



Exhalation of ^{222}Rn in areas affected by mining industry

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Description of the problem


- **Earth's crust contains small quantities of naturally radioactive elements.**
 - **Extraction and processing of the minerals cause accumulation on the surface of waste with elevated level of radioisotopes**
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Description of the problem


Storage of waste material can cause:

- **not only radioactive contamination of natural environment**
 - **but additional radiation risk for inhabitants of industrial areas as well**
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- Radioactive gas **RADON**, the member of ^{238}U series, is known as the second factor (first is tobacco smoking) responsible for lung and larynx cancer
 - The results of investigations of **RADON** ^{222}Rn emission in industrial areas are presented.
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Applied investigation method

- Measurements of **radon exhalation coefficient** e_{Rn} [mBq/m^2s^1] were applied as the basic method to identify the level of radiological contamination



Radon exhalation – the ability to escape from intergranular porosity and to transfer into the atmospheric air.

Average values for the soils:

- **17 mBq/m²s¹** - **Wilkening, 1972**
 - **26 mBq/m²s¹** - **Porstendorfer, 1981**
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Investigation sites

- **Abandoned surface settling ponds**
 - **Heaps of waste rocks**
 - **Sites reclaimed with use of waste material from mining industry and coal combustion**
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Settling pond A

- **The bottom of the abandoned pond was dried and filled with waste rocks**
 - **The maximum radium 226-Ra content in bottom sediments was about 3.0 kBq/kg**
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Results of the measurements

• Radon exhalation coefficient:

- 2 mBq/m²s¹ in the part covered by waste rocks
 - 12 mBq/m²s¹ in not covered part
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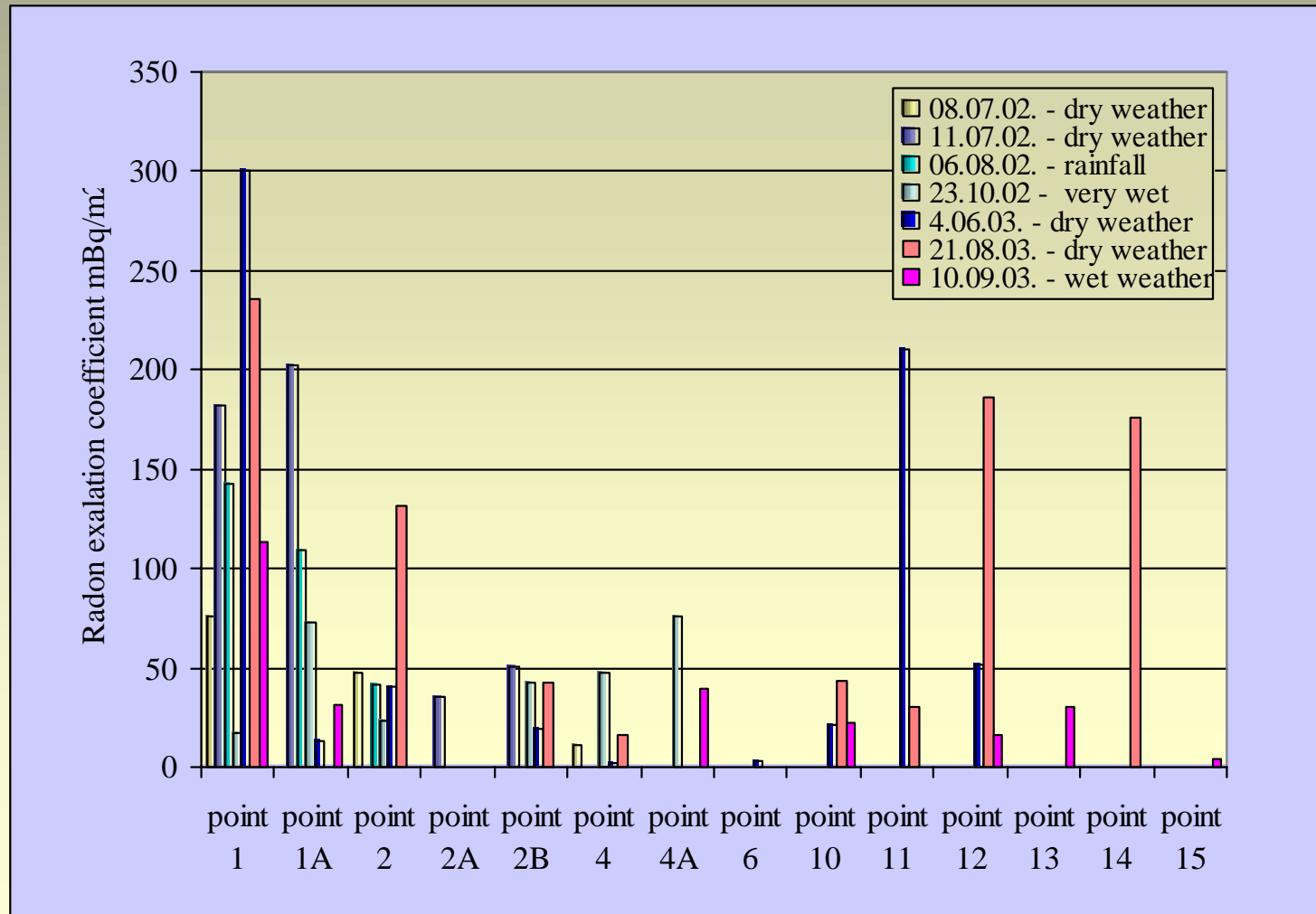
Settling pond B



