Randon

measurements conducted in Poland

Małgorzata Wysocka

Krzysztof Ciupek

GIG

Central Laboratory for Radiological Protection

03/12/2013

Radon Protection Conference, Dresden

National Atomic Energy Agency (PAA) is a central organ of governmental administration competent for the issue of nuclear safety and radiological protection. PAA President executes his/her tasks through the Agency, which internal organization is established by the statute conferred by the Environment Minister.

ACT OF PARLIAMENT
Atomic Law

Executive acts of: **Council of Ministers, Minister of Finance, Minister for Environment**

Executive acts of the Minister
of Interior and Administration

natural hazards in mining

Executive acts of the Minister
-of Economy

occupational safety and health, operation, and specialized fire protection in underground mines.

Mining industry

Executive acts of the Minister:
- of Interior and Administration
- of Economy

Class A excavation - controlled areas
Class B excavation - supervised areas

Radiation Protection Officer type 1

Methods and frequency of environmental monitoring:
- potential alpha energy concentration in the air
- kerma rate in the air
- total concentration of radium isotopes Ra-226 and Ra-228 in water
- specific activity of radium isotopes Ra-226 and Ra-228 in sediments

Executive acts of
Council of Ministers

Regulation on:

the requirements concerning **the content of natural radioactive isotopes of potassium K-40, radium Ra-226 and thorium Th-228 in raw materials and materials used in buildings** designed to accommodate people and livestock, as well as **in industrial waste** used in construction industry, and the procedures for controlling the content of these isotopes

ACT OF PARLIAMENT
Atomic Law

Article 1 .3. This Act shall apply also to the activities conducted in conditions of exposure to natural ionizing radiation enhanced by human activity.

Article 13.1. Dose limits shall include the sum total of the doses from external and internal exposures.

2. Dose limits shall not include the exposure to natural radiation, provided that such **exposure has not been enhanced by human activity**; in particular they shall **not include the exposure resulting from radon in homes**, natural radioisotopes incorporated in human bodies, cosmic radiation on ground level and above-ground exposures to radioisotopes present in the undisturbed Earth crust.

Executive acts of
Council of Ministers

Regulation on ionizing radiation dose limits:

For radon progeny and thoron progeny the following conventional conversion factors apply, **effective dose** per unit potential alpha-energy exposure (Sv per J·h·m^{-3}):

Radon at home: 1.1 **Radon at work: 1.4** **Thoron at work: 0.5**

Potential alpha energy (of radon progeny and thoron progeny): The total alpha energy ultimately emitted during the decay of radon progeny and thoron progeny through the decay chain, up to but not including ^{210}Pb for progeny of 222Rn and up to stable ^{208}Pb for progeny of ^{220}Rn. The unit is J (Joule). For the exposure to a given concentration for a given time the unit is J·h·m^{-3}.

ACT OF PARLIAMENT
Atomic Law

Article 23.1. Occupational activities involving the presence of natural radiation leading to an increase of the exposure of workers or the general public, which is significant from radiological protection viewpoint, shall require an assessment of this exposure.

3. (…) include in particular the work performed in:

1) Mines, caves and other underground sites, and also in health resorts and spas; (…)

Article 23.4. Council of Ministers, taking into account the European Union's recommendations, regulations issued under Art. 25(1), the characteristic features of the occupational activity and those of the exposed worker tasks, **may establish by regulation**:

1) **Types of occupational activities involving the presence of natural radiation leading to the increase of the exposure of workers or general public, which is significant from radiological protection viewpoint,** other than those referred to in paragraph 3,
2) Methods of assessment of the exposure resulting from activities referred to in paragraph 1, procedures for reducing this exposure and other measures designed for radiological protection of exposed workers and of population.

Since 1991 up to now a nationwide survey of Polish dwellings has been conducted to determine the radon exposure of the Polish population and prepare radon map for dwellings and outdoors.

The mean value of Rn concentration outdoors in Poland is 4 Bq/m^3, max 8 Bq/m^3.

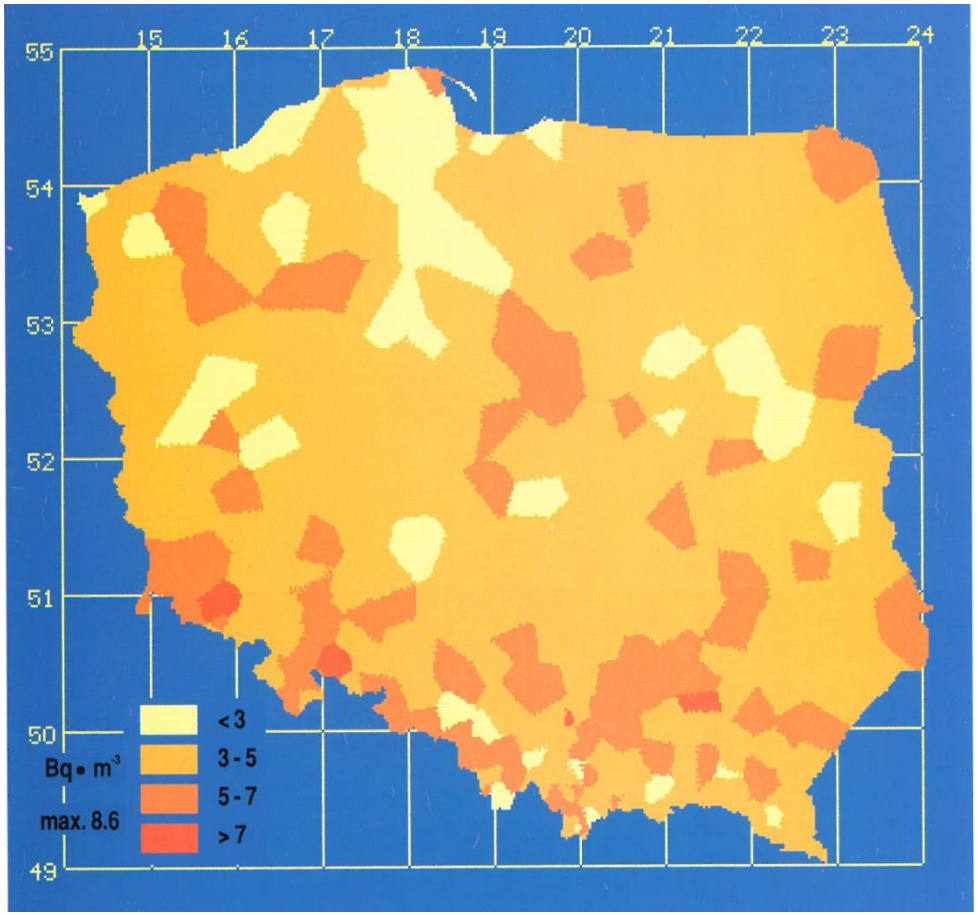
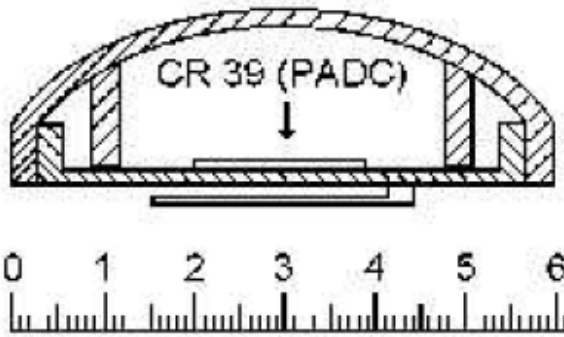


Fig. 1 Radon concentration in air outdoors

Results were achieved by means of the passive solid state nuclear track detector (SSNTD) technique based on CR-39 foils in diffusion cups (Fig.2) exposed from 6 to 12 months.



