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**CHANGES IN RADON EMISSION IN THE AREA
AROUND THE COAL MINE DURING CLOSING
PROCESS.**

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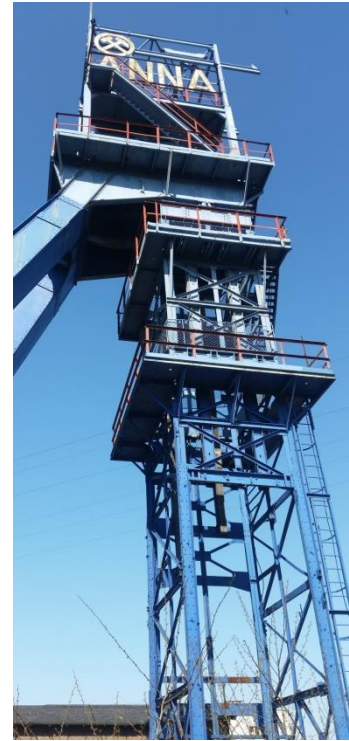
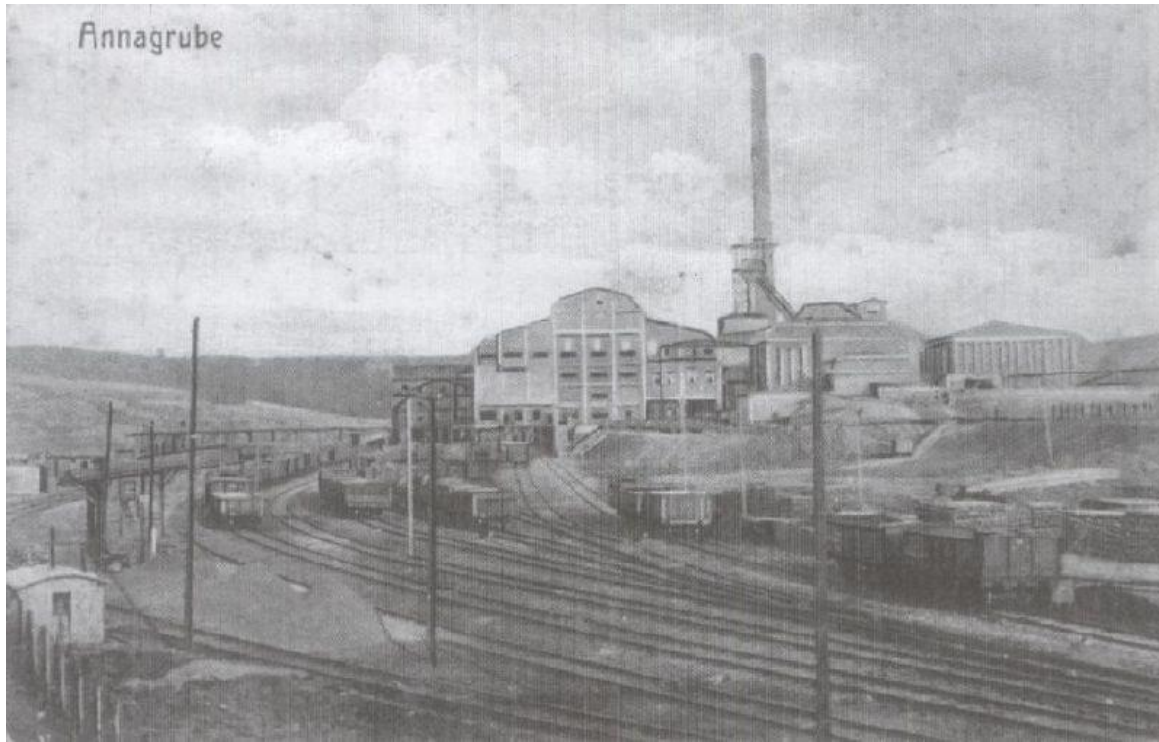
ENVIRONMENTAL RISKS DURING AND AFTER MINE CLOSURE

The closure of coal mines brings impacts to the environment.

The hazards associated with past mining operations will affect the environment for many years and, some of them may occur uncontrollably.

The goal of the work is to observe changes in radon emission in the area around the coal mine during and after closing process.

