AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY

The efficiency of capturing methane using a drainage system in Polish conditions

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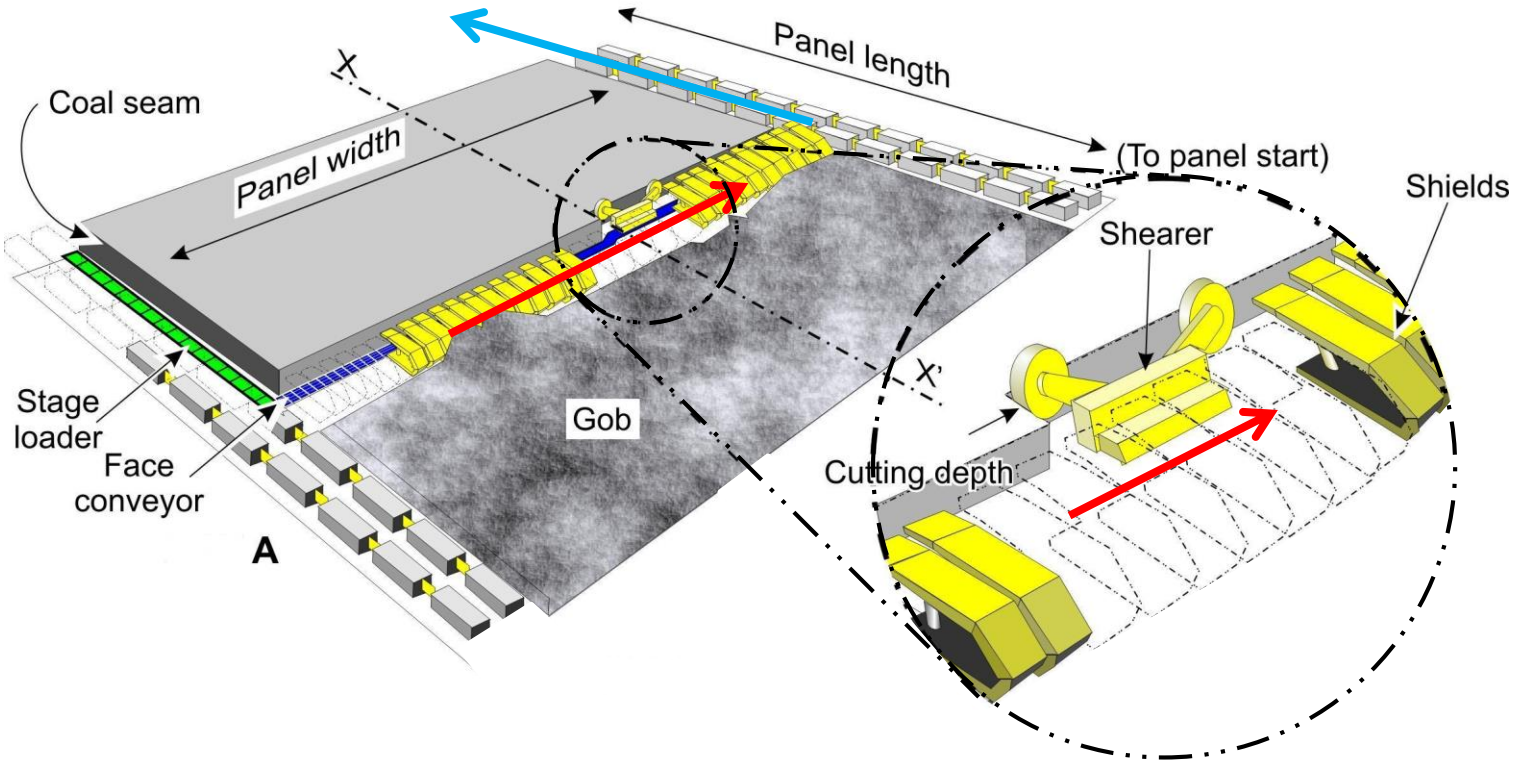
Introduction



Methane hazard remains one of the most serious natural hazard occurring in underground coal mining.