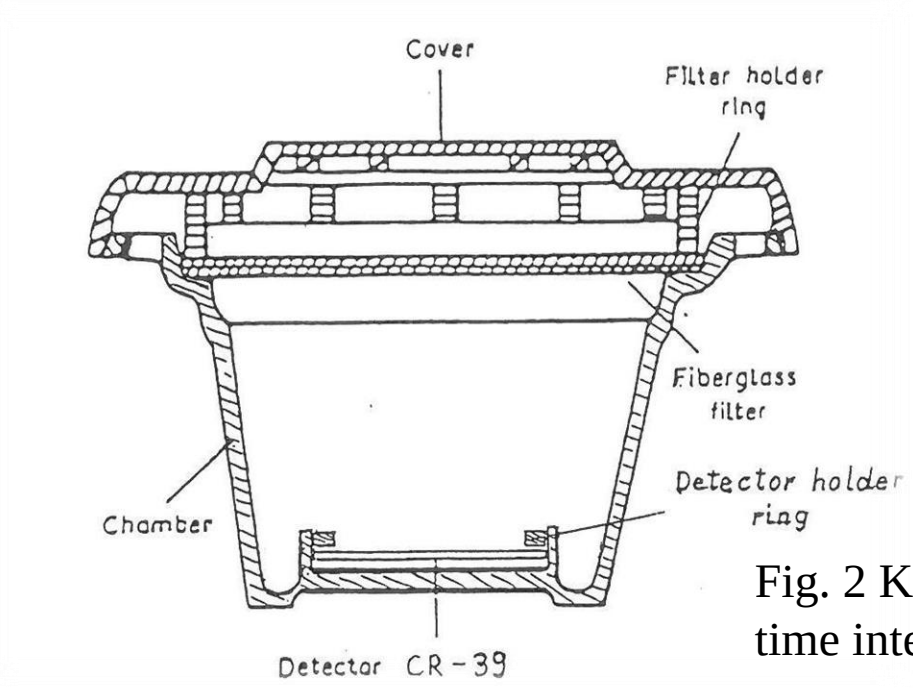


Fig. 2 Karlsruhe-type passive time integrating radon detector

Table 1 Radon concentration indoors. All flats. (First campaign)

Region of	All buildings		Buildings with cellars		Buildings without cellars		Ratio: non-cellar / cellar
	Number of flat	Arithmetic mean Bq/m^3	Number of flats	Arithmetic mean Bq/m^3	Number of flats	Arithmetic mean Bq/m^3	
Katowice	324	45,7	272	41,3	35	75,2	1,8
Wrocław	429	47,1	344	42,8	62	67,1	1,6
Białystok	320	47,0	279	45,3	28	63,7	1,4
Warszawa	727	39,8	531	40,1	162	38,6	1,0
Gdynia	281	28,0	164	25,3	15	52,6	2,1
5 regions together	2081	41,8	1590	40,2	302	52,7	1,3

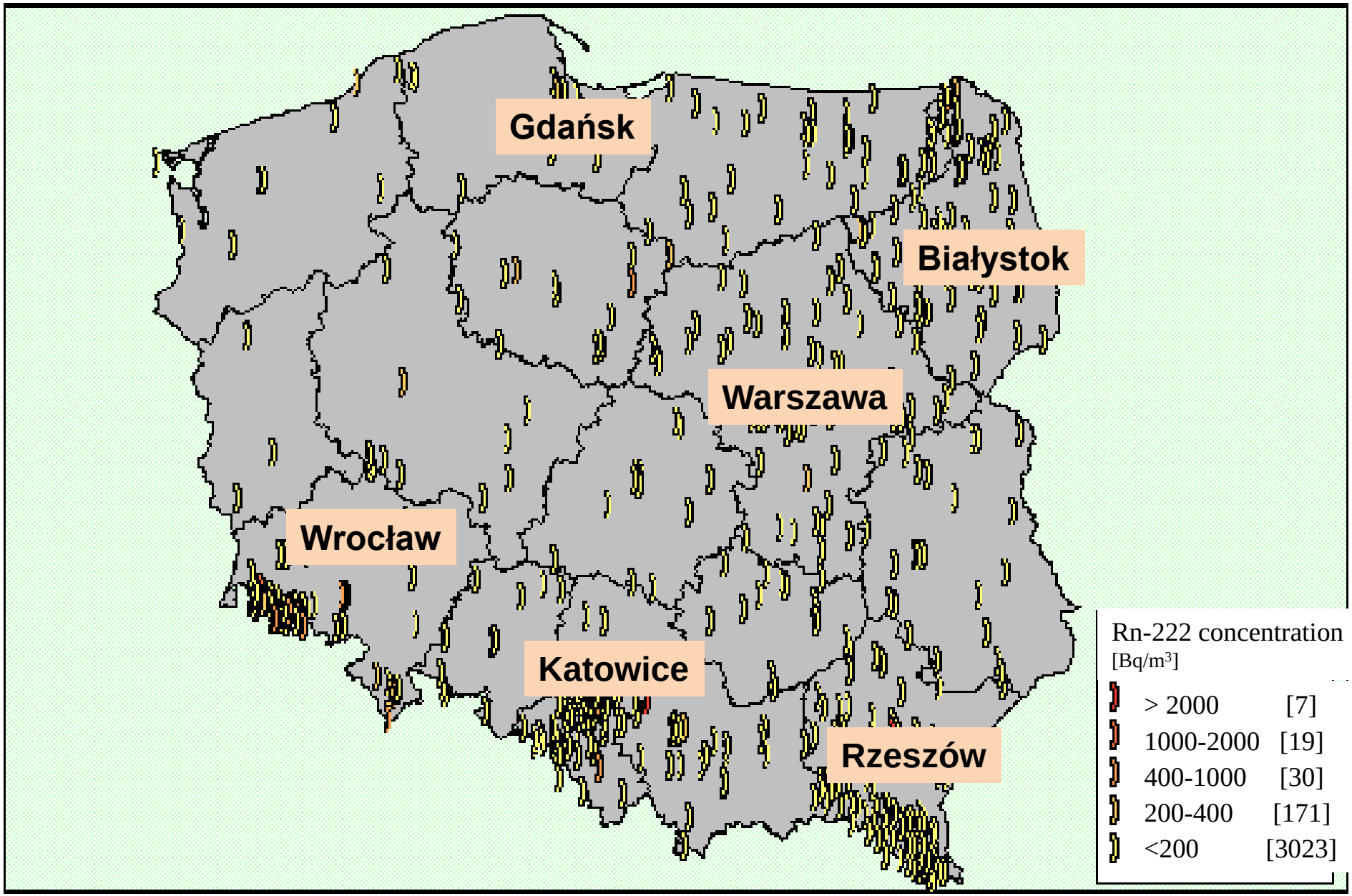


Fig. 2 Radon concentration indoors. Summary.