MEASUREMENTS ARE CONDUCTED IN THE AREA OF ONE OF THE OLDEST COAL MINES ANNA

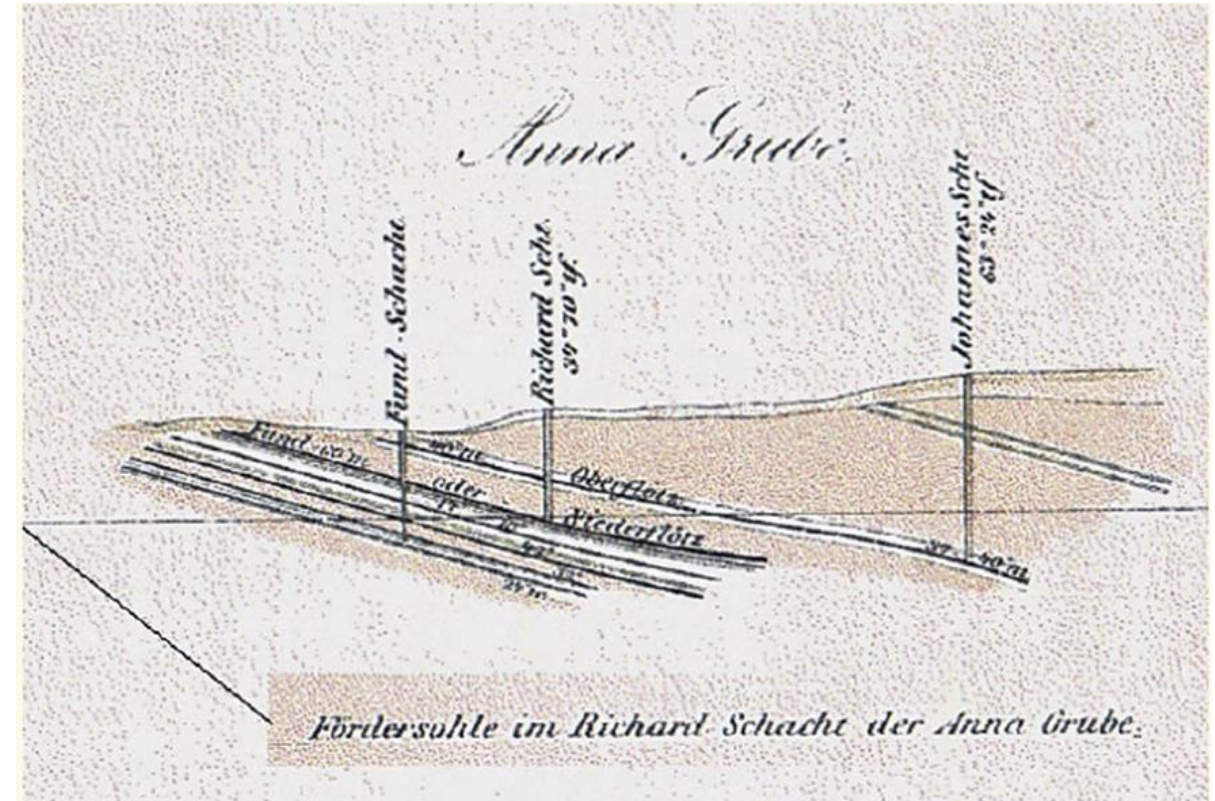
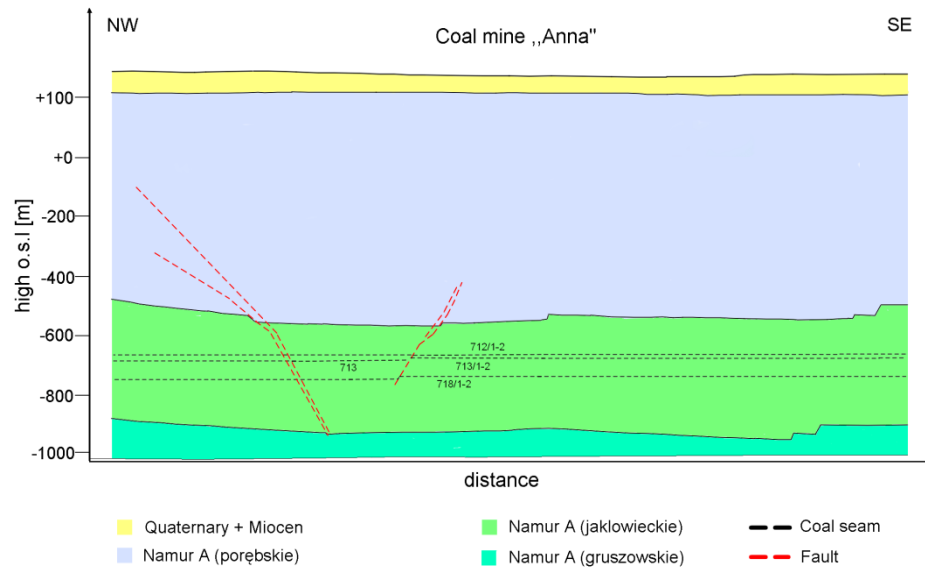


During the last years of operation coal extraction was about 2 000 000 t/year, (about 7800 t/day) employment amounted to 4000 - 6000 people.

Liquidation of coal mine was initiated in 2006 and it is planned to be finished in at the end of 2018.

Erected in 1832; at the very beginning: 3 shafts, coal seam about 1.5, from the depth about 31 m was exploited. In 1847 annual coal extraction equaled 3 293 tons, 50 miners were employed.

