

# Activation of the human body exposed to high radon activity



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Jáchymov mines



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# Activation of the human body exposed to high radon activity

- High radon activities in the air are used for a long time for **inhalation therapy in spas**.
- Typical activities applied for Rn treatment are in the range  $X - X0 \cdot 10^3 \text{ Bq m}^{-3}$
- Radon penetrates the body through the skin and breathing. The skin and hair are activated. (Falkenbach et al. 2002, Tempfer et al. 2010, Ciorba et al. 2018)
- Even higher radon activities are known from **abandoned uranium mines**.
- There are usually in the range  $X0 - X00 \cdot 10^3 \text{ Bq m}^{-3} \text{ Rn}$ .
- They are often visited by cavers, montanists and mineral collectors (and some geologists, of course).
- The hair and sweaters made of artificial fibers are always the most activated, as it is electrostatical and attract charged radon products.
- **What does the activation of the human body in a high concentration of radon look like in macroscopic scale???**



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## Example 1:

„**Some**“ abandoned U-mine in Czechia, 2003  
(Visiting them is prohibited and criminalized in my country.)

The activity of radon inside was not measured.  
In another term, the gallery air exhaust had an activity of  $20.3 \cdot 10^3 \text{ Bq m}^{-3}$ .

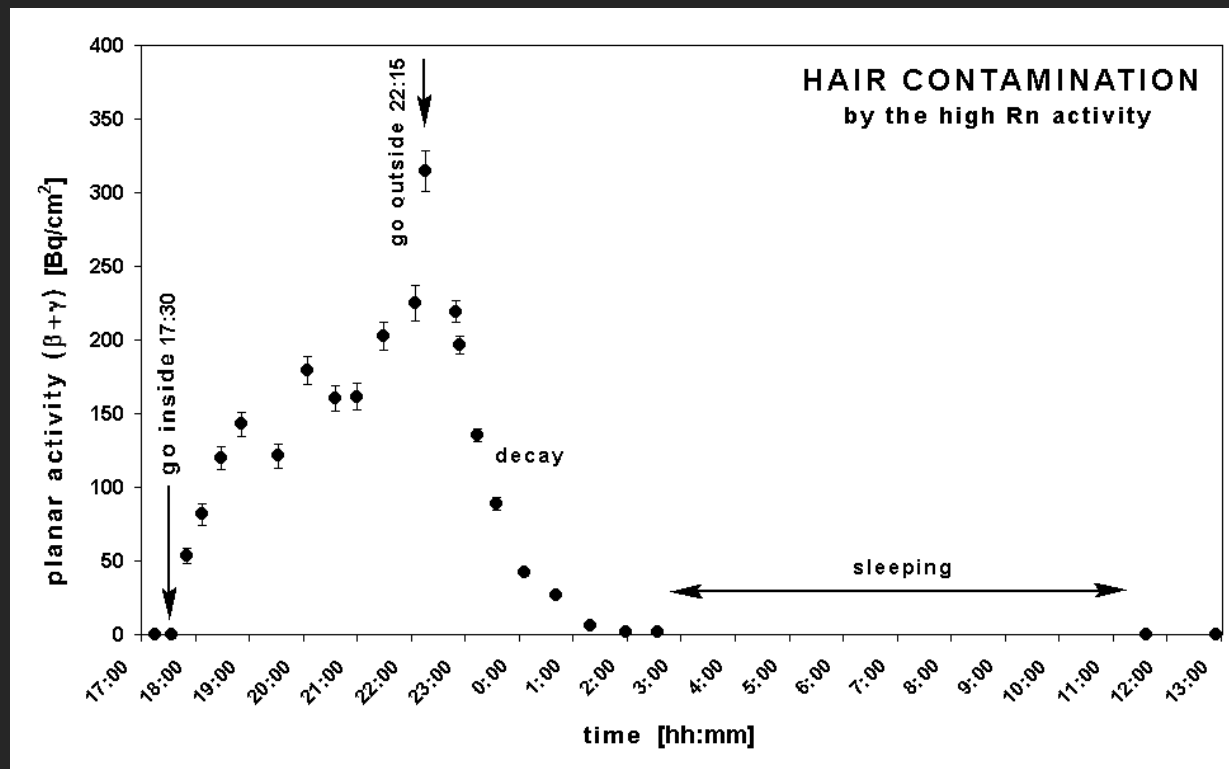
It was measured the time evolution of hair activity on the back of my neck.