**Radium 226-Ra concentration in
sediments – 2.0 kBq/kg**

**The measurements have been started in spring
2002 when part of the bottom was covered with
water**

Results of radon exhalation coefficient measurements – settling pond B





vegetation started to
grow at exposed and
dried sites of former
pond's bottom

eRn – 300 mBq/m²s¹

A photograph of a pond bank. In the foreground, a silver metal container with a lid sits on the sandy ground. To its right, a small, bushy green plant with some yellow flowers is growing. A red arrow points from the text 'up to 375 Bq/kg' to the plant. The background shows a wide, shallow pond with a sandy bank and some trees in the distance under a clear sky.

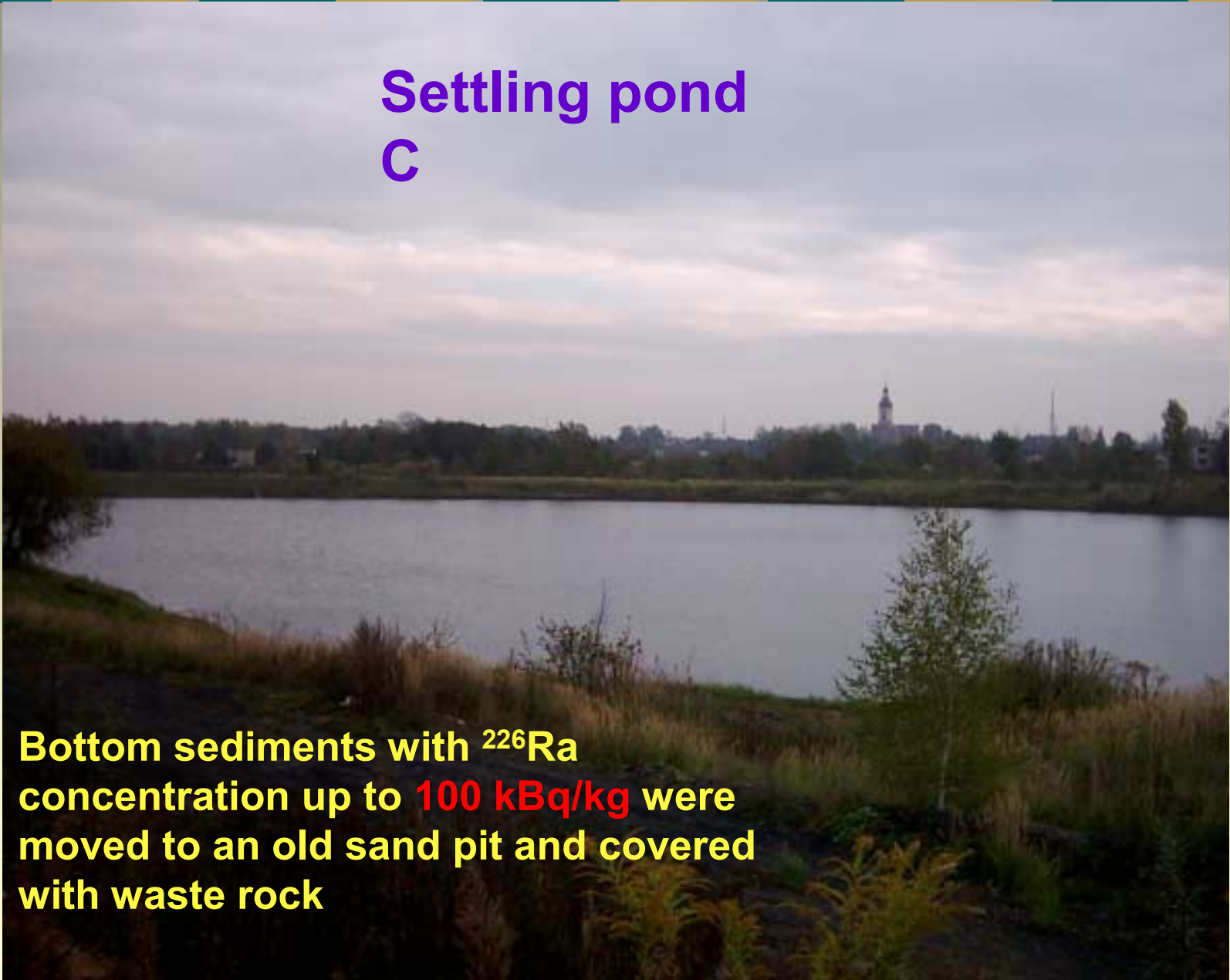
Radium content was determined in the samples of plants