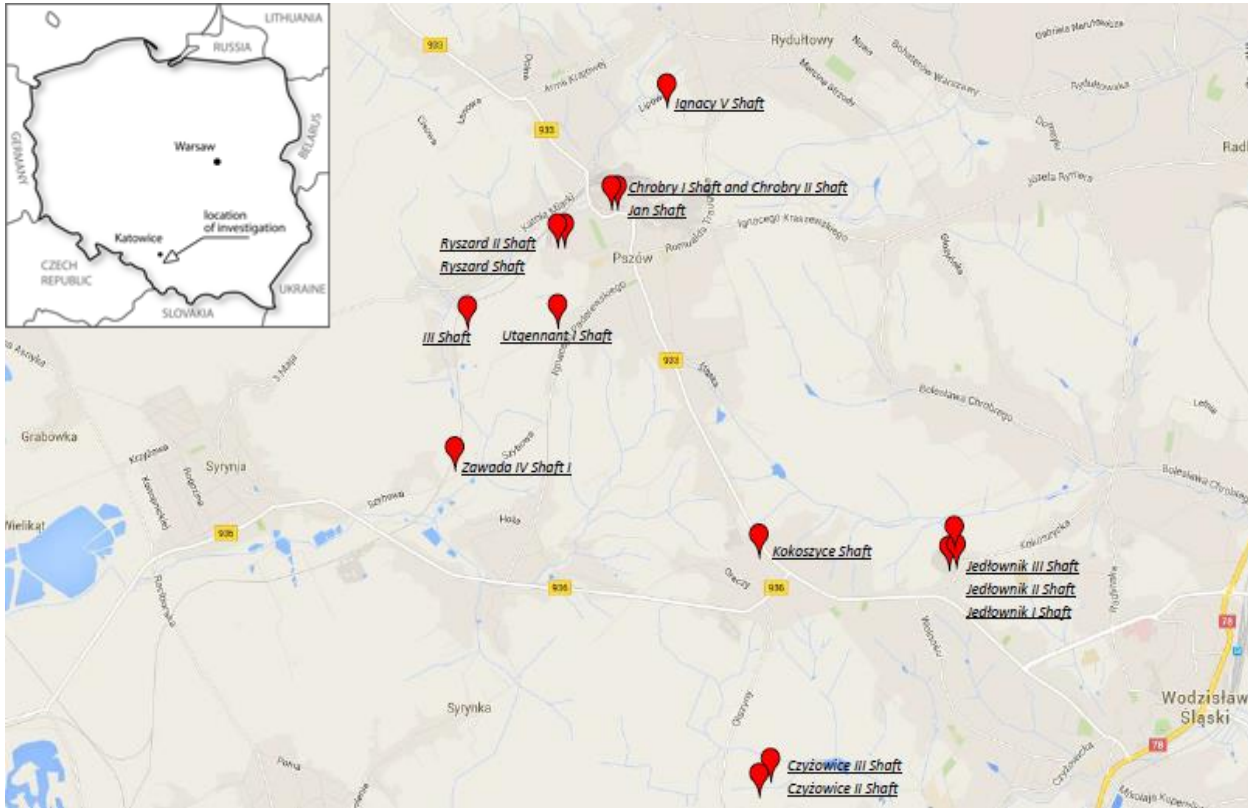
THE SIMPLIFIED GEOLOGICAL CROSS-SECTION OF ANNA DEPOSIT



THE SCOPE OF THE MEASUREMENTS

- since 2016 we conduct measurements of radon emission in locations of 8 old shafts;
- two of monitored shafts - Chrobry I and Ryszard II - are in the process of liquidation;
- the other ones were closed down several dozen or a few years ago;
- in locations where conditions allowed it, radon concentration measurements in the soil gas are performed at the center of the channel of the liquidated shaft, and at certain distances from the shaft;
- additionally, measurements of radon exhalation rates from soil are performed.

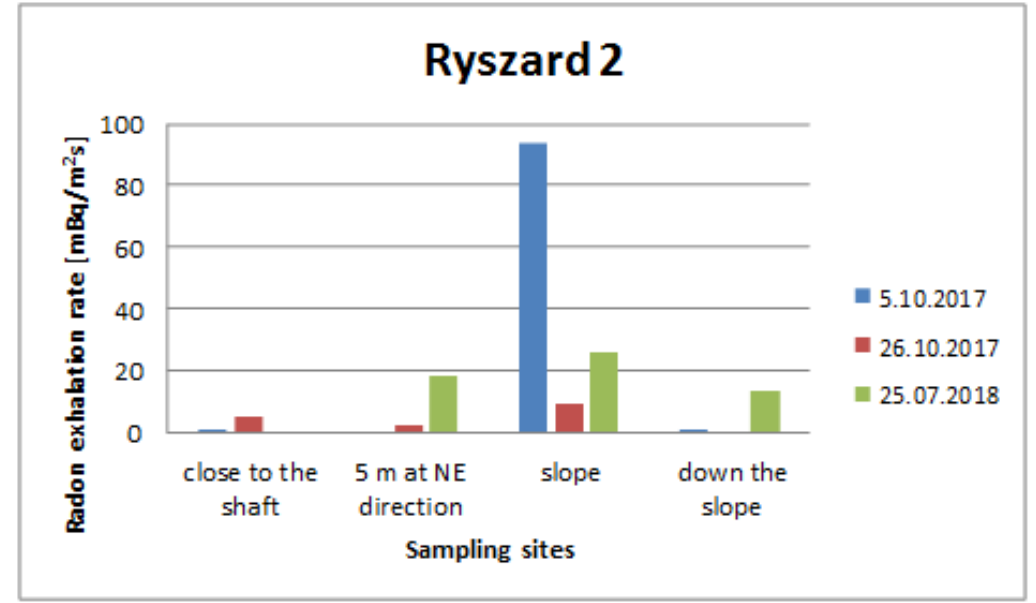
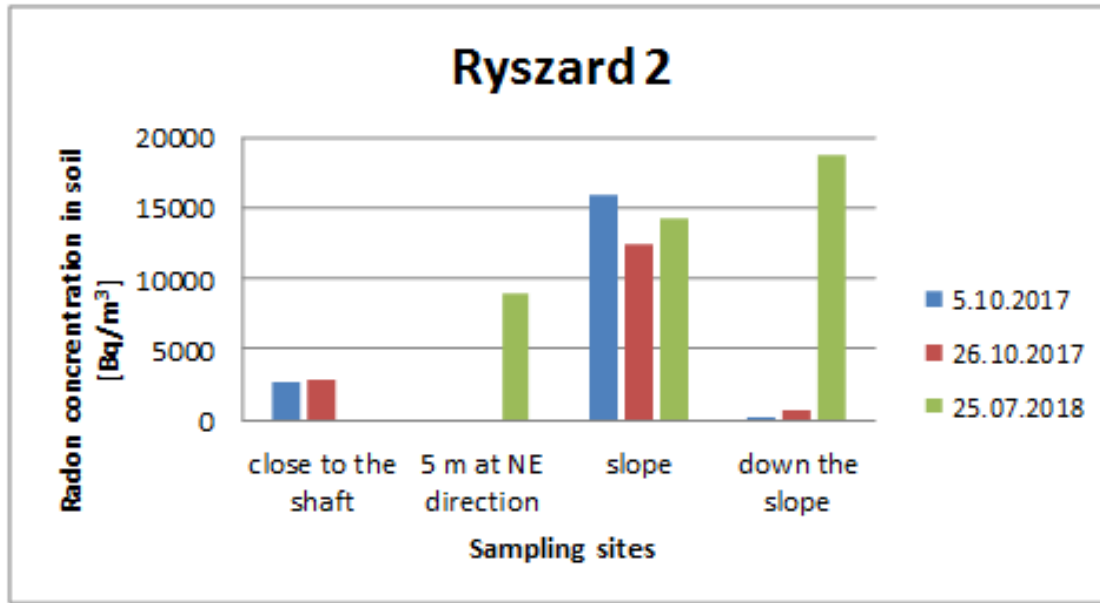
LOCATION OF THE MONITORED SHAFTS