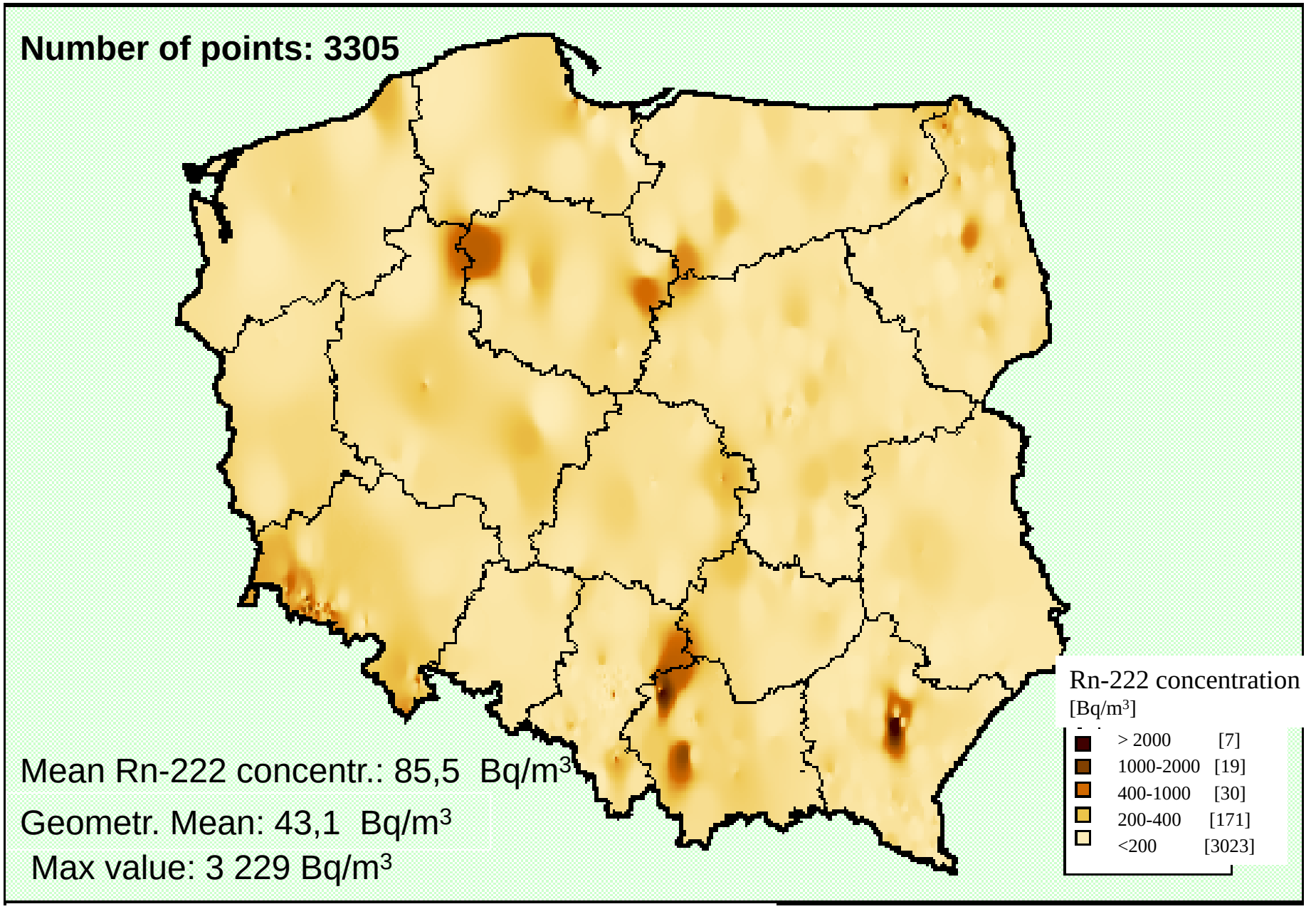
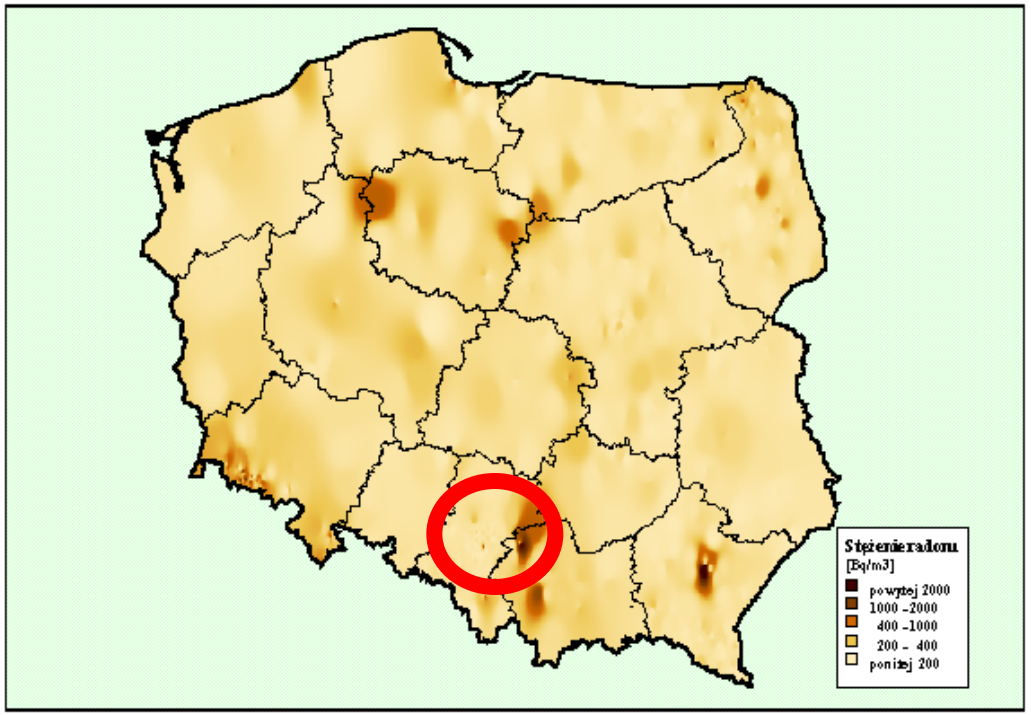


Fig. 3 Radon concentration indoors. Raster map.

Radon levels in dwellings in **Upper Silesia** region is related to:
- local geological structure,
- mining activity.

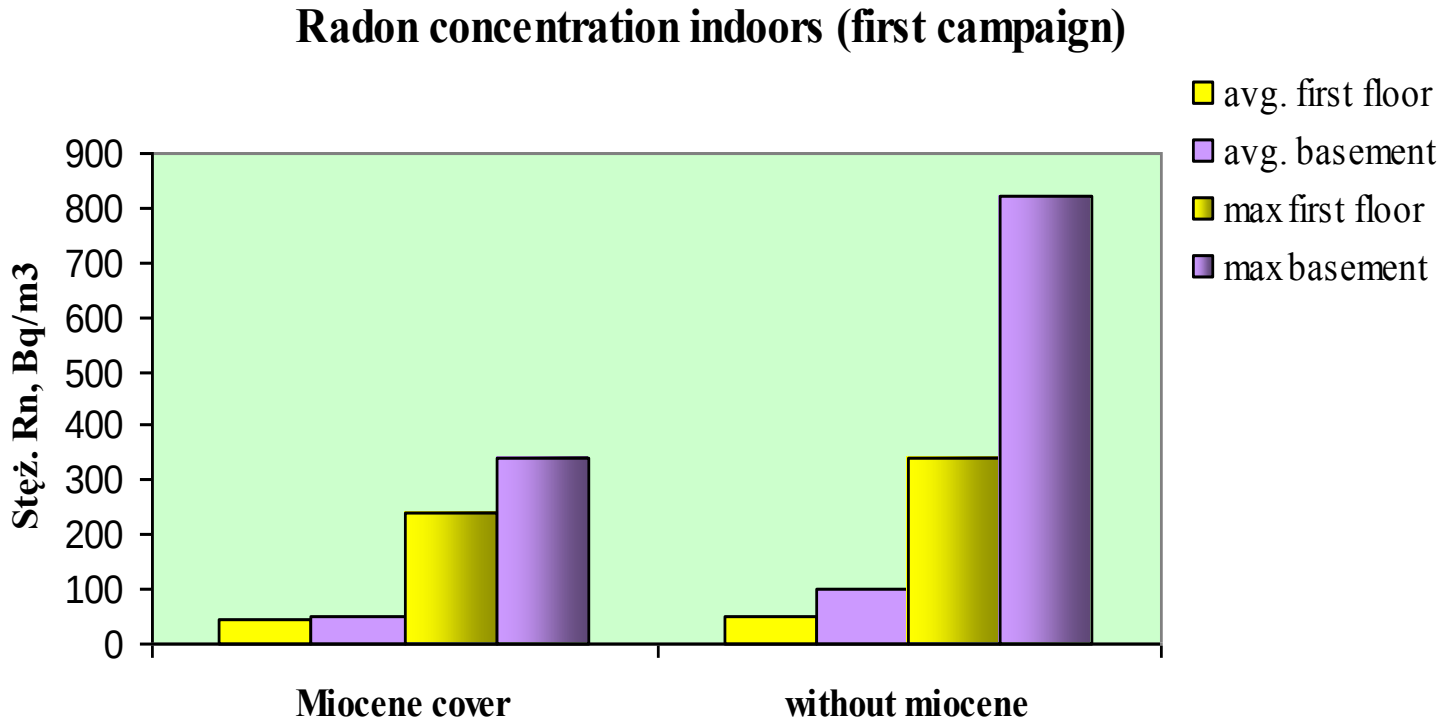


Mapa 1. Stężenie radonu w Polsce – mapa rastrowa.