up to **375 Bq/kg**

up to **5 Bq/kg** in plants from
pond's banks

Settling pond C

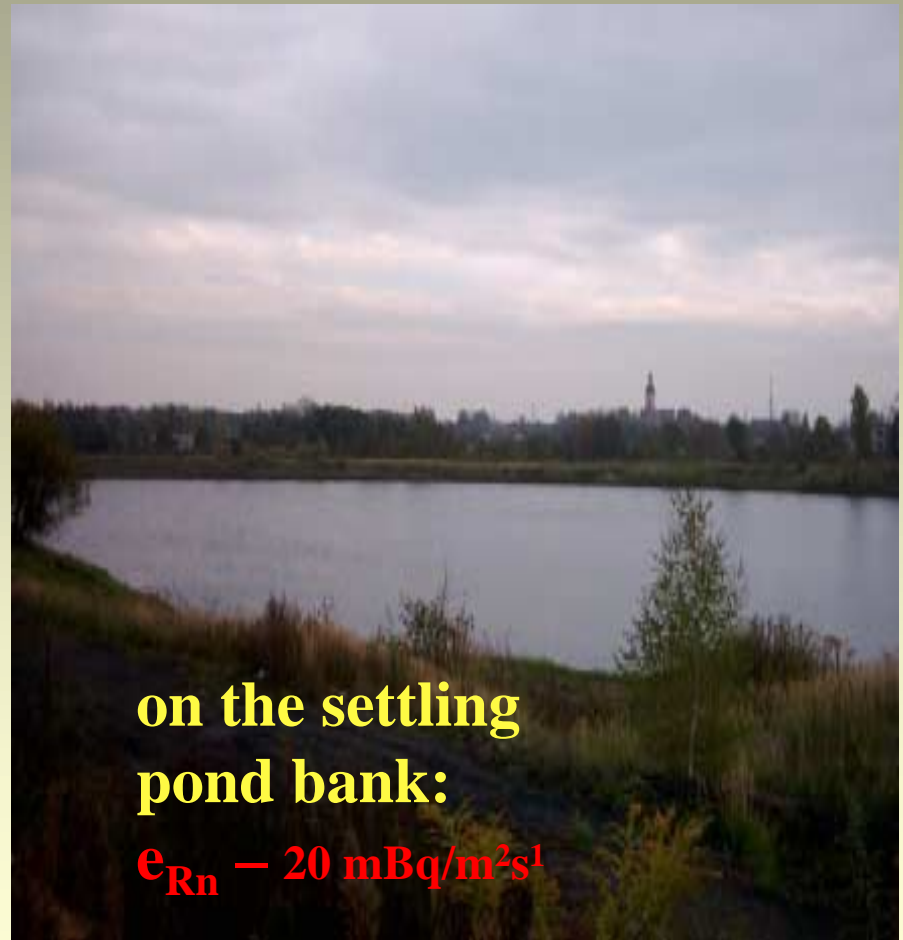
**Bottom sediments with ^{226}Ra
concentration up to 100 kBq/kg were
moved to an old sand pit and covered
with waste rock**



