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Indoor radon survey - preliminary results from Sološnica village, Slovakia

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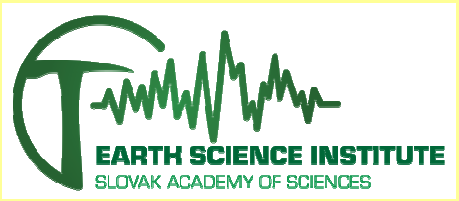
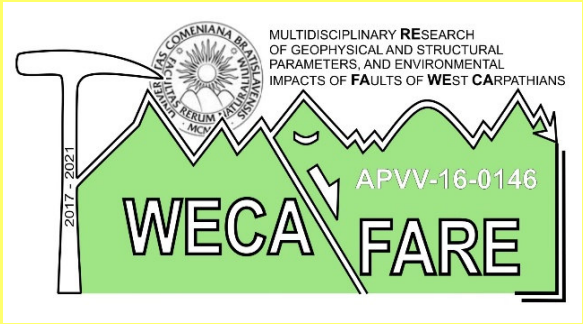
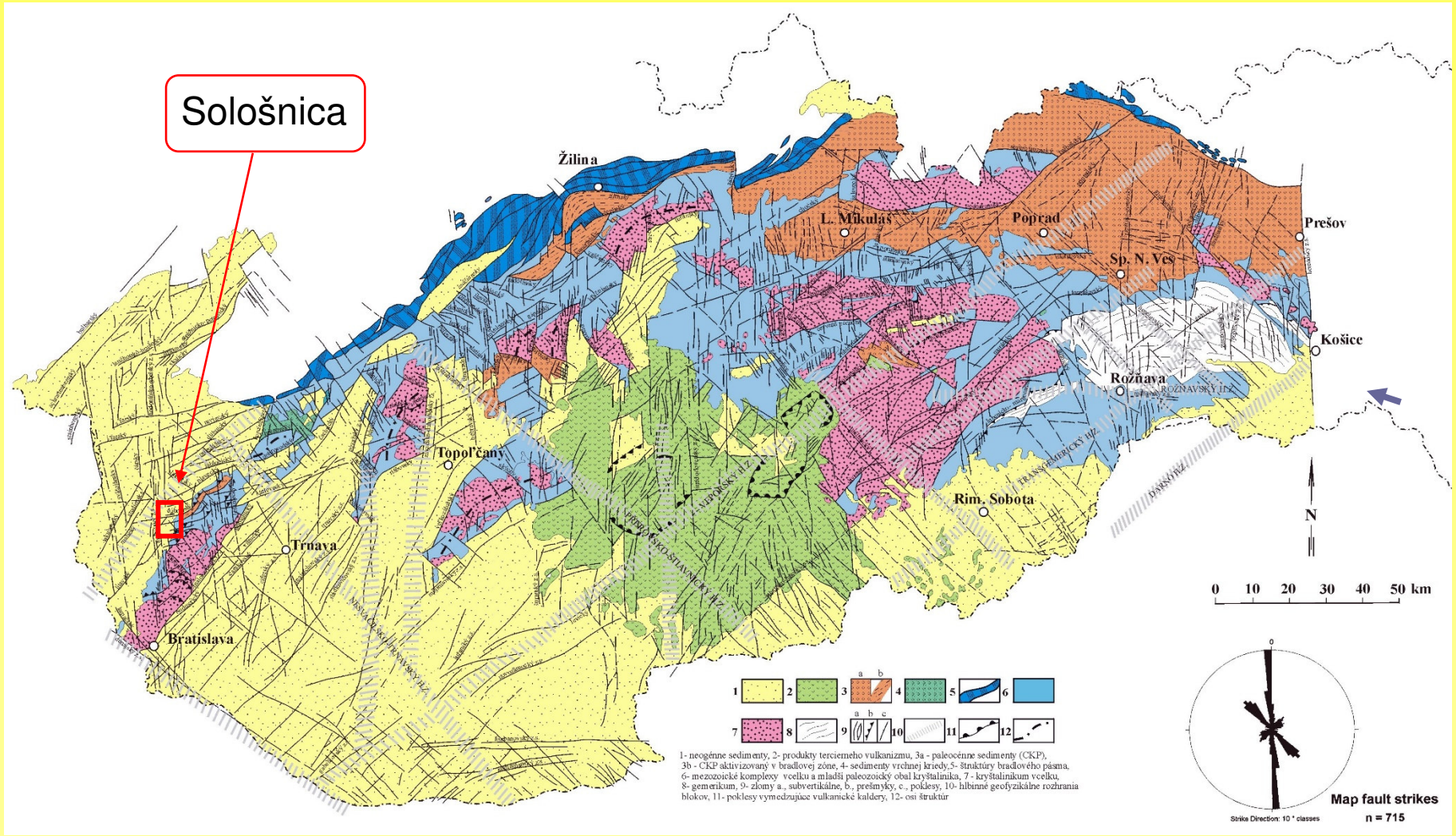