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glass GM tube VA-Z-115, counting time 30 s (10 s for high activities)  
for both hairs and background, calibrated on large-area beta standard

- The activity develops (increases) not uniformly, due to walking between parts with different Rn concentrations
- The highest activity of hairs was at the end of the visit, with a maximum of  $320 \text{ Bq cm}^{-2}$ . Saturation was not achieved.
- After leaving of adit, the activity decreases exponentially with an effective half-life of about 1/2 hour. (Decay of  $^{214}\text{Pb}$  and  $^{214}\text{Bi}$ )



Time development of the hair activity, surrounding background subtracted.  
Modified after Goliáš 2017: Safe collection and handling of radioactive minerals. *Minerál*, 3, 219-226. (in Czech)

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## Example 2:

### Kowary-Podgórze (Poland), 2003

#### Adit 19 and 19A

- Operated 1950-1958,
- about 200 t U mined out
- In the years 1974-1989, the underground sanatorium **Inhalatorium Radonowe®**, renowned by doctors from Wrocław, was operated here. However, the flood tore down the driveway and the inhalatorium was closed.
- At the time of my visit, the gallery was abandoned but open.
- The gallery is a tourist attraction nowadays: [www.kopalniapodgorze.pl](http://www.kopalniapodgorze.pl)





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## Kowary-Podgórze (Poland), 2003

Adit 19 and 19A

The activity of radon inside was not measured.

Air that the adit exhaust had an activities of  $230 \cdot 10^3 \text{ Bq m}^{-3}$  (Adit 19) and  $37 \cdot 10^3 \text{ Bq m}^{-3}$  (Adit 19A)

(0.43 L ionization chamber Emanometer RP-25)

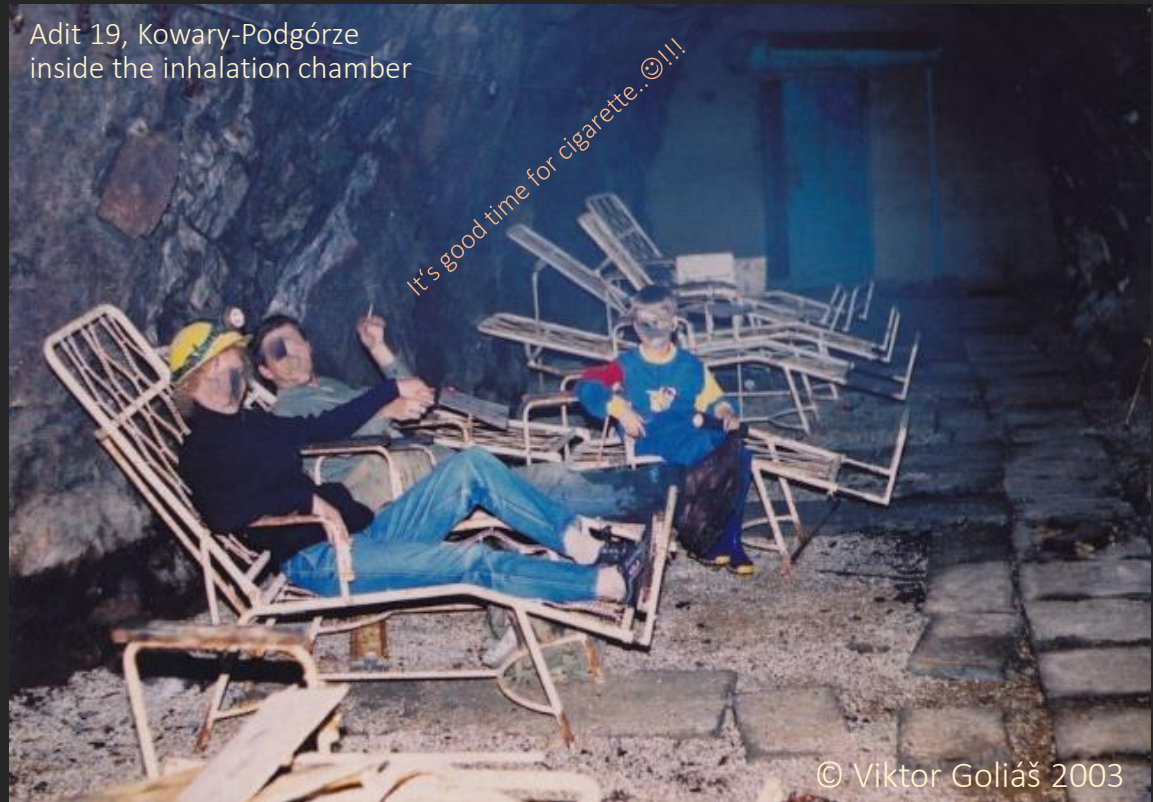


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# Activation of the human body exposed to high radon activity

Kowary-Podgórze (Poland), 2003, Adit 19 and 19A

We were inside with Polish colleagues for about two hours...