The results of measurements of radon exhalation

on the waste
rock pile
covering the old
bottom
deposites

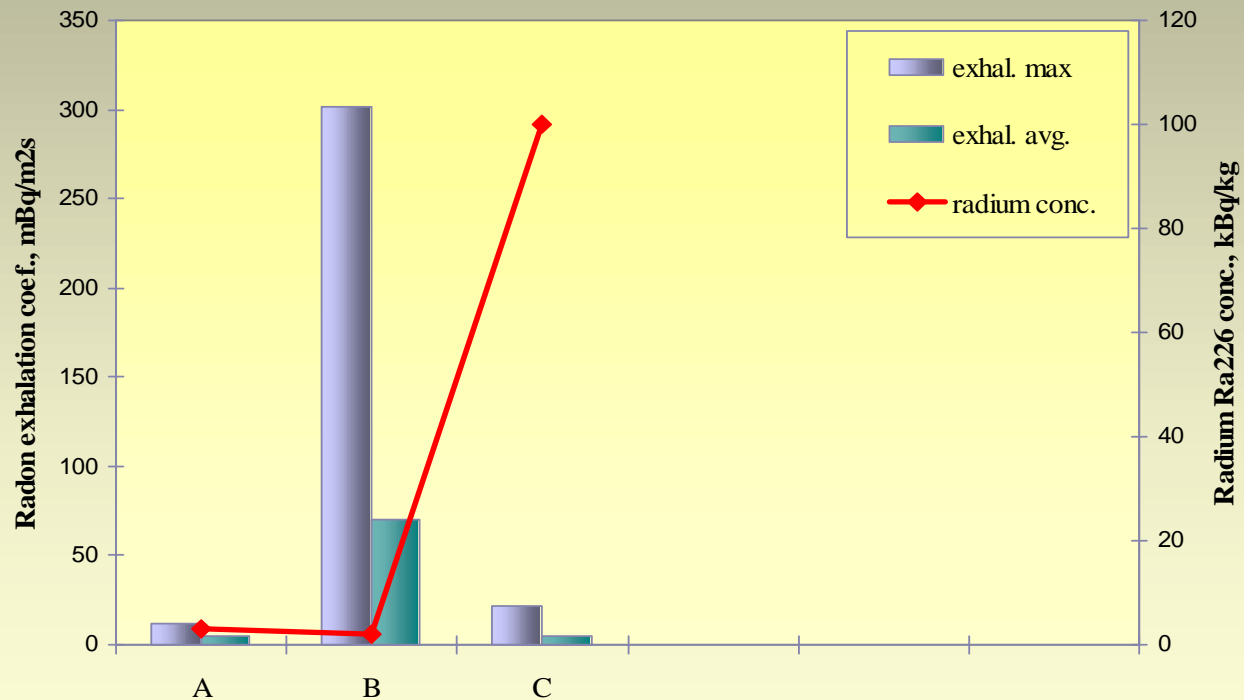
$$e_{Rn} - 2 \text{ mBq/m}^2\text{s}^1$$



on the settling
pond bank:

$$e_{Rn} - 20 \text{ mBq/m}^2\text{s}^1$$

Comparison of radon exhalation and radium content of bottom sediments from the abandoned mine water settling ponds.