Aim of the research



- indoor radon survey in Sološnica is performed within the frame of the project „Multidisciplinary Research of Geophysical and Structural Parameters and Environmental Impact of Faults of Western Carpathians“
- Sološnica is supposed to be crossed by several faults, their exact position is investigated by various geological and geophysical methods
- geological fault mapping methods are hardly applied in covered or built-up areas
- presence of geologic faults near buildings increases the vulnerability of the buildings to elevated indoor radon
- indoor radon monitoring can be used for fault course identification
- indoor radon risk assessment in residential buildings

Faults of Central and Inner Western Carpathians and Vienna Basin (F. Marko, 1991)

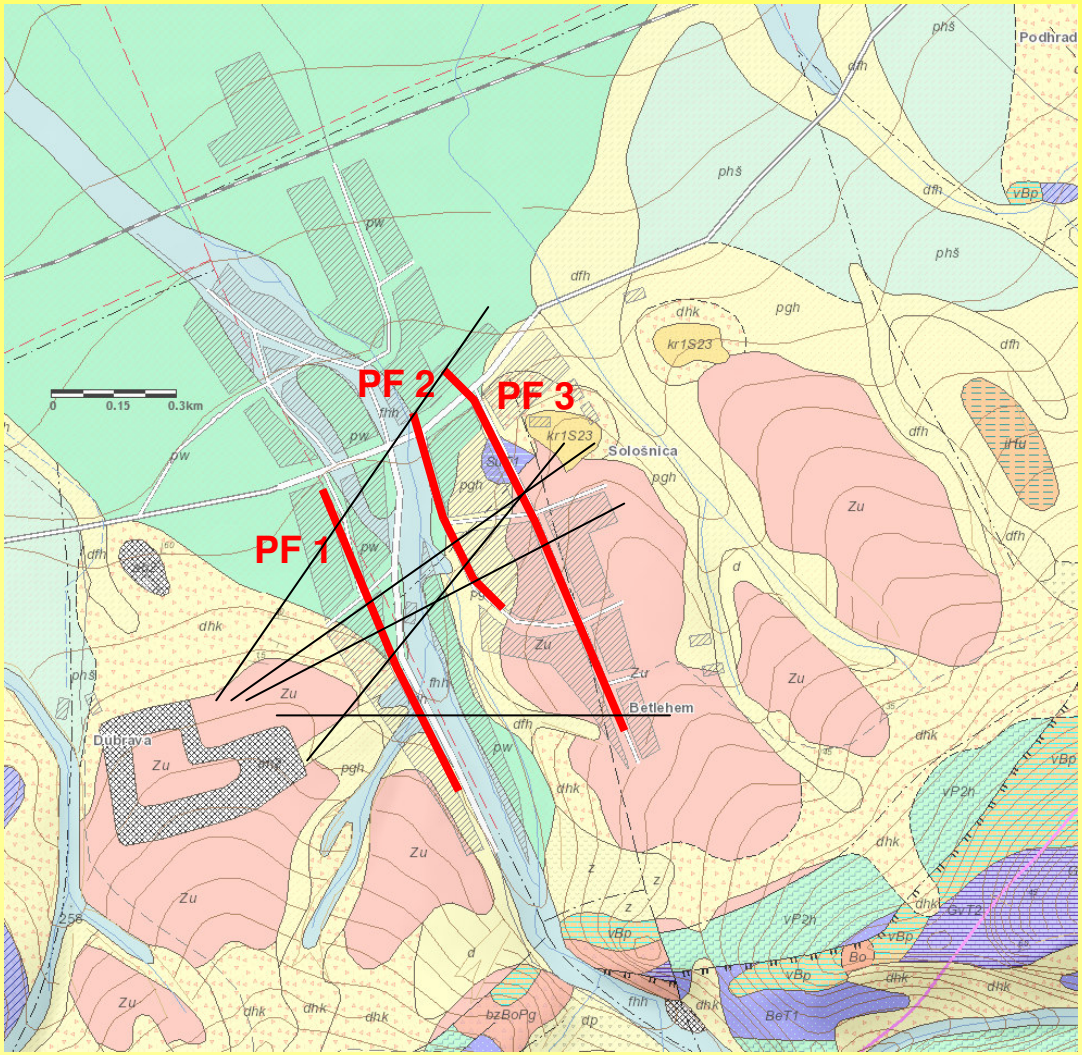


Sološnica is situated at the border of 2 geomorphological provinces:

the **Malé Karpaty Mts**. and the **Záhorská nížina Lowland**

Geological map of Sološnica

- buildings situated on 3 profiles were chosen for indoor radon monitoring



Proluvial sandy gravel
Lower Pleistocene

Flysch (claystone, mudstone, sandstone)
Eocene-Oligocene

Deluvial-fluvial sediments
Lower Pleistocene-Holocene

Sandstones, limestones, shales
Triassic

Proluvial sediments
Lower Pleistocene-Holocene

Calcareous claystone, conglomerate
Miocene

Claystones
Eocene-Oligocene

Deluvial sediments
Pleistocene-Holocene

Basalt, andesite
Lower Permian

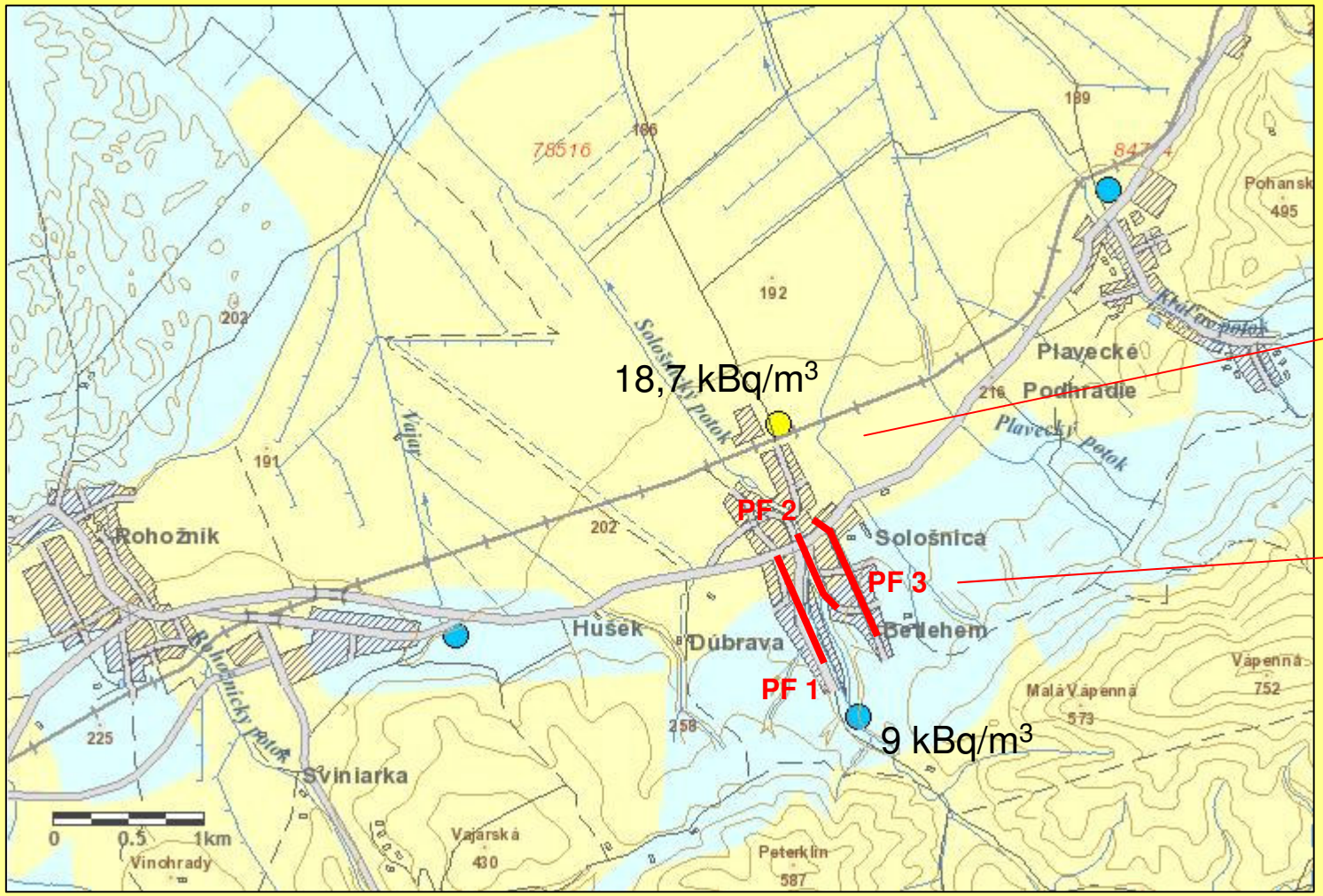
Guttenstein limestones
Middle Triassic

Limestones
Eocene

Anthropogenic sediments

Radon risk map of Sološnica

- based on soil radon measurements, soil gas permeability and geology (A. Gluch et al., 2009)