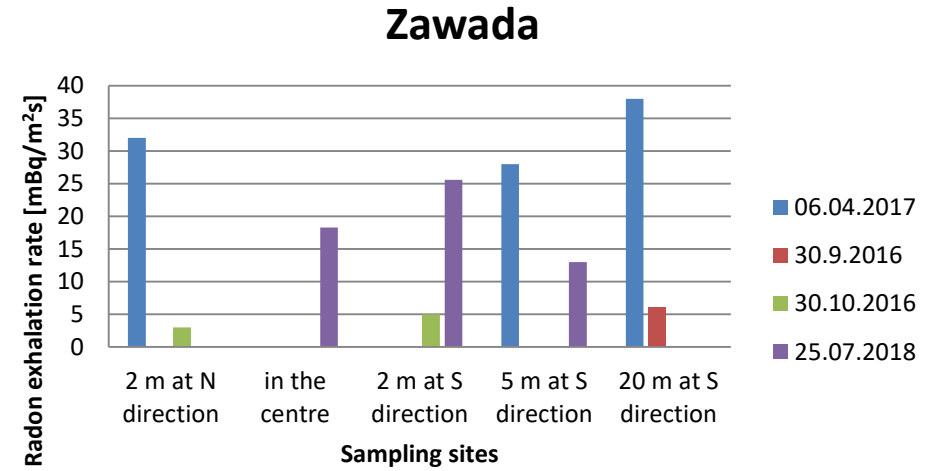
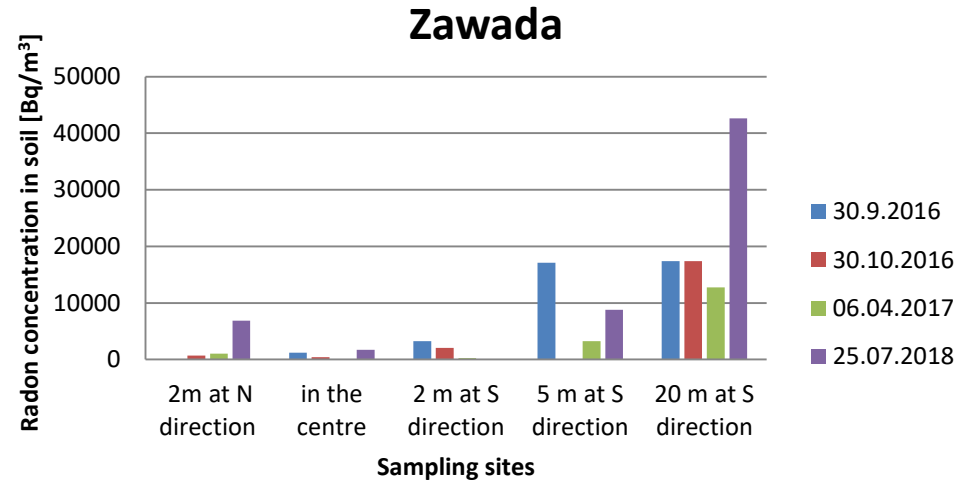
THE SCOPE OF THE MEASUREMENTS

- in 2017 we started measurements of indoor radon concentration in dwellings and working places located close to the monitored shafts;
- additionally we performe measurements of indoor radon concentrations in shaft buildings of two shafts (Chrobry I and Ryszard II). Although miners do not work there, but we want to monitor changes in radon concentration within the closure process. The shafts are backfilled and there is no ventilation connection with underground workings of former coal mine.