Radon exhalation at the mine waste storage sites - west rocks piles





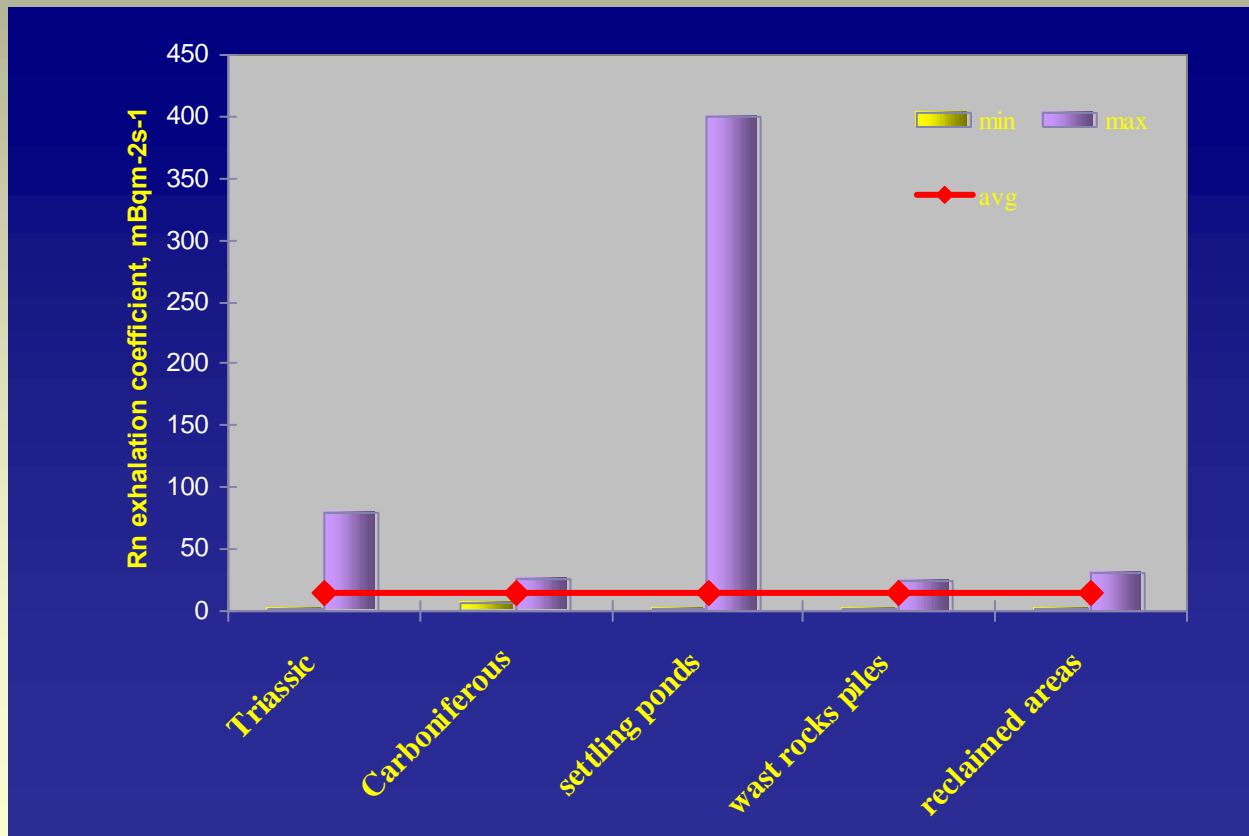
Reclamation with use of power plant wastes

- Open pit filled up by the slag and ashes from the coal-fired power plant, covered by soil
 - **Results of the measurements:**
 - Radon exhalation rates did not exceed **30 mBq/m²s¹** at the reclamation sites,
 - Radon exhalation rates reached **80 mBq/m²s¹** at the adjacent area
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Radon exhalation in the areas reclaimed with use of Zn-Pb ore mining wastes



Rn exhalation rates measured in the disturbed and undisturbed areas





Conclusions

- **Coal-mine closure operations may have a severe impact on the surrounding environment due to:**
 - **intensified radon emission: potential radiation hazard for public**
 - **variations of the gamma radiation background;**
 - **radiological plant contamination resulting from radium transfer from the sediments with elevated radium content.**
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Conclusions

- **The assessment of radon exhalation level is the essential information pointing to the way the post industrial areas can be reclaimed.**
 - **In the case of increased radon exhalation the reclamation (the sediments sealing) should be planned so as to avoid migration and penetration of that gas into the future buildings.**
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