Indoor radon monitoring in Sološnica

- RAMARn alpha track detectors (SÚJCHBO - National Institute for Nuclear, Chemical and Biological Protection, Czech republic), with Kodak LR 115 film located at the bottom of the diffusion chamber

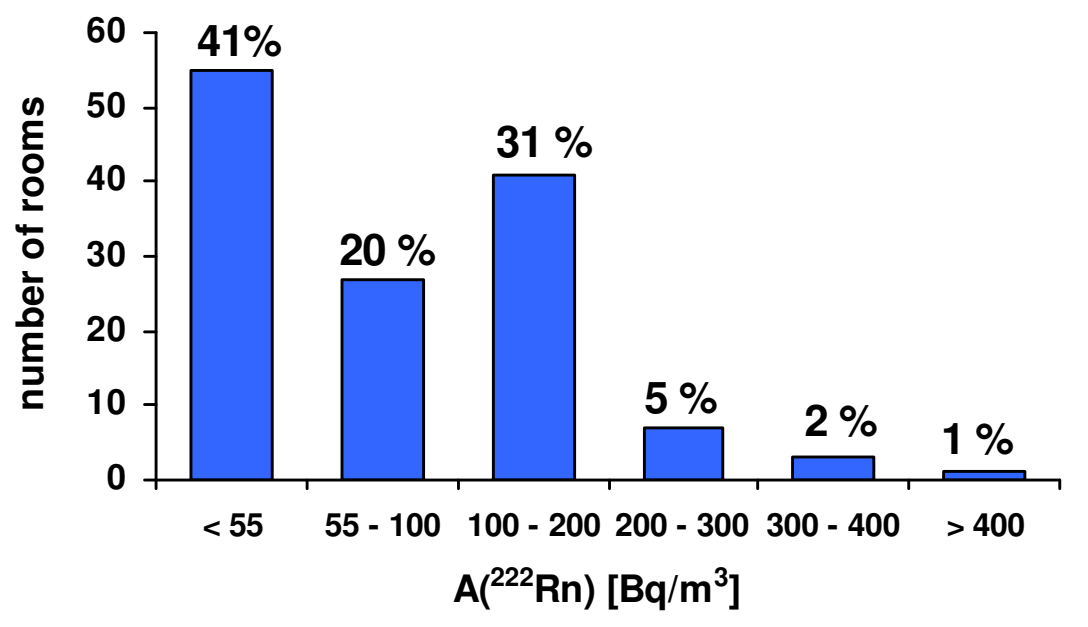
Indoor radon monitoring in Sološnica

- houses, offices, kindergarten and school included in the survey
- detectors are placed in two rooms on the groundfloor
- monitoring started in March 2018
- four monitoring periods: March - May 2018
  June - August 2018
  September - November 2018
  December 2018 - February 2019
- questionnaire (building material, window tightness, intensity of ventilation, cellar, year of construction and reconstruction, number of inhabitants and time spent in monitored rooms)
- information flyer about radon

Indoor Rn survey has been carried out in 134 rooms of 65 buildings:

Results – the first monitoring period: March-May 2018

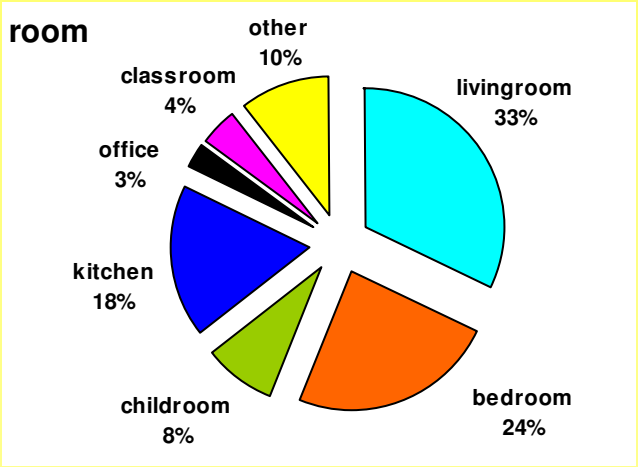
The frequency distribution of indoor radon activity concentration:

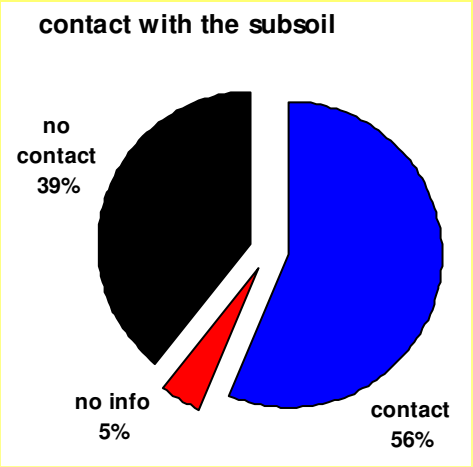


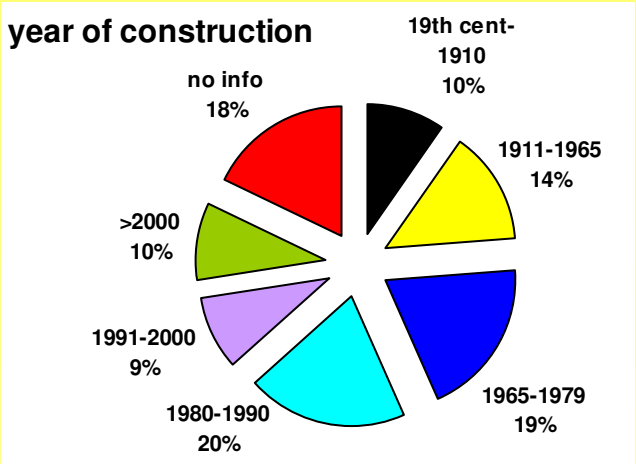
- indoor radon ranged from values under the detection limit of 55 Bq/m^3 to 415 Bq/m^3
- in 41 % of rooms indoor radon was lower than the detection limit
- less than 200 Bq/m^3 was found in 92 % of monitored rooms

The distribution of monitored rooms according to:

- type of a room
- contact with the subsoil
- year of construction

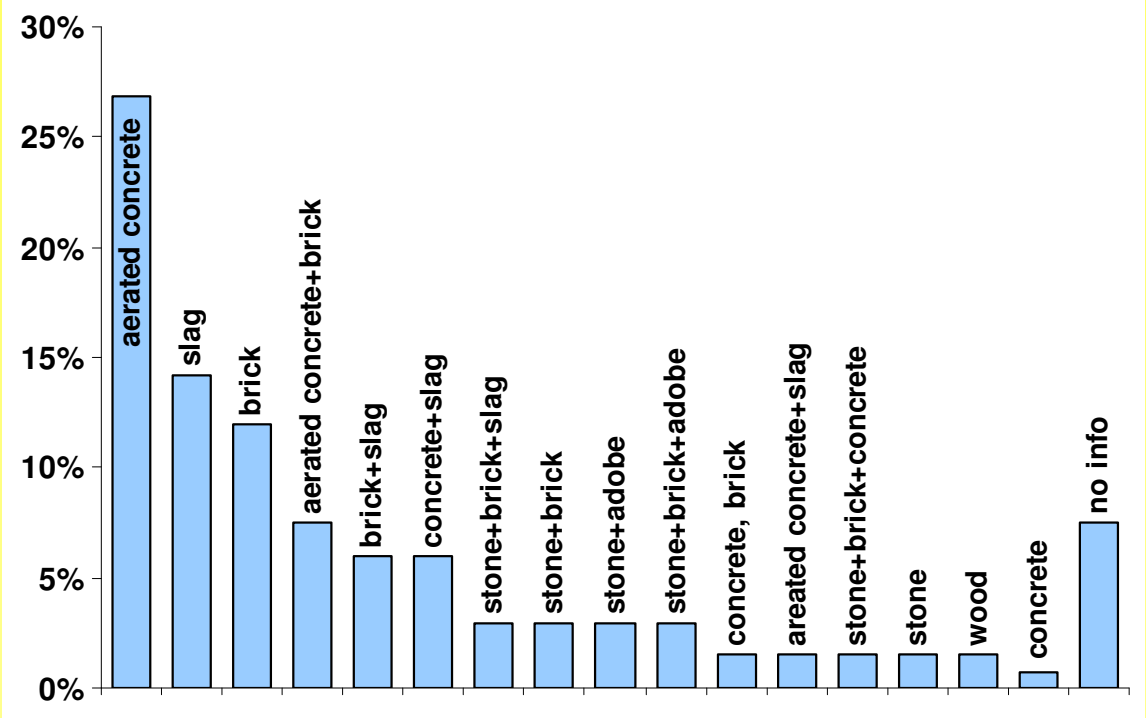






- Rn monitoring is performed mostly in the living room, bedroom and kitchen
- more than half of the monitored rooms was in a direct contact with the subsoil
- the majority of monitored buildings were built before year 1990 (63 %)