- Correlation of results with local geological structures
- Analysis of the influence of mining activity on radon potential
- Dose assessment for inhabitants of Upper Silesia region

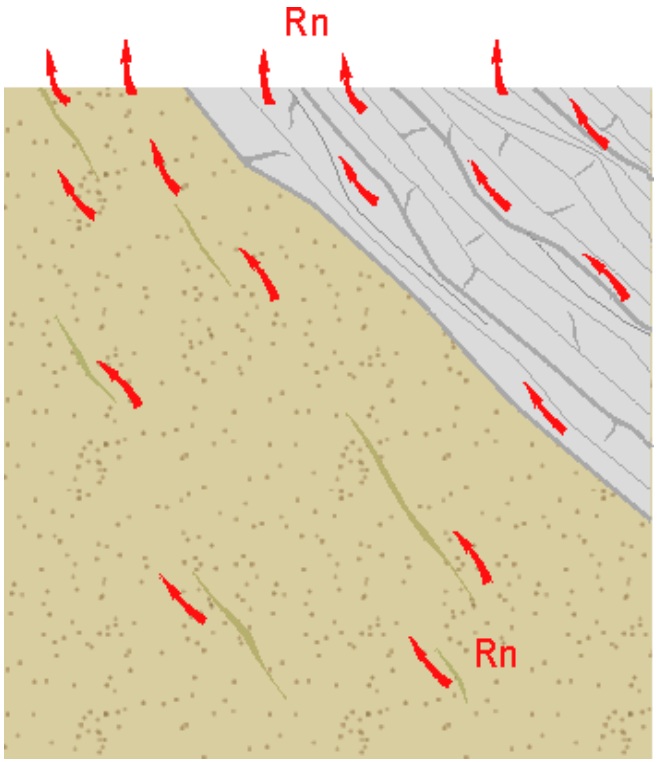
The average radon concentration for Upper Silesia:

- groundfloor: 47 Bq/m3
- cellars: 64 Bq/m3

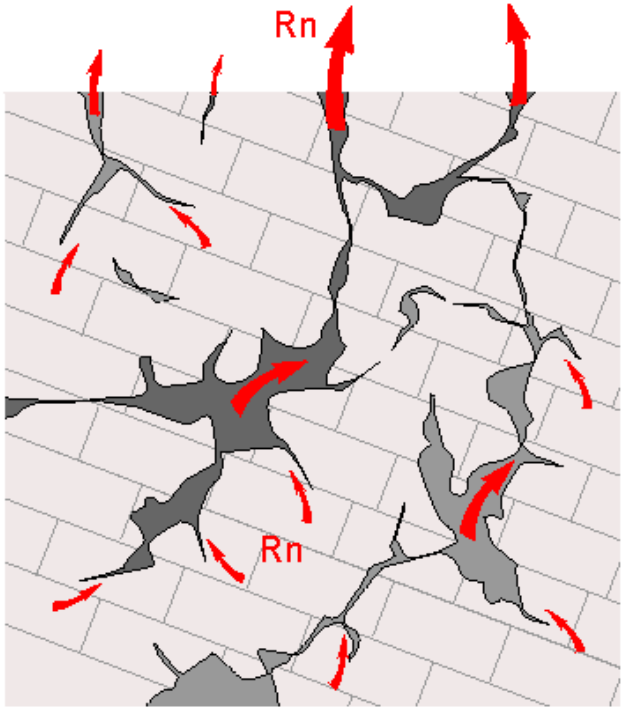


However, significant variations in different zones of Coal Basin

Possible explanation - different patterns of radon migration

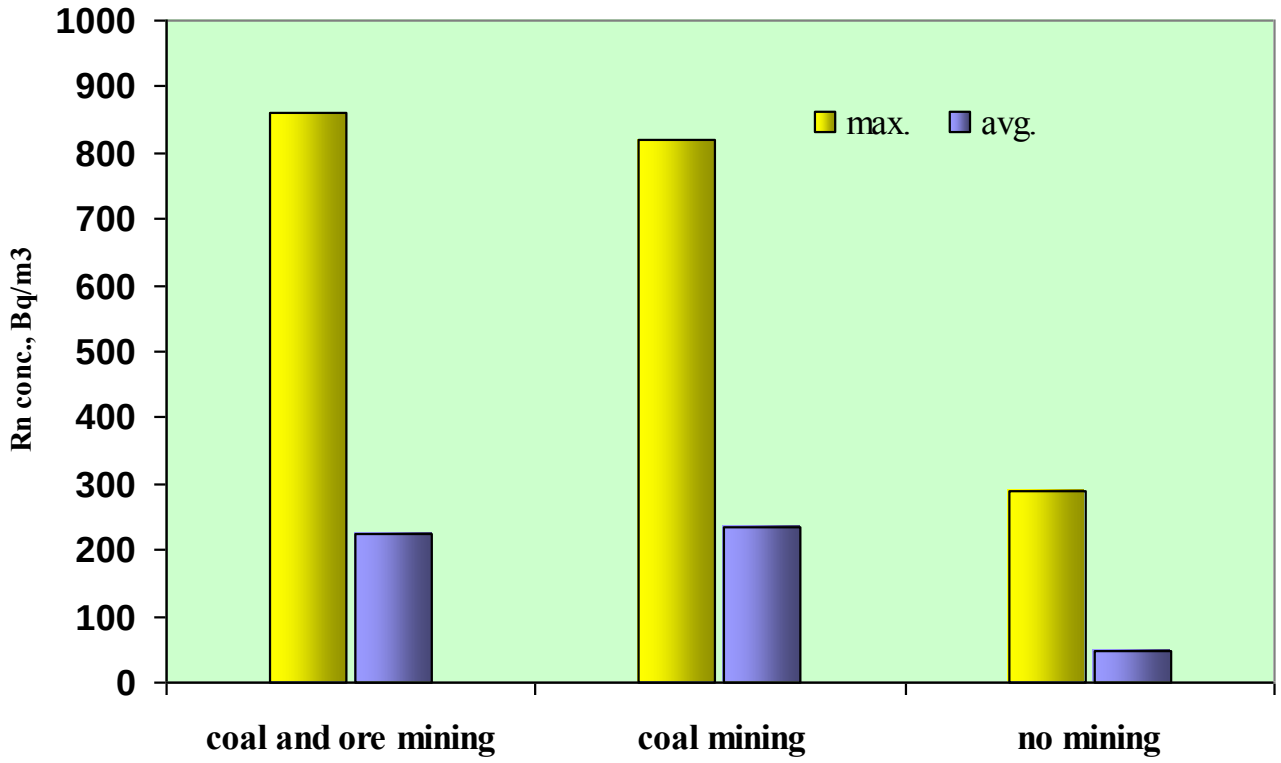


Carboniferous rocks



Triassic rocks

The influence of mining activity on radon levels in dwellings in Piekary Śląskie

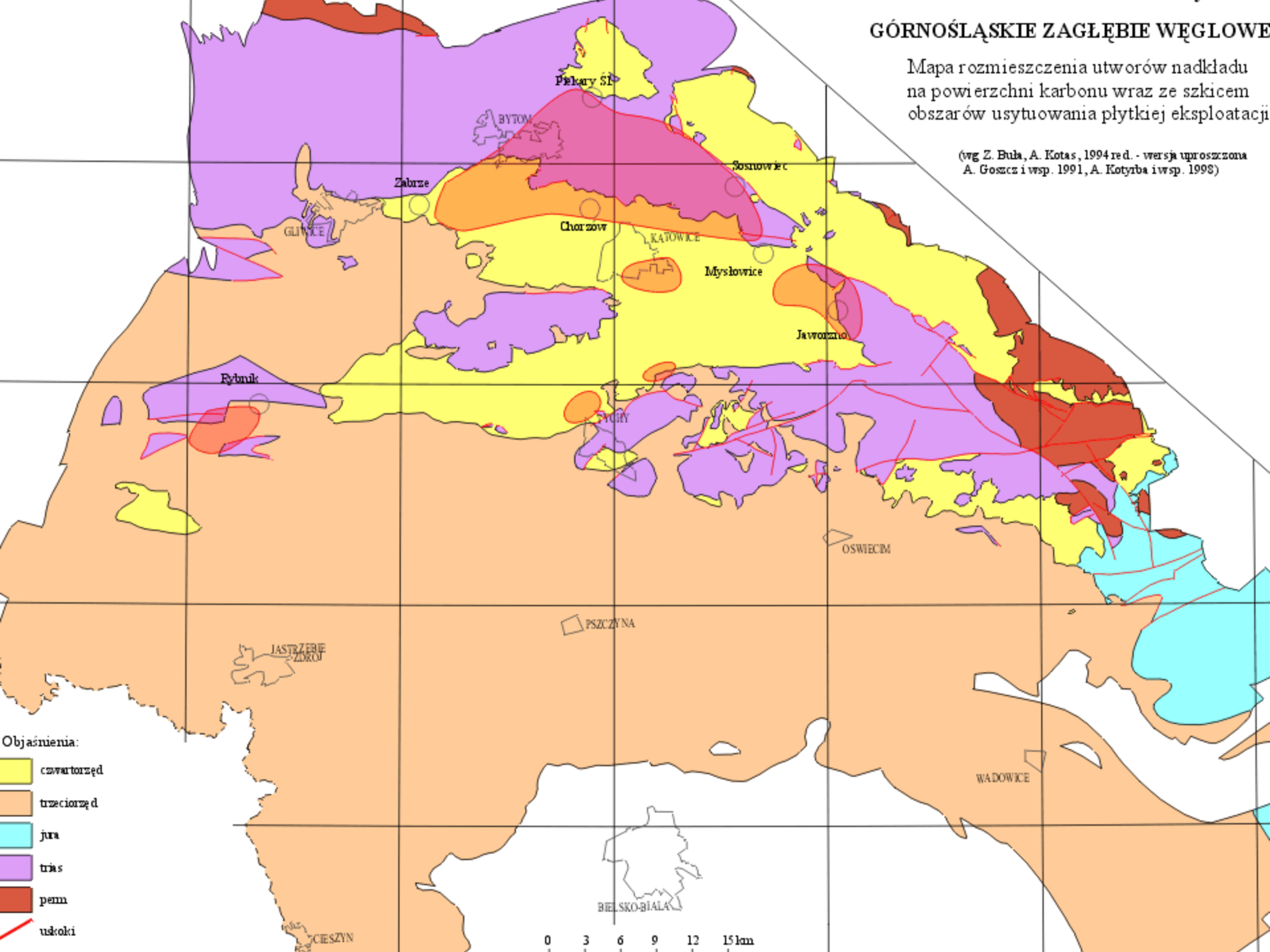


In buildings located in the zone without influence of mining average radon concentration in dwellings is significantly lower

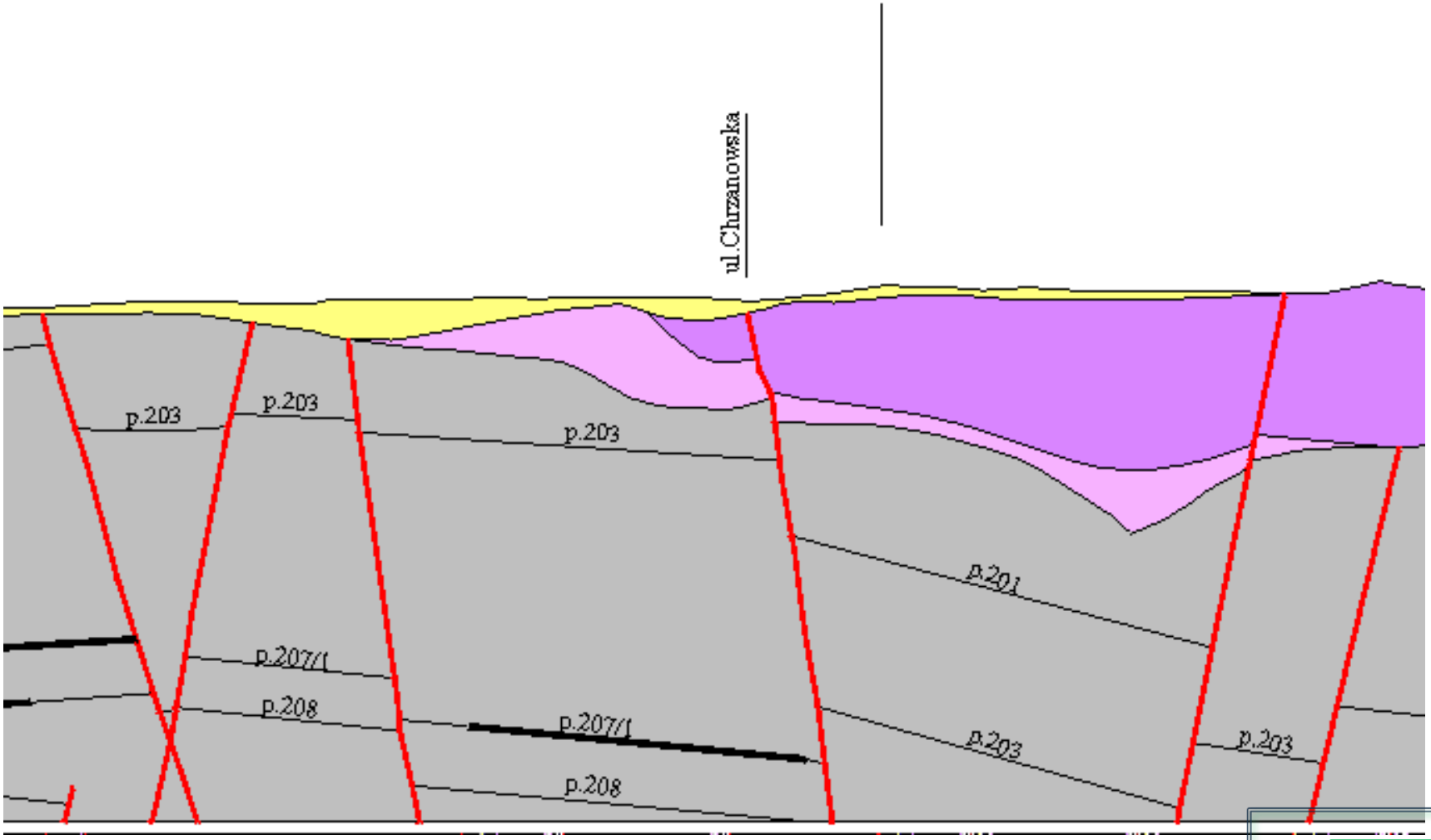
GÓRNOŚLĄSKIE ZAGŁĘBIE WĘGLOWE

Mapa rozmieszczenia utworów nadkładu na powierzchni karbonu wraz ze szkicem obszarów usytuowania płytkiej eksploatacji

