

# THE DAILY INTAKE OF $^{226}\text{Ra}$ BY PHOSPHATIC REGION RESIDENTS

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## ABSTRACT

The uranium-phosphate region of northeastern Brazil comprehends a 4-km wide land strip that spans over 150 km of the coastal region of the states of Pernambuco and Paraíba. People that live in these regions are subject to higher than normal levels of background radiation, due to the presence of natural uranium and their progeny in the environment. In this study, the concentrations of  $^{226}\text{Ra}$  in locally grown produce, as well as in the water were determined. The mean concentration of  $^{226}\text{Ra}$  in the food items included in this study was of 357.7 mBq/kg (wet weight). The mean  $^{226}\text{Ra}$  concentration in the water was of 282.2 mBq/L. The annual rate  $^{226}\text{Ra}$  intake, due to the combined consumption of food and water by the local population was estimated to be of 275.35 Bq.

## INTRODUCTION

Uranium and thorium are observed in all major rock forming minerals, with predominance in igneous rocks, which generally exhibit higher levels of radioactivity than sedimentary rocks. The major separation between uranium and thorium occurs during the weathering and the sedimentary cycle. Due to its geochemistry, uranium in solution is moved into the environment of sedimentary deposition, while thorium remains tied up in resistant minerals or strongly adsorbed by clay particles. Therefore, the radioactivity found in sedimentary rocks is mainly caused by the presence of uranium and other members of the uranium series.

The abnormally high levels of uranium and radium associated with the phosphate deposits know to exist in the Northeast of Brazil called the attention of scientists concerned with the evaluation of human exposure to naturally occurring radiation.

In general, it is believed that a state of secular equilibrium exists between uranium and its progeny in the host rock. During weathering, the radioactive elements may become separated, breaking this equilibrium. Due to its chemical similarity with calcium, some radium is dissolved from the rock and enters the biological chain, going from water, to plants, animals, and finally the human organism.

According to Lima and Penna Franca<sup>(1)</sup>, food is the major source of radium ingestion by man. Other studies indicated, however, that water consumption contributes with the major fraction of radium to the human diet. A survey carried out in 19 sources of mineral water in the Poços de Caldas Plateau showed  $^{226}\text{Ra}$  concentrations ranging from 17 to 2358 Bq/L.

Studies performed by Watson and Mitsch<sup>(2)</sup> in North Carolina indicated that  $^{226}\text{Ra}$  concentrations in water range from 4.4 to 110 mBq/L, with a mean value of 16 mBq/L. Havlik, on the other hand, detected the presence of  $^{226}\text{Ra}$  in surficial water of the Bohemian region, in the former Czechoslovakian Republic, in concentrations ranging from 77.1 to 333 mBq/L.

Fisenne<sup>(3)</sup> measured concentrations of  $^{226}\text{Ra}$  in the main dietary components in the northern hemisphere ranging from 0.1 to 5.0 pCi/kg (3.7 to 185 mBq/kg) of wet weight. In another study covering the cities of New York, Chicago, San Francisco, San Juan, Bombay and Kerala, Wrenn<sup>(4)</sup> found that the intake of  $^{226}\text{Ra}$  was mainly due to the consumption of vegetables, grains, and fruits. The estimated rate of intake of  $^{226}\text{Ra}$  in San Juan and Kerala varied from 0.7 to 2.8 pCi/day (25.9 to 103.6 mBq/kg)

This paper presents the results of a study aiming to assess the intake of  $^{226}\text{Ra}$  by the population of the phosphate area of the State of Pernambuco - Brazil, due to both the ingestion of locally grown foodstuffs and water consumption.



Figure 1. - Location of Phosphate Deposits Regions.

## MATERIALS AND METHODS

The uranium-phosphate region in northeastern Brazil is partially occupied by industries, small farms, and houses, being fairly populated. As the phosphate region is very extensive, an area of 40 km<sup>2</sup> that includes part of the cities of Abreu e Lima, Cruz de Rebouças, and Igarassu was selected for this study.

Vegetable samples were collected in 15 selected points. The produce grown in the area and that are of daily consumption were included in this study. Seasonal foods whose crop is restricted to part of the year, such as the majority of the tropical fruits, were not considered. With basis on these criteria the following items were selected: a) grains: corn (*Zea mays* Linn) and beans (*Phaseolus vulgaris* Linn); b) tubers and roots: sweet potato (*Ipomoea batatas* Poir), cassava (*Manihot dulcis* Pax), and yam (*Dioscorea* sp); c) fruits: banana (*Musa sapientum* Linn), cashew (*Anacardium occidentale* Linn), and mango (*Mangifera indica* Linn).

Vegetables were cleaned and peeled as usually prepared for human consumption. They were cut in small pieces, covered with aluminum foil and dried in an oven during 24 hours and then ashed at 500° C. For the determination of  $^{226}\text{Ra}$  a 10 g aliquot of ashes was taken and dissolved in concentrated nitric acid.

Water samples were collected in 5 L plastic containers and acidified immediately to avoid radium being adsorbed to the walls of the container. A total of 101 points (13 of superficial and 88 of groundwater) were selected for this study. At least two water samples were collected from each point (corresponding to the dry and rainy seasons) in order to detect the influence of climatic conditions in the concentration of  $^{226}\text{Ra}$  in the water.  $^{226}\text{Ra}$  was measured by the radon emanation technique, as presented by Rushing et al.<sup>(5)</sup>

## RESULTS AND DISCUSSION

The estimate of the annual consumption of  $^{226}\text{Ra}$  due to the ingestion of produce by the rural population living in the phosphate area of the State of Pernambuco was obtained by combining data from its concentration in the food with the per capita annual food consumption. The evaluation of the  $^{226}\text{Ra}$  ingestion due to potable water consumption, on the other hand, was performed by using the arithmetic mean of the  $^{226}\text{Ra}$  concentrations in the water collected in the two different periods, according to the procedure utilized by WATSON et al.<sup>(6)</sup>

The results show a radium ingestion of 206 Bq/year due to water consumption. For foodstuffs, on the other hand, the rate of ingestion was of 69,4 Bq/year. These intakes are twice as high as the world average radium consumption.

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