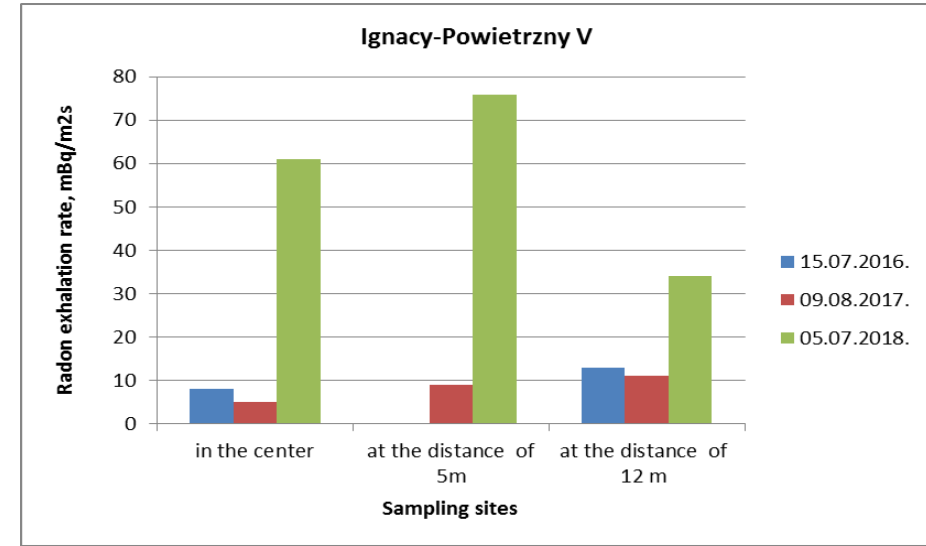
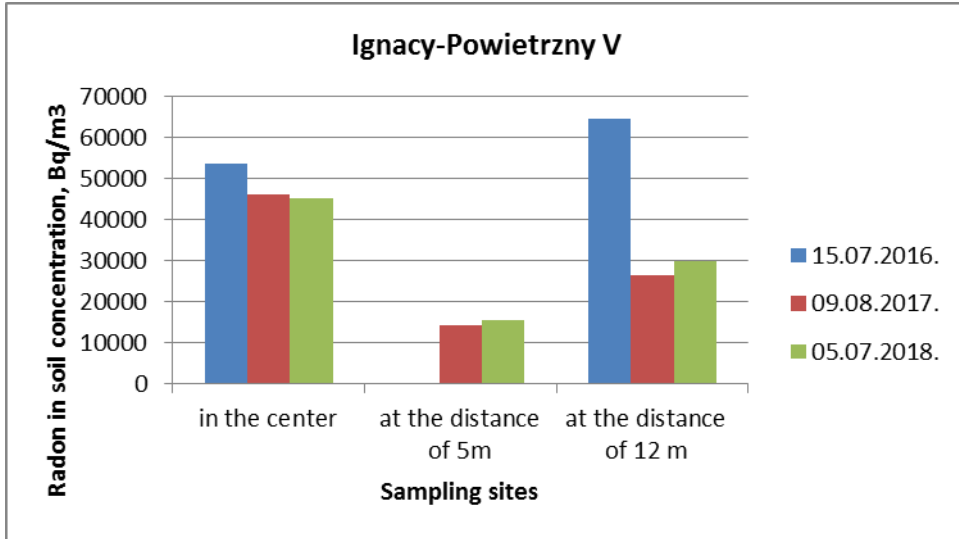
RESULTS: EXAMPLES OF MEASUREMENTS OF RADON IN SOIL GAS CONCENTRATIONS AND RADON EXHALATION RATES



