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Temporal variation of soil radon/thoron concentration using twin chamber monitors in San Miguel district, Lima, Peru

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Abstract

In the present study, radon and thoron concentrations were measured for two months in 24 wells of 80 cm deep with respect to ground level, located within the PUCP university campus in the San Miguel district. Continuous monitoring was carried out over four two-week periods using pin-hole based twin chamber monitors and LR-115 type II nuclear tracks detectors. A high inverse correlation (-0.95) between radon concentration and temperature was found during the investigation period. The maximum radon and thoron concentration values were presented in the first period, were found to be 6809.5 Bq m^{-3} and 6246 Bq m^{-3}, respectively. The minimum radon and thoron concentration values were presented in the third period, were found to be 2857 Bq m^{-3} and 2089.1 Bq m^{-3}, respectively. The average concentrations of radon and thoron were observed to be 4601.5 ± 1784.3 Bq m^{-3} and 3834.1 ± 1763.7 Bq m^{-3}, respectively.

Introduction

Soil is the main source of radon (^{222}Rn) and thoron (^{220}Rn) due to the uranium and thorium content [1]. Alpha particles emitted in the decay of these natural radioactive elements produce nuclear reactions in the ground, increasing the levels of ionizing radiation (Figure 1). Therefore, measure of soil radon and thoron concentrations is important. Generally, these measurements are made using costly active systems compound of an air extraction pump with 1-m long steel soil probe and a desiccant [2]. An alternative is passive monitors that provide integrated measurement, pin-hole monitors have been commonly used for indoor measurement [3]. Due to the influence of the environmental conditions on the exhalation of radon and thoron from the soil, the results obtained were analyzed with environmental parameters [4].

