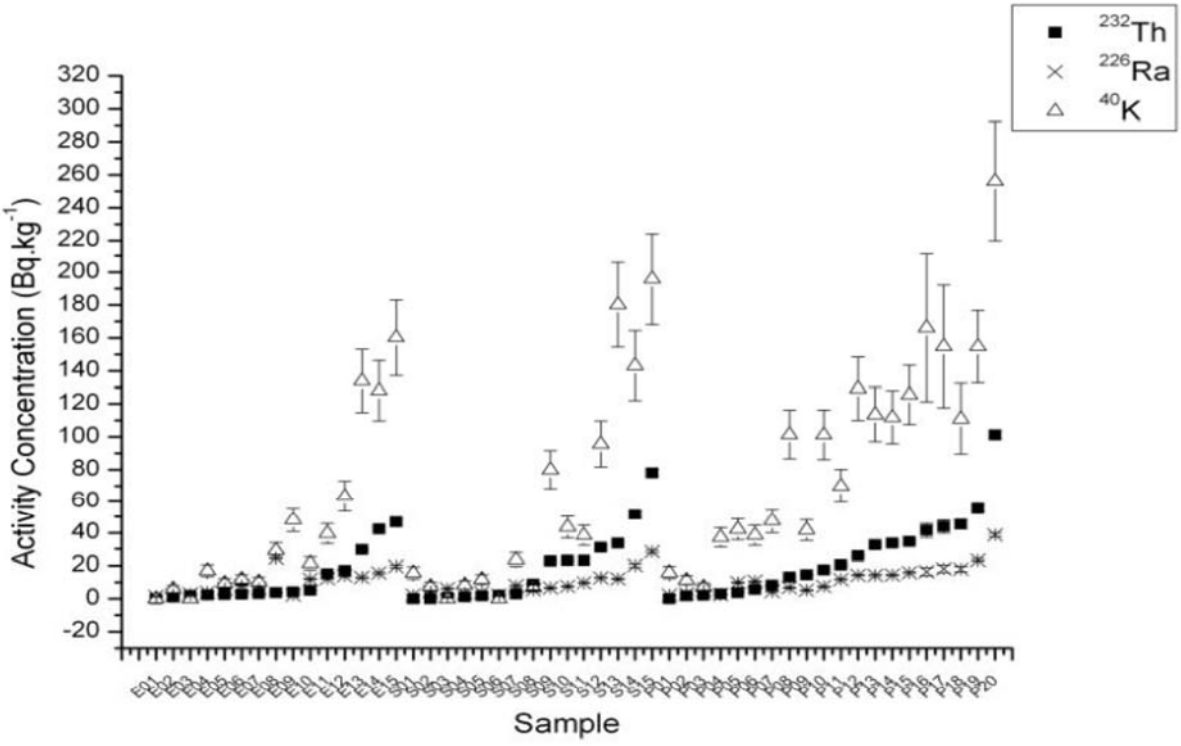

FIG. 1. Radionuclide activity concentrations in samples of 50 different wall paints. The paints are labeled E, S and P for economic, standard and premium quality, respectively.

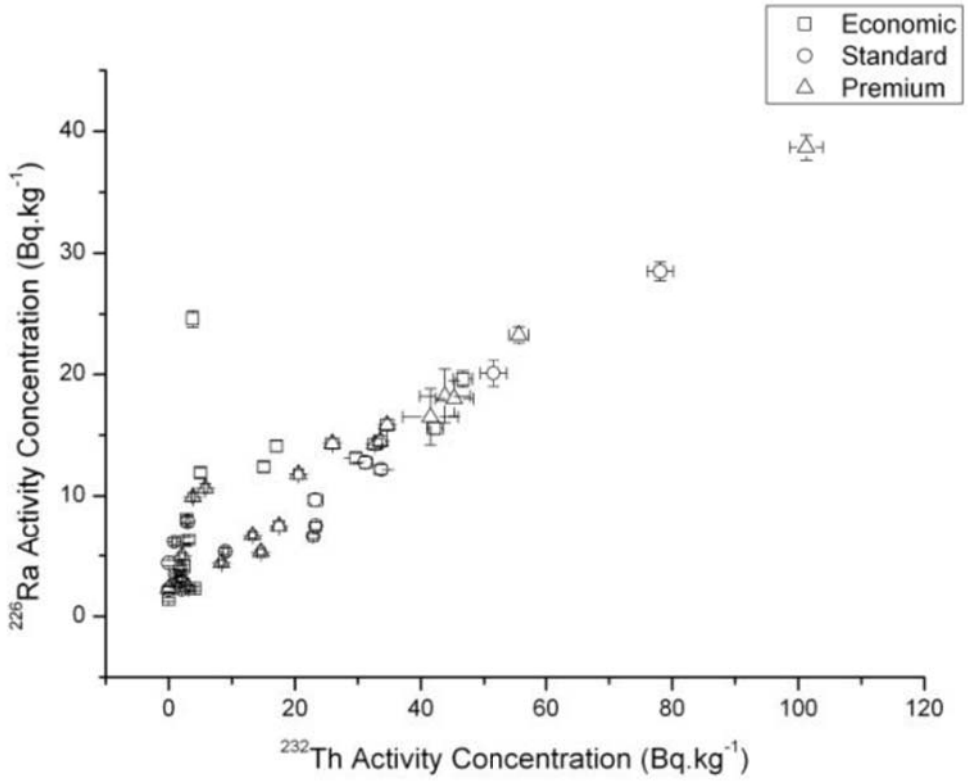

FIG. 2. Correlation between ^{232}Th and ^{226}Ra activity concentrations.

4. CONCLUSIONS

The results of the activity concentration measurements in 50 samples of wall paint show elevated ^{232}Th concentrations in most samples, as would be expected for a material originating from ilmenite or rutile. The maximum activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K were 38.7 ± 1.0, 101.2 ± 2.6 and 260 ± 40 Bq/kg, respectively, all in sample P20. No correlation between the activity concentration and the grade of wall paint (economic, standard or premium) was observed. It was concluded that all paints were safe for use.

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