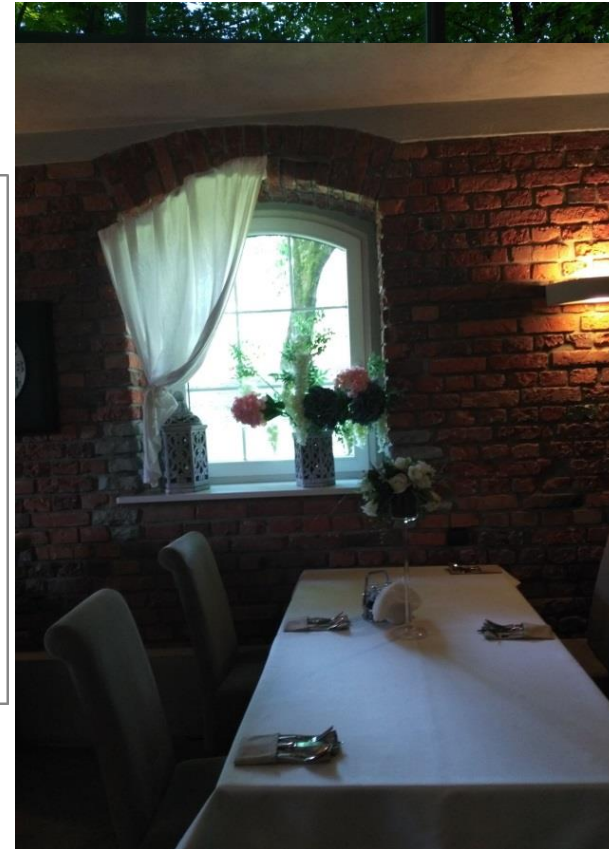
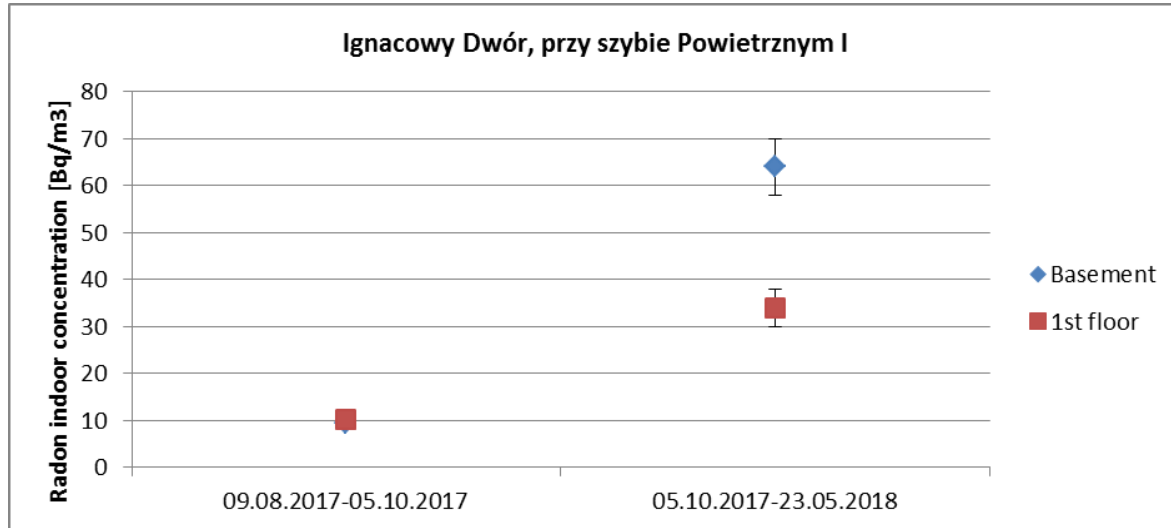
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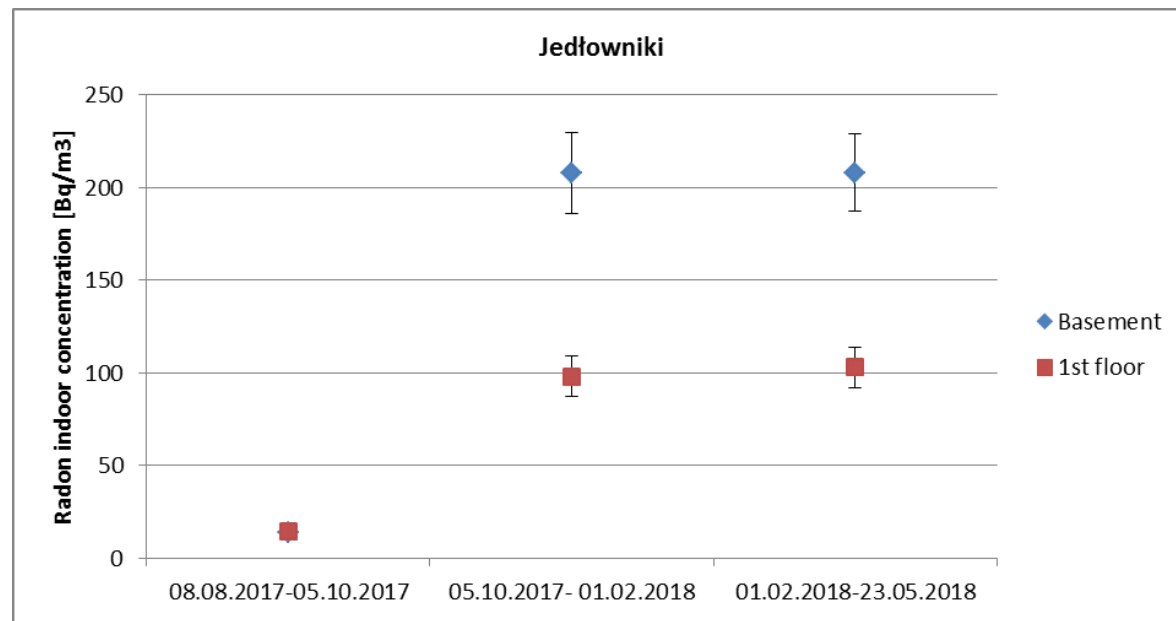
RESULTS: EXAMPLES OF MEASUREMENTS OF RADON INDOOR CONCENTRATIONS



Backfilled in 1966 with use of rocks (sandstone, mudstone), not covered. Currently in the private area.

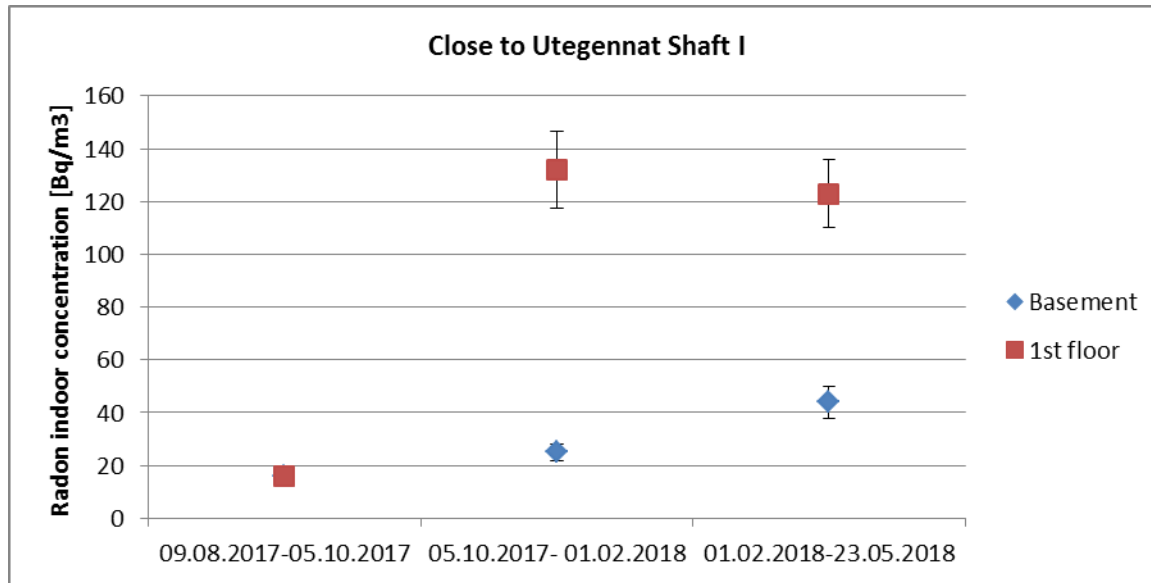
Measurements are conducted in the private building – restaurant.