# Activation of the human body exposed to high radon activity

Kowary-Podgórze (Poland), 2003, Adit 19 and 19A

- We prepared a plastic pad with a drawn grid and body outline in advance.
- Immediately after leaving the gallery, my gamma activity was measured at the nodes of the grid.
- A sensitive scintillometer with  $\varnothing 18.5 \times 30$  mm NaI(Tl) detector was used.
- The measurement was performed in a total time of 18 min.



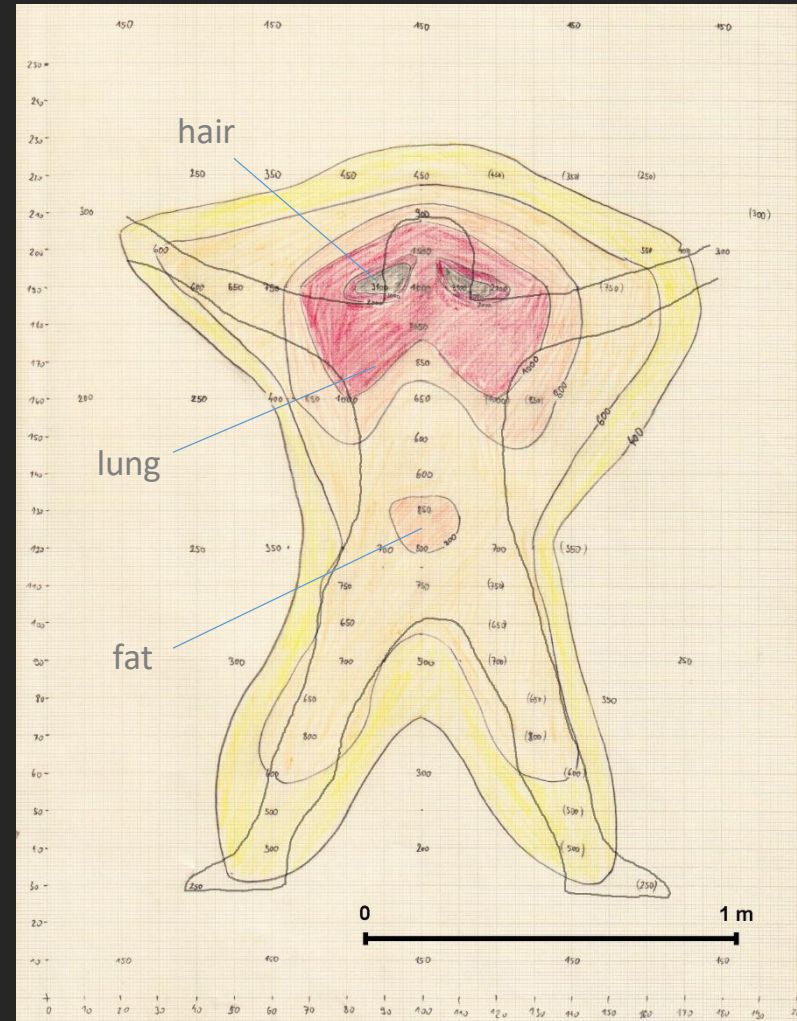


# Activation of the human body exposed to high radon activity

Kowary-Podgórze (Poland),  
2003, Adit 19 and 19A

- The isoline map then shows the shape of the gamma field of my, then current, activity.
- Radon with a biological half-life about 20 minutes dissolves rapidly in the blood. It is also very lipophilic, so it binds to fats. In addition to the high activity of the hair (not under the helmet!) and the lungs, the increase was also detected in the abdominal area.
- Clothing on the whole body also had increased activity.
- I was just a nice radioactive doll! For a while...