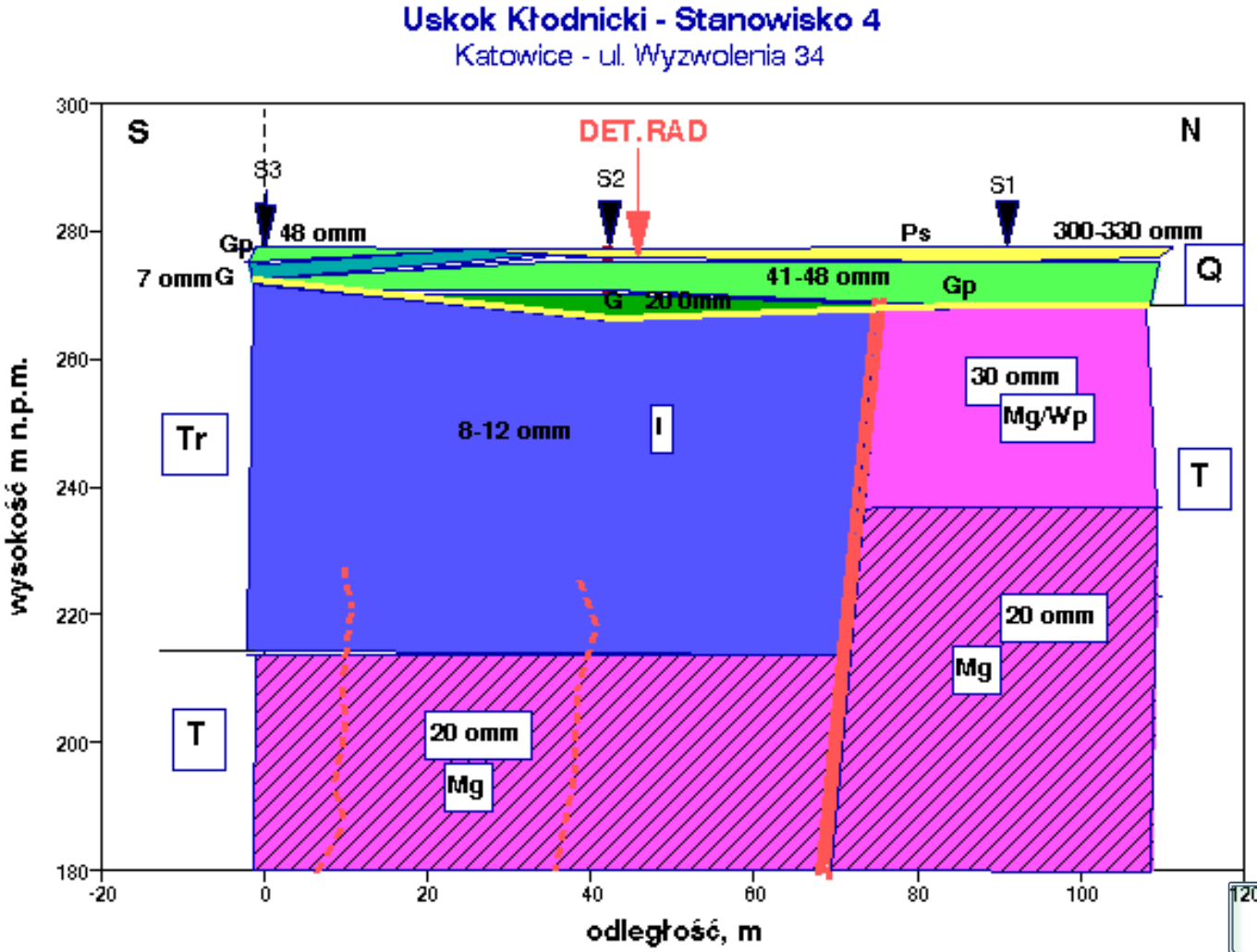
(wg Z. Buła, A. Kotas, 1994 red. - wersja uproszczona A. Goszcz i wsp. 1991, A. Kotyrba i wsp. 1998)



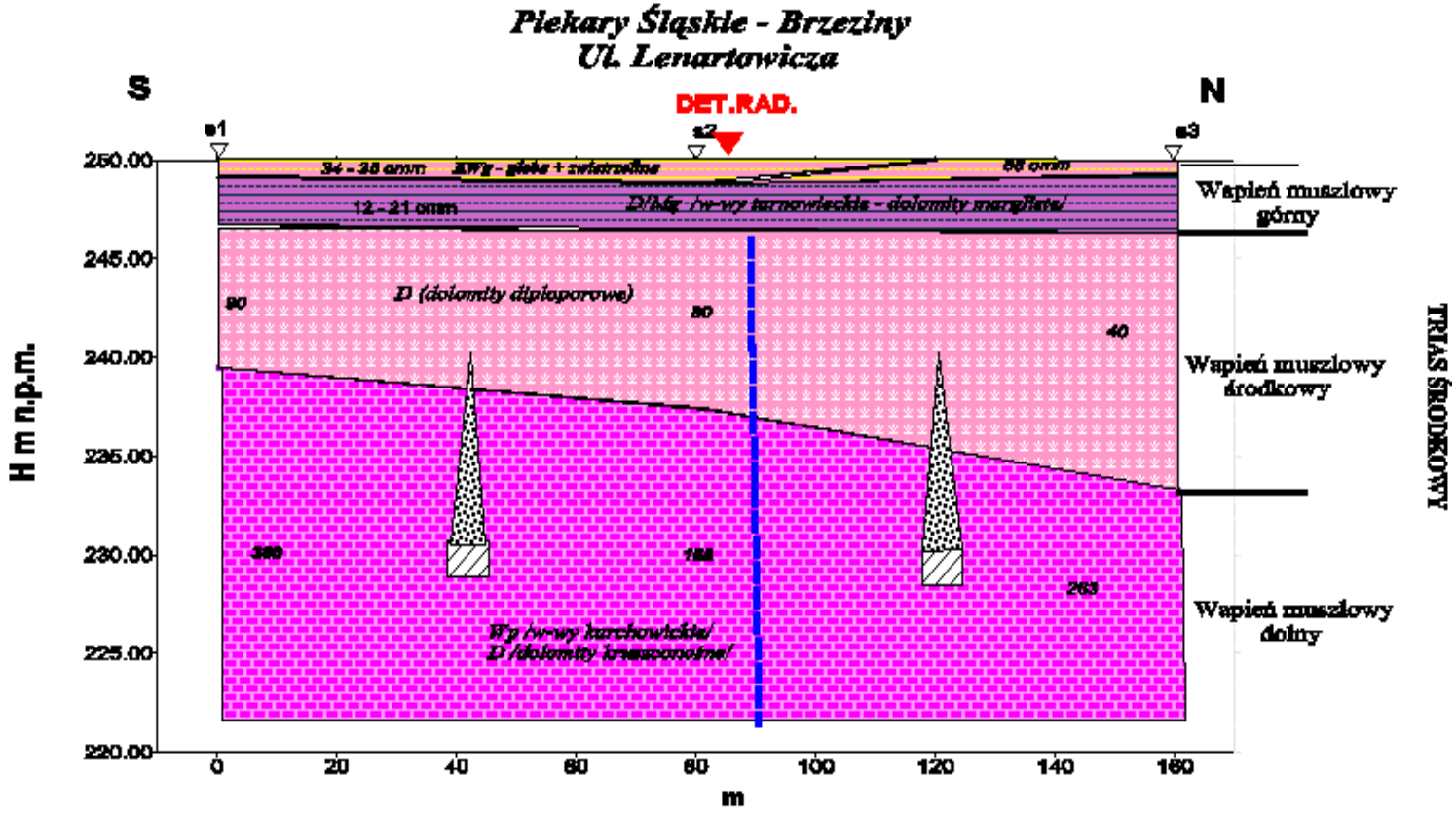
The cross-section of the investigation site