RESULTS: EXAMPLES OF MEASUREMENTS OF RADON INDOOR CONCENTRATIONS



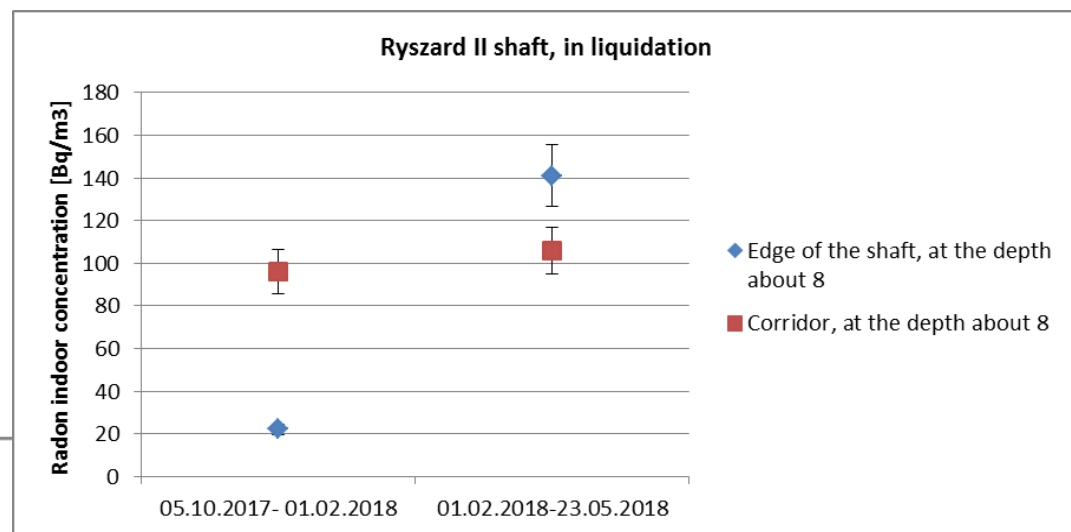
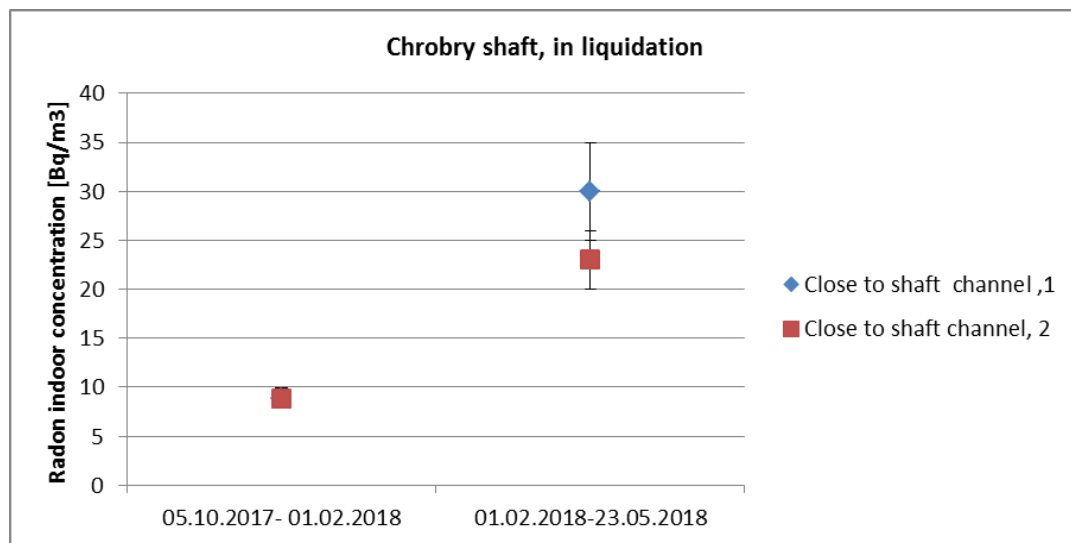
Closed down in 1966: backfilled with use of fly-ash and covered by reinforced concrete cover. Measurements are performed in the office of company located near the shaft.

RESULTS: EXAMPLES OF MEASUREMENTS OF RADON INDOOR CONCENTRATIONS



Closed down in 1964, backfilled with use of rocks (sandstone, mudstone), not covered. Currently in the private area. Measurements are conducted in the private building.