calibration: 1 imp/s  $\sim$  2.7 nGy/h

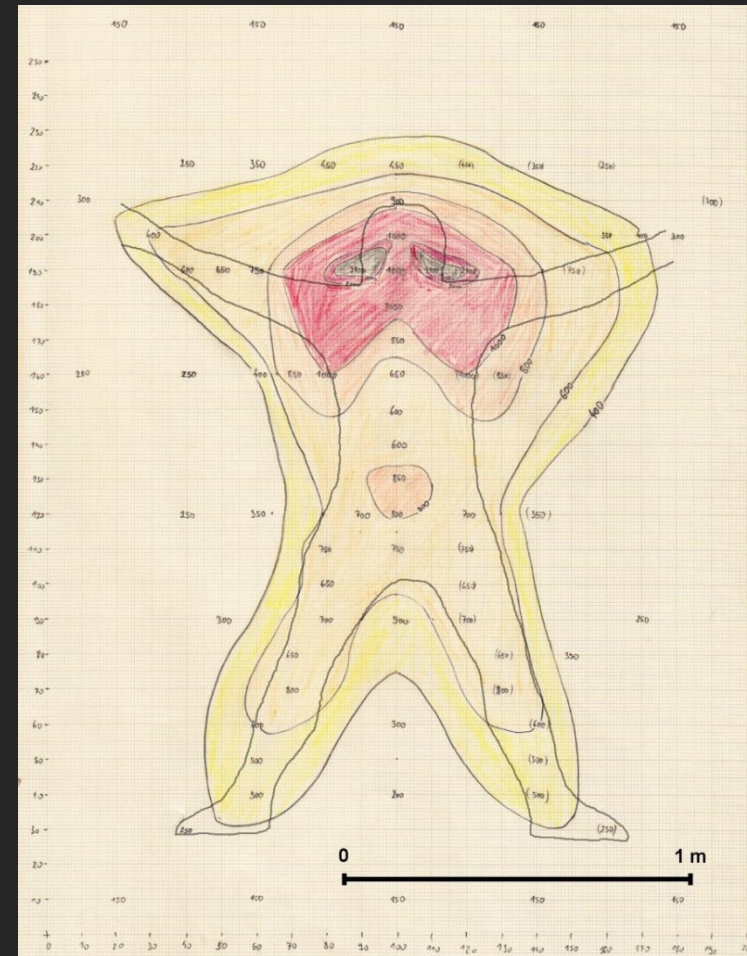


Manually interpolated scintillometer count rates [imp/s]. At contact with hair, the gamma dose rate locally reaches up to 9  $\mu$ Gy/h.  
Modified after Goliáš 2017: Safe collection and handling of radioactive minerals . *Minerál*, 3, 219-226. (in Czech)

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## Main results:

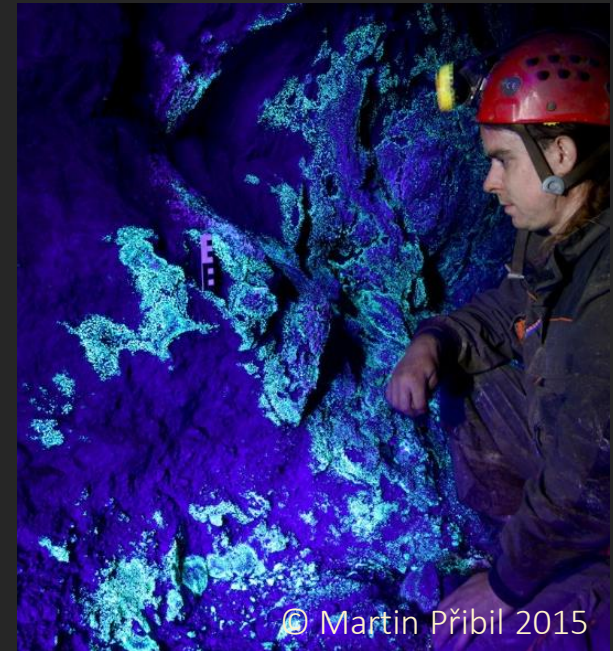
- Activation of the human body is short-lived, as it is caused by short-term radon daughters ( $^{214}\text{Pb}$ ,  $^{214}\text{Bi}$  for  $\beta$  and  $\gamma$  signal measured).
- The effective daughters half-life (about 30 min) is similar to the biological half-life of radon (about 20 min). Therefore, their effects cannot be distinguished.
- The macroscopic shape of the gamma field is the sum of surface (hair, skin, cloth) and internal (lung, fat) activation.
- According to the measured gamma dose rate, body parts are activated as follows:  
**Hair >> lung > abdominal fat > other parts of body**



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## Discussion: It's really dangerous?

- Doses can be **quite high**, they can exceed the standard levels for radiation workers. Annual doses of **up to 120 mSv** have been calculated for some cavers (Gillmore et al. 2000).
- However, this is still in the **low doses region**, where the risk is only **theoretical**, calculated according to criticized LNT.
- It is not a chronic exposure, just an **occasional episode** with which the organism copes well.
- There is **not reported** increased incidence of lung cancer in these „hobbyists“. On the contrary, they usually enjoy very good health.
- On the other hand, we praise the **significant improvement** in diseases of protracted and resistant to conventional treatment of **inflammation of the upper respiratory tract**. No wonder after such harsh speleootherapy..!
- But **information** that it is „dangerous“ **can be very dangerous** for the health of these people. Then they can really get sick, as the **psychosomatics** is very powerful.



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## Thanks for watching!