The geophisical cross-section of the investigation site

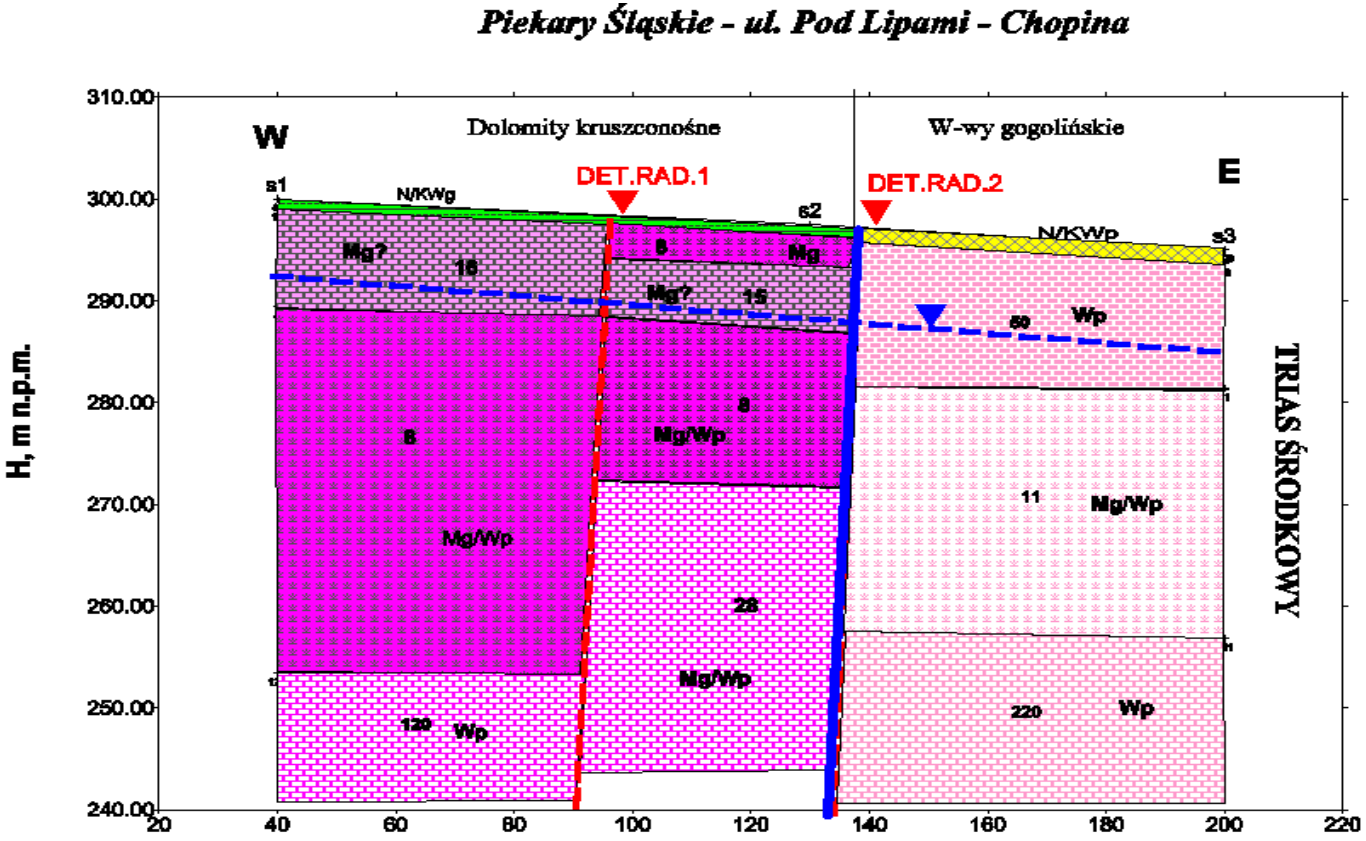


Support of geophysical methods in radon survey
vertical electroresistivity sounding



Values of electroresistivity in ore-bearing dolomites are changing in wide ranges. It proofs that rocks are fractured and fissured. This damages are induced by shallow exploitatin of Zn-Pb ores

Support of geophysics in radon survey elcetric resistance profiles



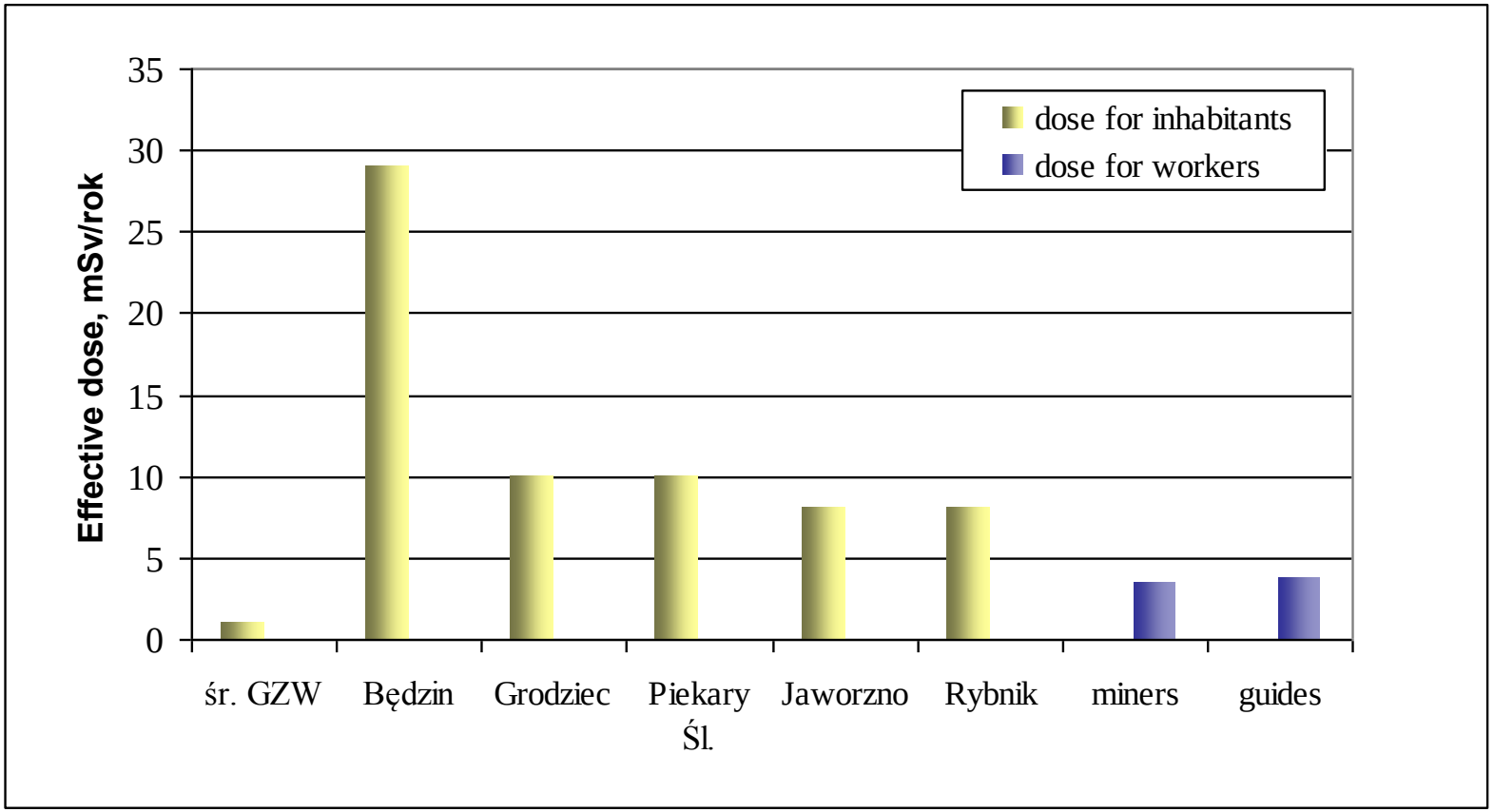
Application of that method enables detection of shallow caverns and emptiness, water table level, density of fissures and crack etc.