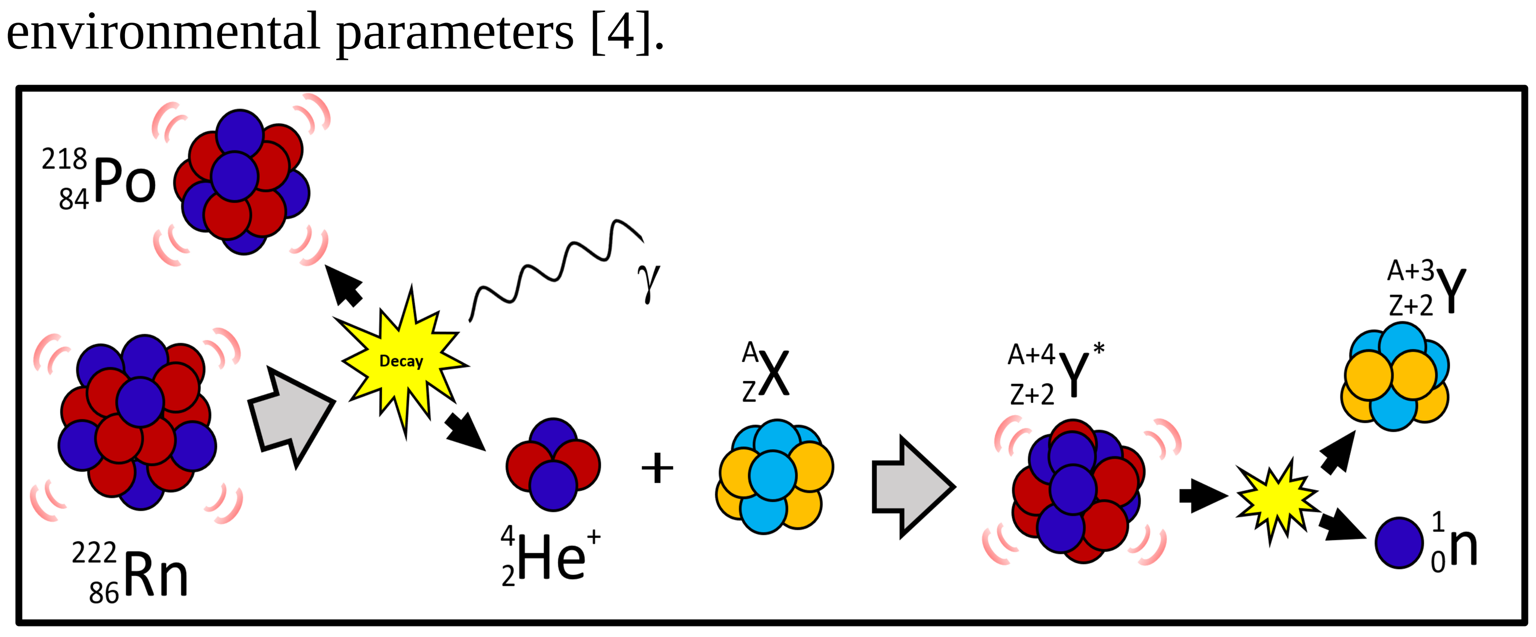

Figure 1: Ionizing radiation generated by radon decay

Methodology

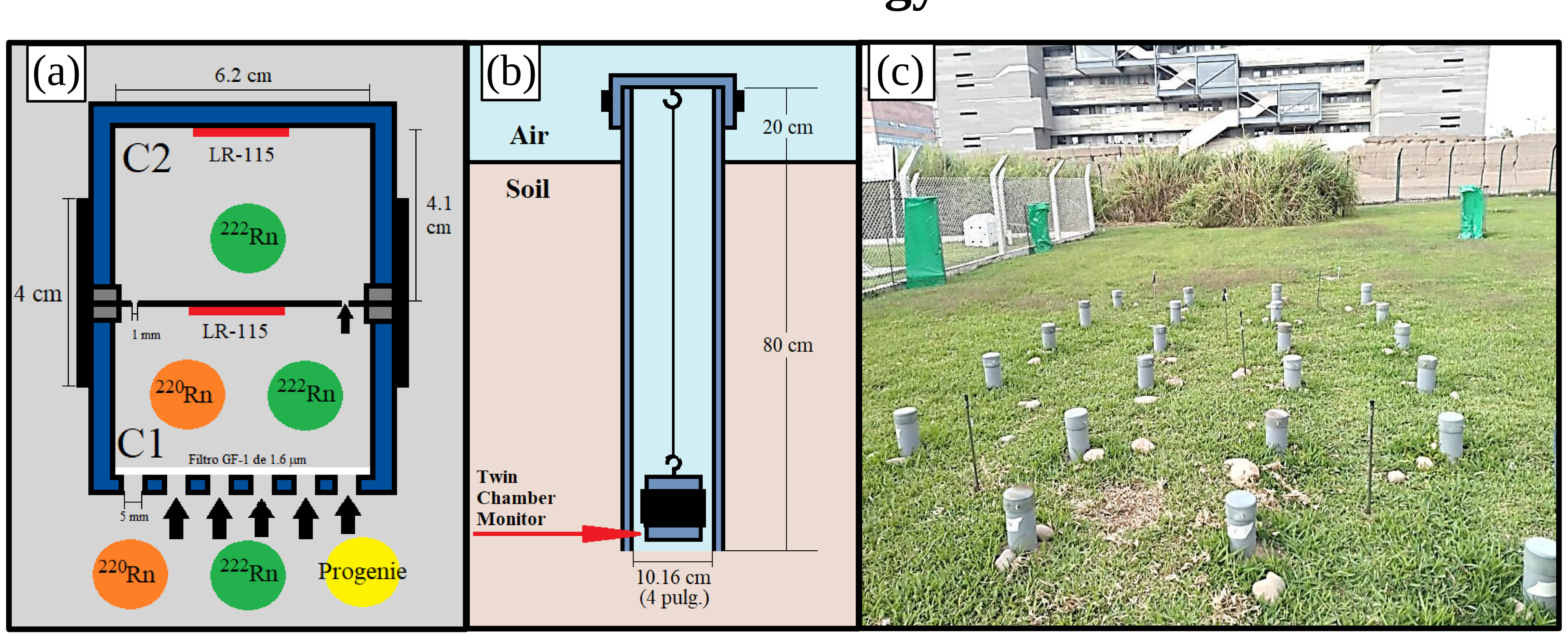

Figure 2: (a) Twin chamber monitor scheme, (b) System of measurement in the soil, (c) Study area