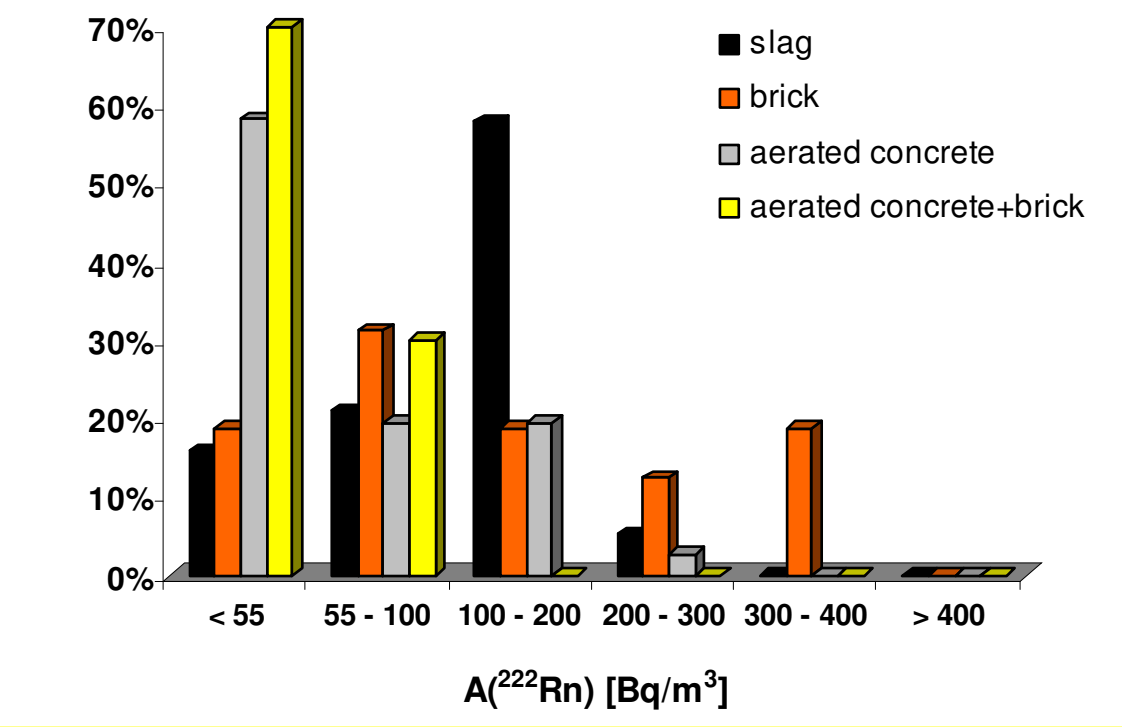
The distribution of monitored rooms according to the building material:



Most of the investigated buildings were built from:

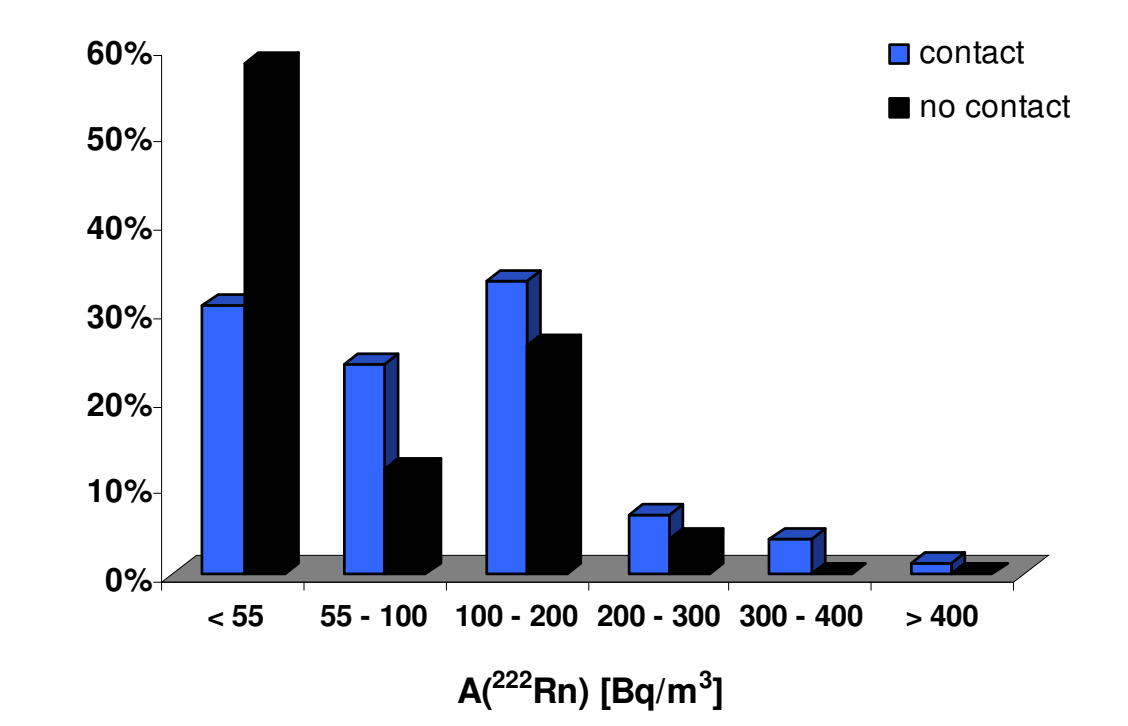
- aerated concrete
- slag blocks
- brick
- combination of aerated concrete and brick

The comparison of indoor radon concentration according to the building material:



- the lowest indoor radon - buildings made of aerated concrete and aerated concrete + bricks
- houses made of slag blocks has higher indoor radon
- several rooms in buildings made of bricks have indoor radon levels exceeding 300 Bq/m^3
- the highest indoor radon (415 Bq/m^3) was found in a house made of slag blocks + bricks

The comparison of indoor radon concentration according to the contact of a monitored room with the subsoil:

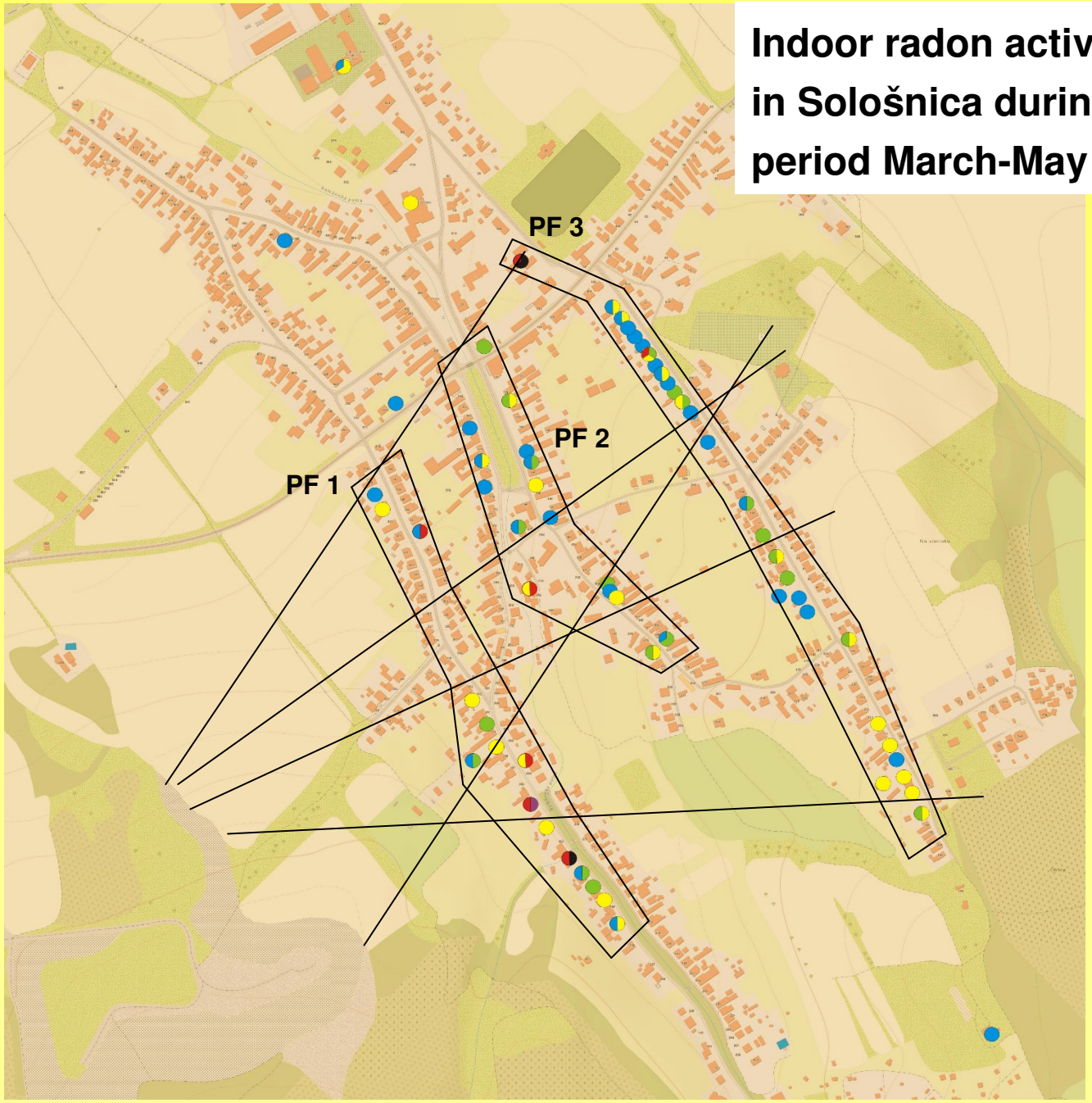


- lower indoor radon levels in rooms with no direct contact with the subsoil
- in 60 % of the rooms situated above the cellar indoor radon levels were lower than the detection limit (55 Bq/m^3)

The comparison of indoor radon concentration according to the age of the building:

- oldest buildings constructed in 19-th century and before year 1910: built mainly from local stone (travertine, limestone), brick and adobe - indoor radon < 200 Bq/m^3
- 1940 - 1965: mainly brick, also stone, adobe, slag, aerated concrete. In the half of monitored rooms activity ranged 100-200 Bq/m^3. The highest activities were found in rooms of a house made of bricks (250 Bq/m^3 and 390 Bq/m^3), in a direct contact with the subsoil, this house was thermally retrofitted.
- 1966 - 1980: mainly slag blocks or slag+bricks, several houses built from bricks and aerated concrete: activities > 200 Bq/m^3 were found in rooms of houses made of slag, the highest activity measured in a house (415 Bq/m^3), kindergarten
- 1981 - 1990: aerated concrete - low indoor radon. Among 27 monitored rooms, in 67% of them indoor radon was lover than the detection limit. Radon > 200 Bq/m^3 was found only in a poorly ventilated room situated in a semi basement
- 1990 - 2000: indoor radon < 200 Bq/m^3: new building materials available, the first legislation determining radioactive elements content limit in building materials was issued in 1992 in Slovakia
- new buildings: aerated concrete, bricks, wood and slag blocks, indoor radon < 200 Bq/m^3

Indoor radon activity concentration in Sološnica during the first monitoring period March-May 2018



- < 55 Bq/m^3
- 55 – 100 Bq/m^3
- 100 – 200 Bq/m^3
- 200 – 300 Bq/m^3
- 300 – 400 Bq/m^3
- > 400 Bq/m^3

Primary school – three monitored classrooms on the groundfloor

- built in 1942 from brick
- reconstructed in 1992, another part of building was added, made of aerated concrete
- new windows, no thermal insulation
- two monitored classroom in old part (cellar/no cellar) and one in new part (no cellar) of the building
- low indoor radon (max 130 Bq/m^3) (one detector was lost)

Kindergarten → increased indoor radon activities in all 3 monitored classrooms

Frogs: 315 ± 55 Bq/m^3

Butterflies: 365 ± 35 Bq/m^3

Owls: 250 ± 50 Bq/m^3

- single storey building
- made of brick, no cellar
- built in 1972 (79), reconstructed in 2008
- thermal insulation, new windows
- intensive ventilation according to the questionnaire
- teachers were recommended to increase the ventilation of classrooms

Conclusions

- in 92 % of investigated rooms low indoor radon (< 200 Bq/m^3) was found during the first monitoring period March - May 2018
- increased indoor radon was measured in the kindergarten
- the lowest indoor radon values were found in houses made of aerated concrete and aerated concrete + brick
- lower indoor radon levels in rooms with no direct contact with the subsoil
- low indoor radon in the buildings built after 1980 (aerated concrete, legislation, new building materials)
- low indoor radon levels in Sološnica in general, probably seasonal effect due to increased ventilation of houses
- increased indoor radon in buildings situated on presumed faults crossing Sološnica was not confirmed, further monitoring is necessary

Thank you for your attention!

Authors are grateful to the inhabitants of Sološnica for their participation in the radon survey