RESULTS: EXAMPLES OF MEASUREMENTS OF RADON INDOOR CONCENTRATIONS IN SHAFTS BUILDINGS



CONCLUSIONS: CONCENTRATIONS OF RADON IN SOIL GAS

changes from about 120 Bq/m³ to about 64 400 Bq/m³, this means that in some cases the investigated areas can be indicated as so-called areas with elevated radon risk;

in some cases radon in soil concentration above the former shaft pipe, is the lowest, in comparison with values measured at the distance from the centre of shaft: it is probably due to low permeability of the rocks and waste material filling the shaft;

outside the borders of the shaft pipe, we observe the increase of radon concentrations within the distance. The rockbody and ground were probably affected during the drilling the shaft and its operation – the permeability was changed;

however in few cases we observed opposite direction of changes of the measured values.

CONCLUSIONS: EXHALATION RATES

the values of measured radon exhalation rates change from the 1 mBq/m²s (lower detection limit) to about 94 mBq/m²s;

at the outcrops of different geological strata in Upper Silesia we measured so far values reaching about 80 mBq/m²s;

the highest value of radon exhalation rates – up to about 700 mBq/m²s – was measured in mining areas polluted by NORM (bottom sediments of settling pond).

CONCLUSIONS: RADON CONCENTRATIONS IN BUILDINGS

in most cases radon concentration measured in dwellings is low, below the average value for Upper Silesia – 49 Bq/m³;

in two buildings – close to shafts - radon concentration in basements are lower than at the first floor;

doses for inhabitants and workers calculated for each period of the exposition of the detectors in some cases exceed 1mSv/y;

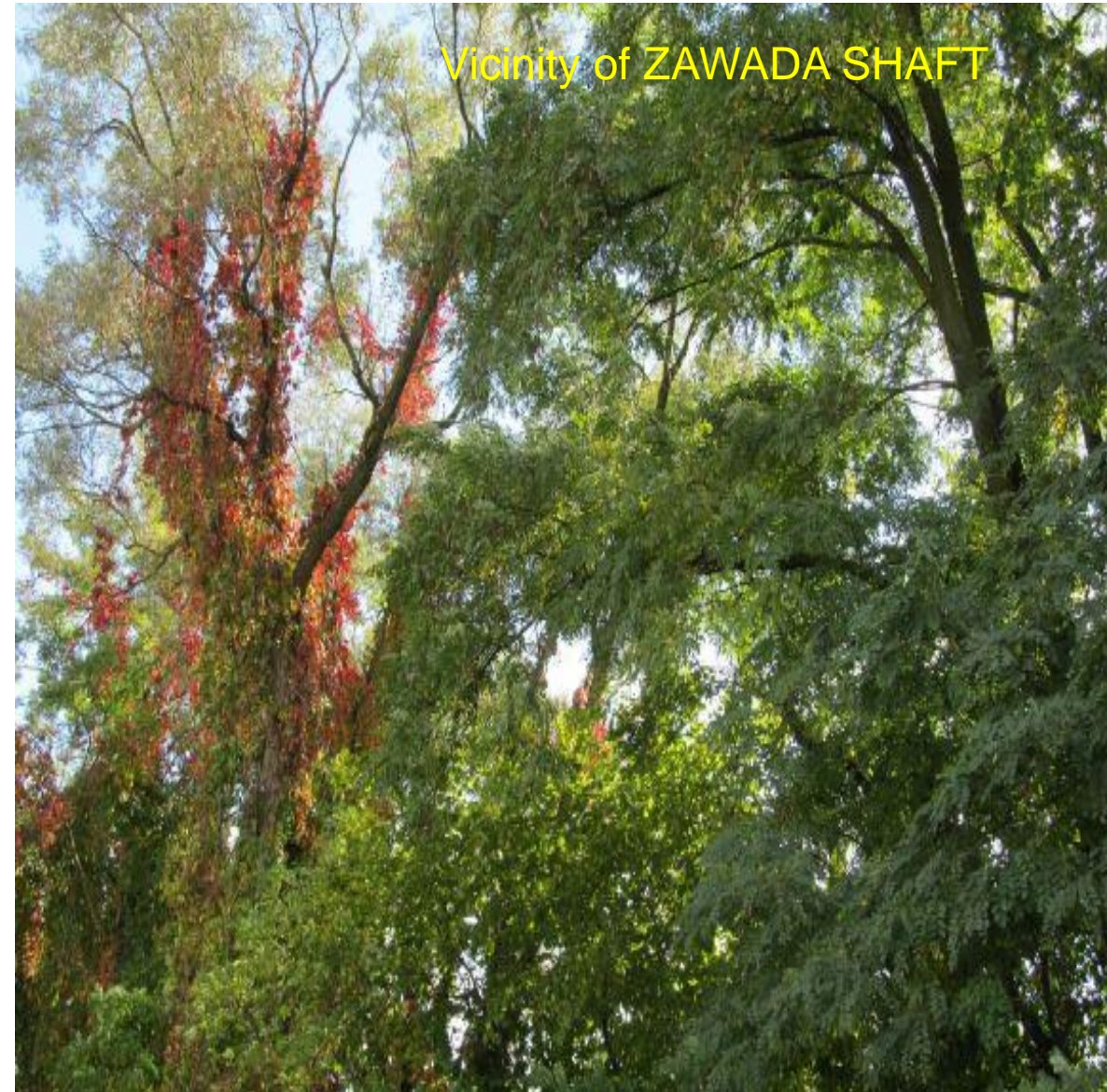
CONCLUSIONS

At the present stage of measurements it is difficult to say if liquidation of coal mine and shafts around may influence indoor radon concentration in nearby buildings and radon exhalation rate.

We hope that the continuation of our research will show if so.

THANK YOU

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