2021 International Nuclear Atlantic Conference – INAC 2021
Virtual meeting, Brazil, November 29 – December 2, 2021

ISBN: 978-65-594-1256-3

Radon and radium activity measurements in artesian well waters from the Carambeí rural area of Paraná state, Brazil

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1. Introduction

Human being is exposed to natural radiation of radon and its progeny, which contribute a considerable portion of about 50% of the total annual dose received by the population. The elevated levels of radon activity in the air of dwellings and workplaces are responsible for the increase of lung cancer risk. High radon activity levels in water can significantly increase indoor radon concentration [1]. The Brazilian Ministry of Health establishes reference values for the radioactivity contained in water for human consumption below 0.1 Bq/L for alpha radioactivity and below 1 Bq/L for beta particles [2].

2. Methodology

The objective of this work was to evaluate the levels of radon concentration in well water from the region of Carambeí rural region (Figure 1) of the Paraná state of Brazil, which presented high levels of natural gamma radioactivity of uranium, thorium, radium, potassium in previous geological studies performed by the Geological Survey of Brazil – CPRM (Curitiba, PR) and the Laboratory for Research in Applied Geophysics (LPGA, UFPR) [3-6]. This rural area of Carambeí has many farms whose residents use well water as an exclusive source of drinking water. The research was carried out gathering water samples from the artesian wells in that region. Radon measurements were performed with the AlphaGUARD monitor [7], which was connected to closed air circulation route that included glass degassing vessel for water sample aeration, security vessel, hoses, valves, filters, and a AlphaPUMP supplied by Bertin Instruments. The survey was performed collecting water samples from eleven artesian wells. For each water sample radon activity measurements were performed using an interval of three days during total period of 30 days after water extraction from the well.

3. Results and Conclusions

Obtained data were used for curve “activity versus time” fitting (Figure 2). Evidently the last results obtained for radon activity in the water sample after 30 days could be used to determine the concentration of radium compounds in collected artesian water samples. Obtained results (Table 1) for initial radon concentrations in well waters ranged from 0.4+/-0.8 to 87+/-13 Bq/L as well as for radium activity the highest activity obtained was of 3.8+/-2.3 Bq/L, which is above the limit established by the Brazilian Ministry of Health [2]. Such activity levels of alpha radioactivity shows that these artesian waters are improper for immediate for human consumption. Thus, the mitigation measures have been proposed to the population.

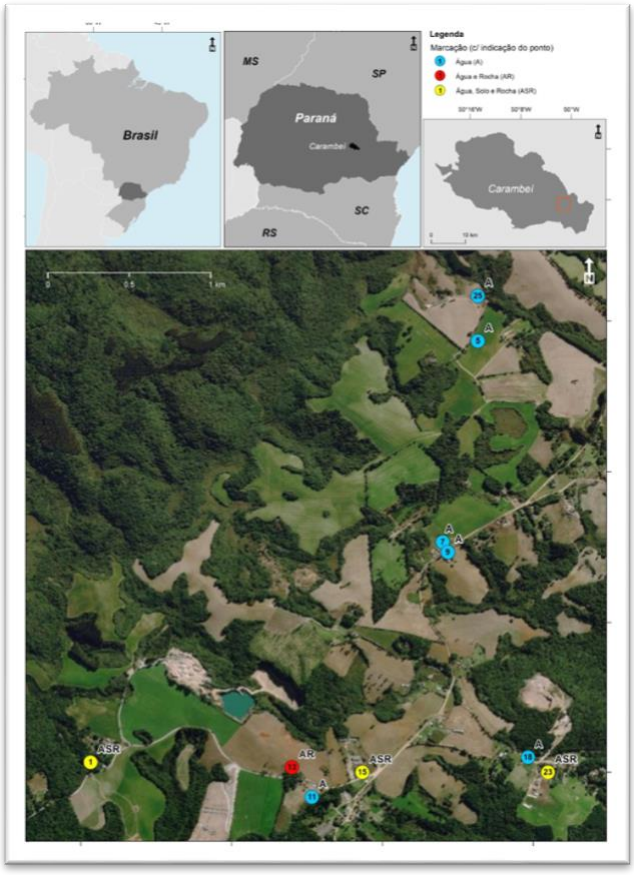
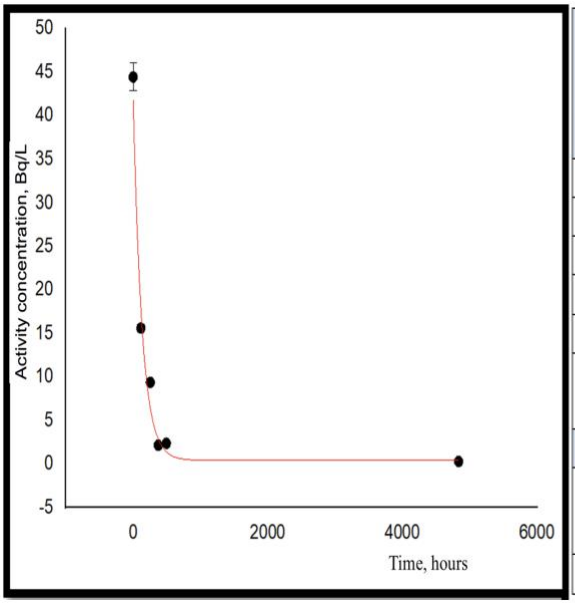


Figure 1: Identification of rural area of Carambeí region where the present survey was performed.



Well 1	Time (hours)	Measured ^{222}Rn activity (Bq/L)	Error of ^{222}Rn activity measurements (Bq/L)
Measurement 1	0	44.5	1.6
Measurement 2	115	15.6	0.4
Measurement 3	234	9.4	0.3
Measurement 4	352	2.2	0.2
Measurement 5	472	2.4	0.2
Secular equilibrium	4344	0.29	0.06
Final results.			
^{226}Ra activity (Bq/L)	Error of ^{226}Ra activity (Bq/L)	^{222}Rn activity (Bq/L)	Error of ^{222}Rn activity (Bq/L)
0.4	0.3	40.9	4.4

Figure 2: An Example of statistical ^{222}Rn decay curve fitting analysis.

Table I: Obtained results concerning ^{222}Rn and ^{226}Ra isotopes activity in studied samples of well water.

Well identification	^{226}Ra activity (Bq/L)	Measurement errors ^{226}Ra activity (Bq/L)	^{222}Rn activity (Bq/L)	Measurement errors ^{222}Rn activity (Bq/L)
P1	0.4	0.3	40.9	4.4
P2	0.6	0.7	87	13
P3	1.4	2.5	0.4	1.2
P4	1.0	0.9	25.3	9.8
P5	0.8	0.7	8.8	4.3
P6	3.8	2.3	0.4	0.8
P7	0.4	0.3	36.5	5.7
P8	0.3	0.2	42.8	4.9
P9	0.6	0.5	25.4	5.8
P10	0.6	0.5	17.3	6.0
P11	0.3	0.3	77.2	7.7

Acknowledgements

The authors are very thankful to Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) and the Graduate Course in Electrical Engineering and Industrial Informatics (CPGEI) for financial support.

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