Effects of mining on surface, increasing radon migration

- Non-linear deformations
- surface subsidence
- activation of faulting zones
- overlapping of effects of shallow exploitation of metal ores and deep coal mining
- karstic processes, caused by mining
- damages of buildings due to mining, creation of pathways for radon migration

Zones with shallow exploitation are specially prone to enhanced radon exhalation

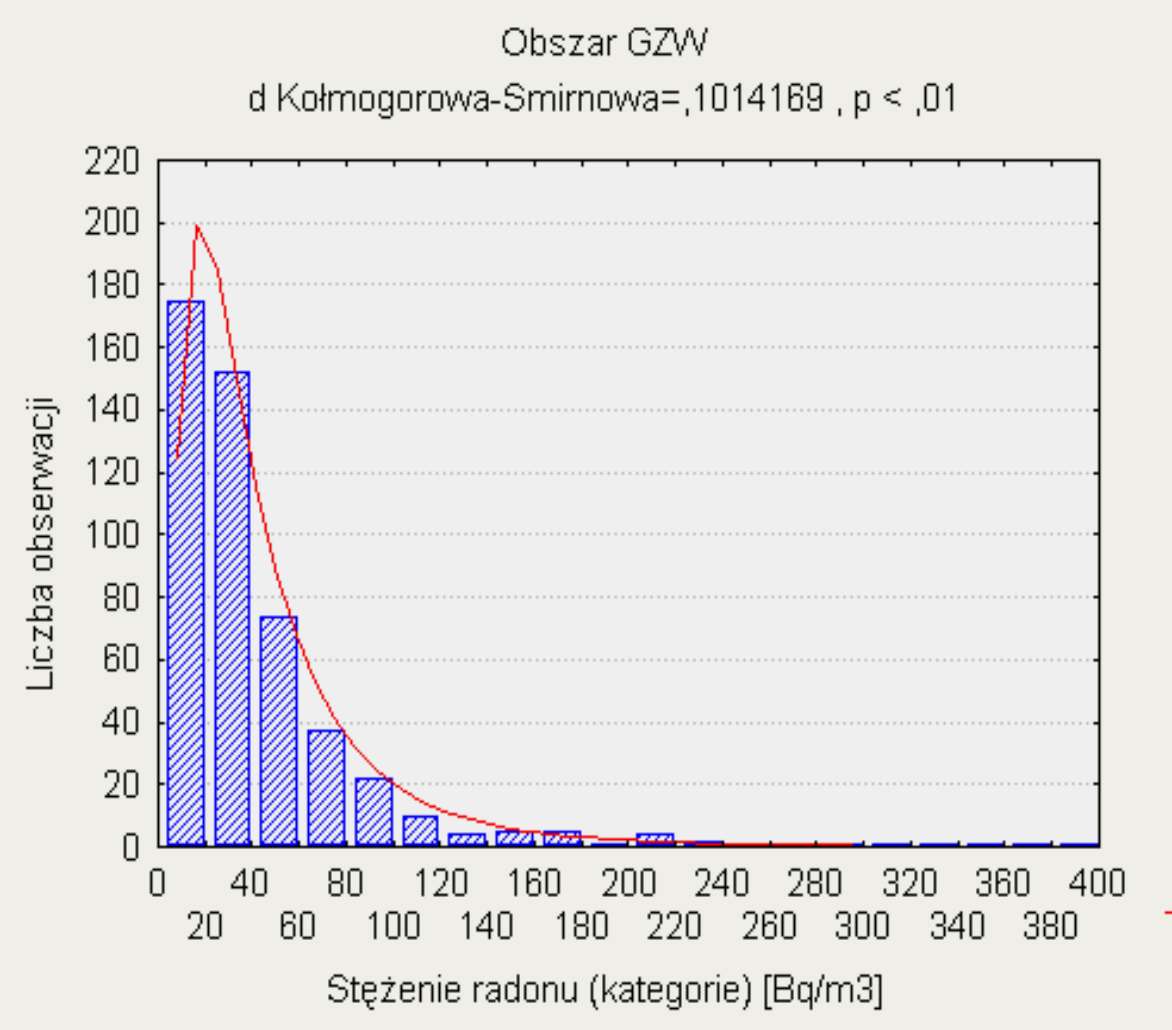
Effective doses for inhabitants of Upper Silesia, miners and cave-guides



Annual dose assesment

➔ The probability of exceeding of the level 200 Bq/m^3 (dose 4.5 mSv) exists only for 2% of dwellings in Upper Silesia

➔Doses below 1 mSv per year have been calculated for more than 70% of inhabitants



Central Mining Institute
GIG
Pl. Gwarków 1, 40-166 Katowice, Poland

Volume: 17 m^3,
Remote control of temperature (-30 °C - +50 °C)
Relative humidity: 10-90%

Central
Mining
Institute
GIG

Pl. Gwarków 1, 40-166 Katowice, Poland

Measurements in the underground coal mine

Central Laboratory for Radiological Protection

ul. Konwaliowa 7; 03-194 Warszawa, Poland

Walk-in radon calibration chamber
Dimensions are: 2.75m x 2.25m x 2.00m
and a volume of ca.12.375 m^3

Climatic condition:
Temperature: –30°C to +60°C
Relative humidity: 10% to 95%

The activity of dry flow-through Ra-226 source in the generator is 137.27 kBq (±4%).
Maximum radon concentration: ca.11 kBq/m^3

PCA Polskie Centrum Akredytacji
WZORCOWANIE
AP 057

The laboratory was accredited by Polish Accreditation Centre

‘Radon’ institutions in Poland…

Central Laboratory for Radiological Protection, Warszawa

Central Mining Institute, Katowice

Medical University of Bialystok

Institute of Nuclear Physics, Kraków

Nofer Institute of Occupational Medicine, Łódź

Wrocław University of Technology, Wrocław

Building Research Institute, Warszawa

University of Silesia, Katowice

Conclusions

- No regulations concerning radon indoors concentration measurements
- Results of radon concentration in Poland only for some areas
- Mean radon concentr.: 85.5 Bq/m^3 (Geometr. Mean: 43.1 Bq/m^3)
- Max value: 3 229 Bq/m^3

- Significant variations in different zones of Coal Basin (Upper Silesian) due to local geological structure (most important) and mining industry

Conclusions

- Analysis of influence of mining activity shows:
  - Enhanced radon levels are related with zones of shallow exploitation
  - In zones with significant deformations of the strata we observe easier migration and exhalation of radon from the ground
  - activation of old faulting zones also may increase radon risk
  - damages of constructions due the subsidence create pathways for radon migration into buildings

Conclusions

- Annual dose assessment shows:
  - ← annual dose equivalent is lower as 1 mSv for more than 70% of inhabitants of Upper Silesia region,
  - ← in specific zones radon levels are higher, but only in 2% of dwellings concentrations could be over 200 Bq/m3 and annual dose may exceed 4.5 mSv.

Małgorzata Wysocka

wysocka@gig.eu
Central Mining Institute
www.radiometria.gig.eu
Pl. Gwarków 1; 40-166 Katowice, Poland
tel. +48 32 259 28 14;
fax. +48 32 259 22 95

Thank you

for your attention

Krzysztof Ciupek

ciupek@clor.waw.pl
Central Laboratory
for Radiological Protection
www.clor.waw.pl
Konwaliowa Street, 7; 03-194 Warszawa, Poland
tel. +48 22 811 00 11;
fax. +48 22 811 16 16