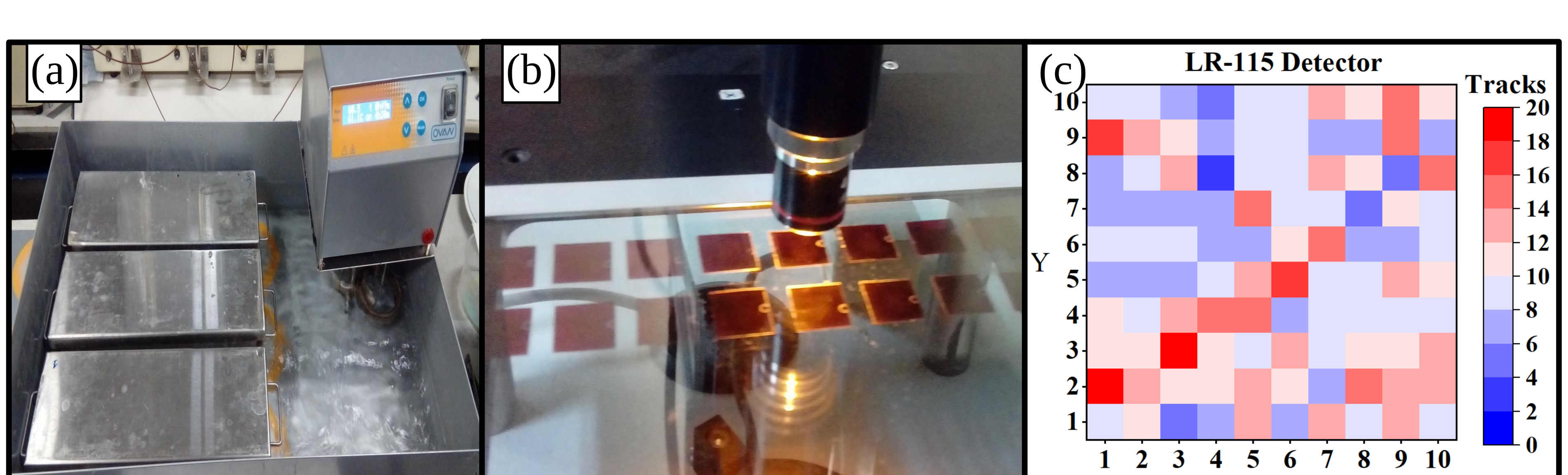

Figure 3: (a) Etching process, (b) Scanning process, (c) Tracks on the LR-115 detector

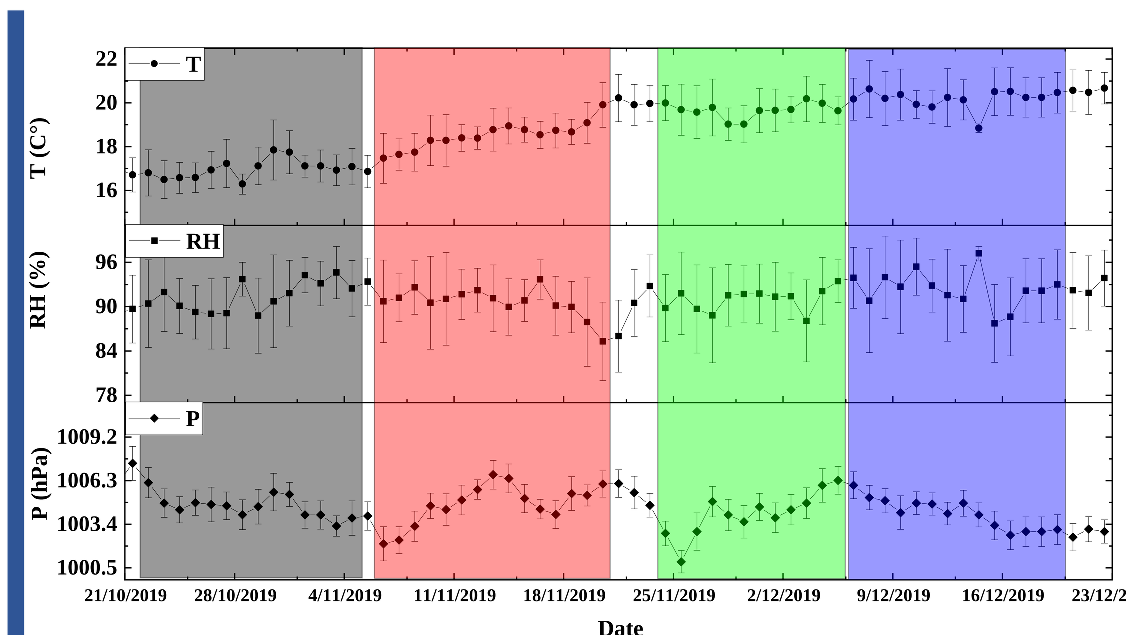

Figure 4: Environmental parameters during the investigation period [4]

Radon concentration (inside C2 chamber)

$$C_R\left(Bq/m^3\right) = \frac{T_2 - B_2}{K_R \cdot d}$$

Thoron concentration (inside C1 chamber)

$$C_T\left(Bq/m^3\right) = \frac{\left(T_1 - B_1\right) - \left(d \cdot C_R \times K_R^{'}\right)}{K_T \cdot d}$$

T is track density, B is background track density, K is calibration factor, d is exposure time

The equations and calibration factors were reported by B.K. Sahoo [3].

