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# TWO DECADES OF RESEARCH IN THE BRAZILIAN AREAS OF HIGH NATURAL RADIOACTIVITY

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# TWO DECADES OF RESEARCH IN THE BRAZILIAN AREAS OF HIGH NATURAL RADIOACTIVITY

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ABSTRACT. A review is made of the most important findings obtained in the decades 1960-1980 in the Brazilian regions of high natural radioactivity. The research was carried out by three university groups: Pontifícia Universidade Católica do Rio de Janeiro, Universidade Federal do Rio de Janeiro and New York University.

RESUMO. Apresenta-se um resumo breve dos dados mais importantes obtidos durante as décadas 1960-1980 nas regiões de alto teor de radioatividade natural no Brasil. As pesquisas foram feitas por três grupos universitários: Pontifícia Universidade Católica do Rio de Janeiro, Universidade Federal do Rio de Janeiro e New York University.

The geology of Brazil presents us with several areas of high natural radioactivity. Our university groups have identified and studied three natural theaters in a collaborative project over twenty years. The results were only recently presented in a symposium[1]. The three areas are Guarapari, Araxa-Tapira, and Morro do Ferro.

## GUARAPARI

With the slow weathering of the mountains that parallel the Atlantic coast, beaches have been formed with mottled patches of monazite sand. Monazite is a complex of rare earth phosphates with strong impurities of thorium and weaker uranium. Guarapari is a town of 12,000 in the monazite region.

The radiation levels were mapped. Patches on the beach showed levels up to 2.0 mR/hr; the streets averaged 0.09 mR/hr. A TLD survey of the population revealed that the dose rate ranged up to 2,000 mrem/year with a mean of 640 mrem/yr.

All the water and most of the food comes from normal areas. Any internal contamination might come from fine inhaled dust or from thoron and radon in the air. Whole body counting gave negative results, and analysis of placentae showed low values of internal contamination, as can be seen in Table 1.

The lack of realiable medical practise and records renders an epidemiological study impractical. With the relatively low dose rate and the small population, the somatic chromosomal aberrations in peripheral lymphocytes were selected as a biological parameter.

From the start a higher rate of chromosomal aberrations, especially the two-break type, were seen in Guarapari. A resumé of the data is given in Table 2. The number of aneuploid cells (2n ≠ 46) and the chromatid type aberration are not considered as radiation induced, but are given as culture technique controls.

The double break phenomenon suggests an internal contaminant, an alpha emitter. Since tests for long-lived body burdens are essentially negative, it is thought that chronic exposure to higher values of thoron and radon are responsible.

TABLE 1. Guarapari: $^{228}Th$ and $^{226}Ra$ in Human Placentae.

| Local | N | $^{228}Th$ (pCi/g Ca) | $^{226}Ra$ (pCi/g Ca) |
|---|---|---|---|
| Controls | 17 | 0.09 - 1.36 | 0.05 - 0.76 |
| Guarapari | 10 | 0.10 - 5.96 | 0.11 - 1.36 |
| Araxą | 5 | 0.19 - 2.63 | 0.07 - 0.41 |
| Tapira | 8 | 1.00 -26.70 | 0.3 - 14.50 |

TABLE 2. Guarapari: Individual Means and Standard Deviations for Cytogenetic Data.

| | Guarapari | Control |
|---|---|---|
| No. Cells | 66.55 ± 22.75 | 61.23 ± 10.72 |
| No. Aneuploid Cells | 3.45 ± 3.81 | 2.46 ± 2.67 |
| Chromatid Aberrations | 2.00 ± 2.54 | 2.23 ± 2.92 |
| Deletions | 0.65 ± 1.01 | 0.52 ± 0.99 |
| Dicentrics | 0.07 ± 0.28 | 0.04 ± 0.19 |
| Rings | 0.02 ± 0.15 | 0.00 |
| Total no. Breaks | 0.85 ± 1.20 | 0.57 ± 0.93 |

**ARAXA-TAPIRA**

In this region in the interior State of Minas Gerais the soil is naturally fertilized by uraniferous apatite, a

phosphate mineral that serves as a source of radium-226. Here the concern is naturally with the food chain as a contaminant. The highest concentrations are found in the staple foodstuffs, manioc and its flour, as well as in potatoes and citrous fruit. Radium-228 content reaches 2,720 pCi/kg and radium-226 81 pCi/kg.

A house to house inquiry gave clear information on the dietary habits of 28 families. Certain poor families live almost entirely on the contaminated produce. As one moves from the hot spots the radium content becomes more diluted. The small group has daily intakes of the range 20-40 pCi of radium-226 and 120-240 pCi of radium-228.This would result in body burdens of the order of 280-560 pCi of radium-226 and 1680-3360 pCi of radium-228. This is below the sensitivity of any whole body counter in Brazil.

It was found that only a small number of people are affected, and only 196 individuals of the 1670 were selected for further investigation.

MORRO DO FERRO

In the region south of the city of Poços de Caldas an alkaline plug thrust its way 400-600 meters above the surrounding land. The inner portion lowered, and became highly mineralized. In the center Morro do Ferro (Iron Mountain) rises 140 m. above its base. Across it two dikes of magnetite have penetrated, with mixtures of titanium and manganese. A great variety of rare earth oxidation compounds

are found here with strong percentages of thorium oxide and traces of uranium.

The harsh face of the mountain offers poor soil for vegetation, and only low grade grazing grass grows. The mountain was mapped with ionization chamber and portable scintillometer. Some 42,000 $m^2$ show levels above 1.0 mR/hr and small patches are above 3.0 mR/hr.

While it was considered an ecological laboratory many measurements were made of the uptake by plants, and of the concentration of thoron and radon in rat holes and termite mounds. Some of the data are given in Tables 3 and 4. In his study of the exposure to local rats Drew found that the greatest dose was to the trachea-bronchi area with an average dose of 200 rads/year and a maximum ten times that. Takahashi conducted a cytogenetic study of the scorpion found on the mountain.

TABLE 3. Morro do Ferro: Range of Radionuclide Concentration in Plants.

(pCi/kg)

| | |
|---|---|
| Ra-228 | 169 - 10,303 |
| Th-228 | 68 - 2,200 |
| Ra-226 | 7 - 1,105 |

TABLE 4. Morro do Ferro: Concentration of Thoron and Radon in Ground Holes

(pCi/l.)

| | Average | Range |
|---|---|---|
| Thoron | 16,790. | 280 - 55,400. |
| Radon | 3,300 | 5 - 27,400. |

The research work on Morro do Ferro has recently taken a different direction. This mountain is conservatively estimated to hold 12,000 tons of thorium. In view of the almost identical chemistries of thorium and plutonium, the deposit is now regarded as an analogue for modeling the transport of plutonium over geological time, once a depository has been breached. The mineral is near the surface of the mountain, and is being washed by tropical rains 170 cm per year. The equivalent amount of plutonium is greater than that which will be produced by the reactors in the United States up to the year 2050. It is thought that the deposit is from 60 to 80 million years old.

The drainage pattern is straightforward. The rain penetrates the surface through the mineral, reaches the water table some 70 meters below, and runs off through springs at the foot of the mountain. The sediments carried off are being analyzed. The water and the solids in suspension are also being measured. Early measurements show about 0.3 pCi/l in the water.

In the future the plume will be studied in detail. A portable X-ray fluorescent spectroscope will follow the pattern of the distribution of thorium, rare earths and uranium.

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## REFERENCE

[1] Cullen, T.L. and Penna Franca, E. (ed.), "International Symposium on Areas of High Natural Radioactivity", Academia Brasileira de Ciências, Rio de Janeiro (1977).