

# Radon concentrations in caves of Parque Estadual do Alto Ribeira (PETAR), SP, Brazil: preliminary results

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**Abstract.** Radon concentrations assessment in the most frequented caves of PETAR, Parque Estadual do Alto Ribeira (High Ribeira River Turistic State Park), created in 1958 and situated south of São Paulo State, Brazil are carried out with Makrofol E nuclear track detectors, installed in the most frequently visited caves. Preliminary results from October 2003 to July 2004 show radon concentrations varying from  $512 \pm 86$  to  $6607 \pm 179$  Bq m<sup>-3</sup>. The complete assessment will be achieved by March 2005. © 2004 Elsevier B.V. All rights reserved.

*Keywords:* Radon; Exposure; Cave; Makrofol E; Track detector

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## 1. Introduction

The most important contributors to the committed effective dose received by population due to natural sources are the short-lived decay products of radon (<sup>222</sup>Rn). Concentrations of indoor radon and its progeny in caves vary from levels hardly higher to levels several thousand times higher than outdoor air concentrations. Prolonged exposure to such high concentration levels increases the risk of developing lung cancer and leukaemia and may also have other harmful effects.

PETAR, Parque Estadual Turístico do Alto Ribeira (High Ribeira River Turistic State Park), created in 1958, is a conservation park with an area of 35,102.8 ha, situated on the left margin of the Ribeira river, south of São Paulo State, Brazil, with more than 180 recorded caves [1]. The park has four visit centers: Santana, Caboclos, Ouro Grosso and Casa da Pedra, receiving nearly 40,000 people annually. Radon concentrations are studied at several cave galleries of Santana center and Ouro Grosso center.

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## 2. Methodology

The SSNTD used in this study is the polycarbonate Makrofol E. Each detector is a small plastic square of  $1 \text{ cm}^2$ , loaded into a diffusion chamber type KFK-FN detector, installed in the selected caves, at least 1 m away from the nearest roof. The exposure period is, at least, 3 months and will cover at least 15 months, in order to determine the long-term average levels of the indoor radon concentrations over varying seasons.

After exposure, the detectors were retrieved to the Environmental Radiometric Division, IPEN, São Paulo and processed. The exposed plastic detectors were etched for 2 h with a PEW<sub>40</sub> solution in a temperature-stabilized water-bath and mild stirring, at 70 °C. The track densities were read under a Zeiss/Axiolab optical microscope connected to a video camera and a personal computer.

Radon concentrations were determined considering the track densities, the exposure period and a calibration factor of  $0.02874 \pm 0.00699 \text{ tr cm}^{-2} \text{ Bq}^{-1} \text{ m}^3 \text{ day}^{-1}$ , obtained by exposing a Makrofol E detector to Pylon model RN-150 calibrated with a <sup>226</sup>Ra source of 18 kBq.

## 3. Results and discussion

Radon concentrations covering the period from October 2003 to July 2004 are presented in Table 1.

As can be seen, all results are within the range of literature values. The highest levels represent caves far-away from the gallery entrances, which were also observed in other studies all over the world [3].

The radon concentrations of the autumn/winter period are, for some galleries, higher than the ones of the spring/summer period. However, for a possible correlation between radon levels and weather peculiarities or frequency of visitors, we are, by now, processing more information.

## References

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Table 1

Concentrations of <sup>222</sup>Rn in several caves of High Ribeira River Turistic State Park (PETAR)

Center	Cave	Radon concentration (Bq/m <sup>3</sup> )		
		October 2003–March 2004 (Spring/Summer)	March 2004–July 2004 (Autumn/Winter)	Literature values [2]
Ouro Grosso	Alambari de Baixo	516±82	1327±134	
Santana	Torres	4950±159	4650±184	
Santana	Cristo	5811±170	3435±168	
Santana	Descanso	6607±179	6358±206	
Santana	Flores 1	2373±122	2359±152	48–21,100
Santana	Flores 2	3972±146	3452±168	
Santana	Chocolate	1957±115	2177±149	
Santana	Plataforma	512±86	1223±132	
Santana	Laje Branca	1009±96	2568±155	
Santana	Água Suja		1674±140	
Santana	Couto		1110±129	