Results

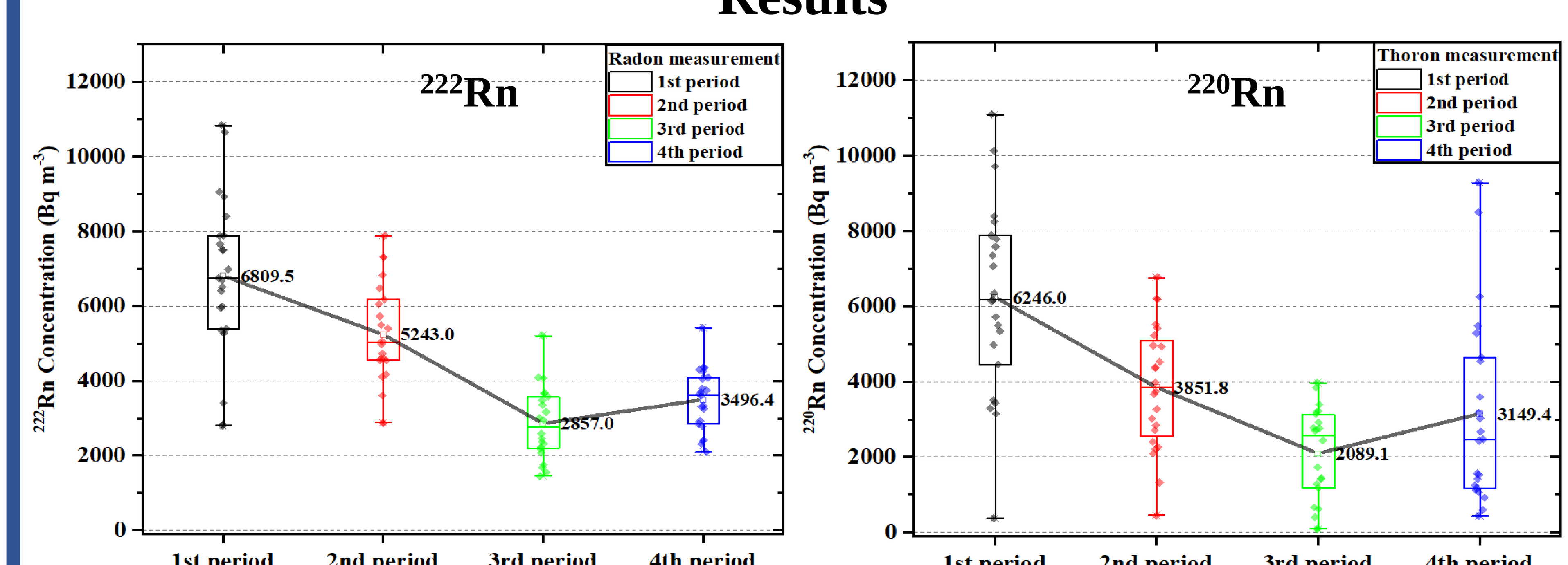

Table 1: Results of average concentration of radon/thoron in soil gas and environmental parameters

Measurement Period	Radon (^{222}Rn)	Thoron (^{220}Rn)	Temperature (T)	Relative Humidity (RH)	Atmospheric pressure (P)
	Bq m^{-3}	Bq m^{-3}	C°	%	hPa
1st	6809.5 ± 835.5	6246.0 ± 1590.6	17.0 ± 0.4	91.1 ± 2.0	1004.9 ± 1.1
2nd	5243.0 ± 652.6	3851.8 ± 1258.5	18.5 ± 0.6	90.6 ± 2.0	1004.7 ± 1.4
3rd	2857.0 ± 369.4	2089.1 ± 717.4	19.7 ± 0.3	91.0 ± 1.5	1004.1 ± 1.5
4th	3496.4 ± 444.8	3149.4 ± 884.3	20.2 ± 0.4	92.4 ± 2.5	1004.1 ± 1.0

Conclusions

Analysis of radon and thoron concentrations in the soil suggests that the influence of meteorological parameters on radon exhalation at 80 cm deep with respect to ground level cannot be neglected. The data constitute preliminary results, give us insight it is needed to measure to major depth to reduce the effects of these environmental parameters on soil gas radon/thoron concentration.

Acknowledgements

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To Research Group on Techniques of Nuclear Tracks - PUCP.

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