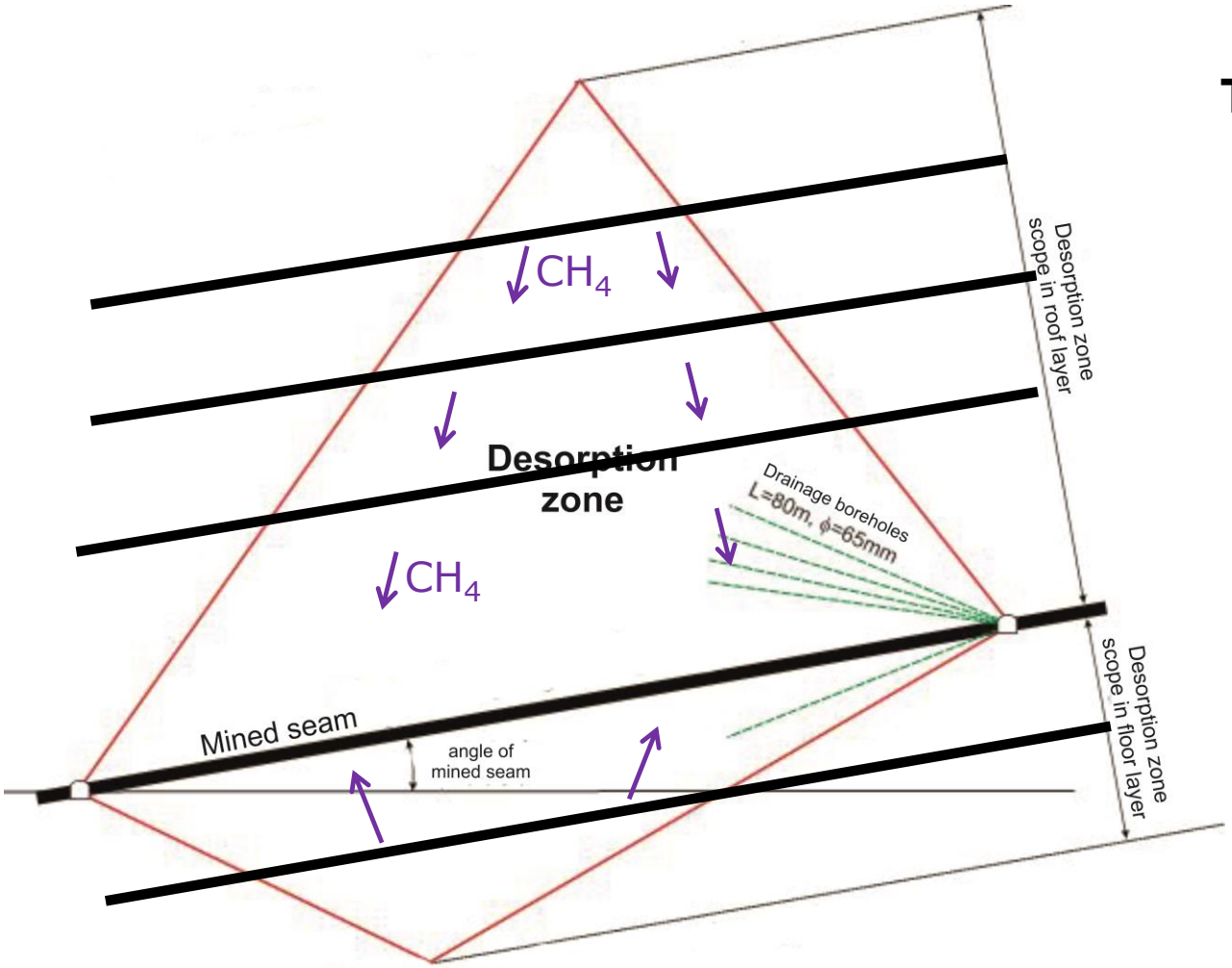
Introduction

Methane emissions are obtained for:

- underlying seams
- underlying sandstone
- mined seams
- overlying seams
- overlying sandstone

To ensure the safety of the working crew and obtain a high levels of extraction, it is necessary to evaluate properly possible release to combat methane hazard.

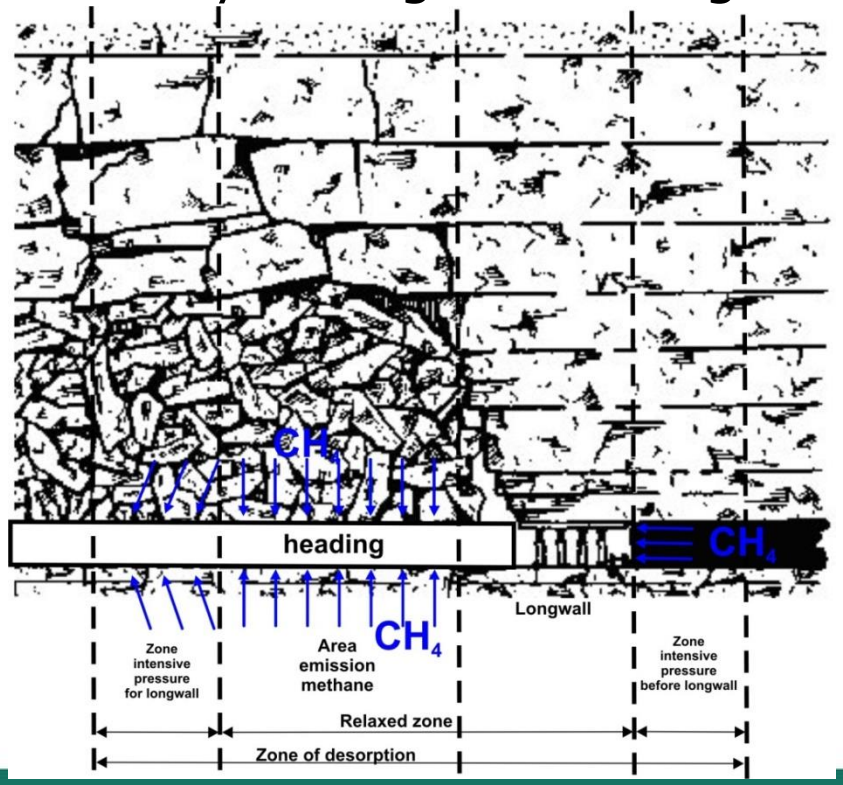
Introduction



The risk assessment is done by forecasting release of methane into longwall workings based on the study of the gas properties of the rock masses.

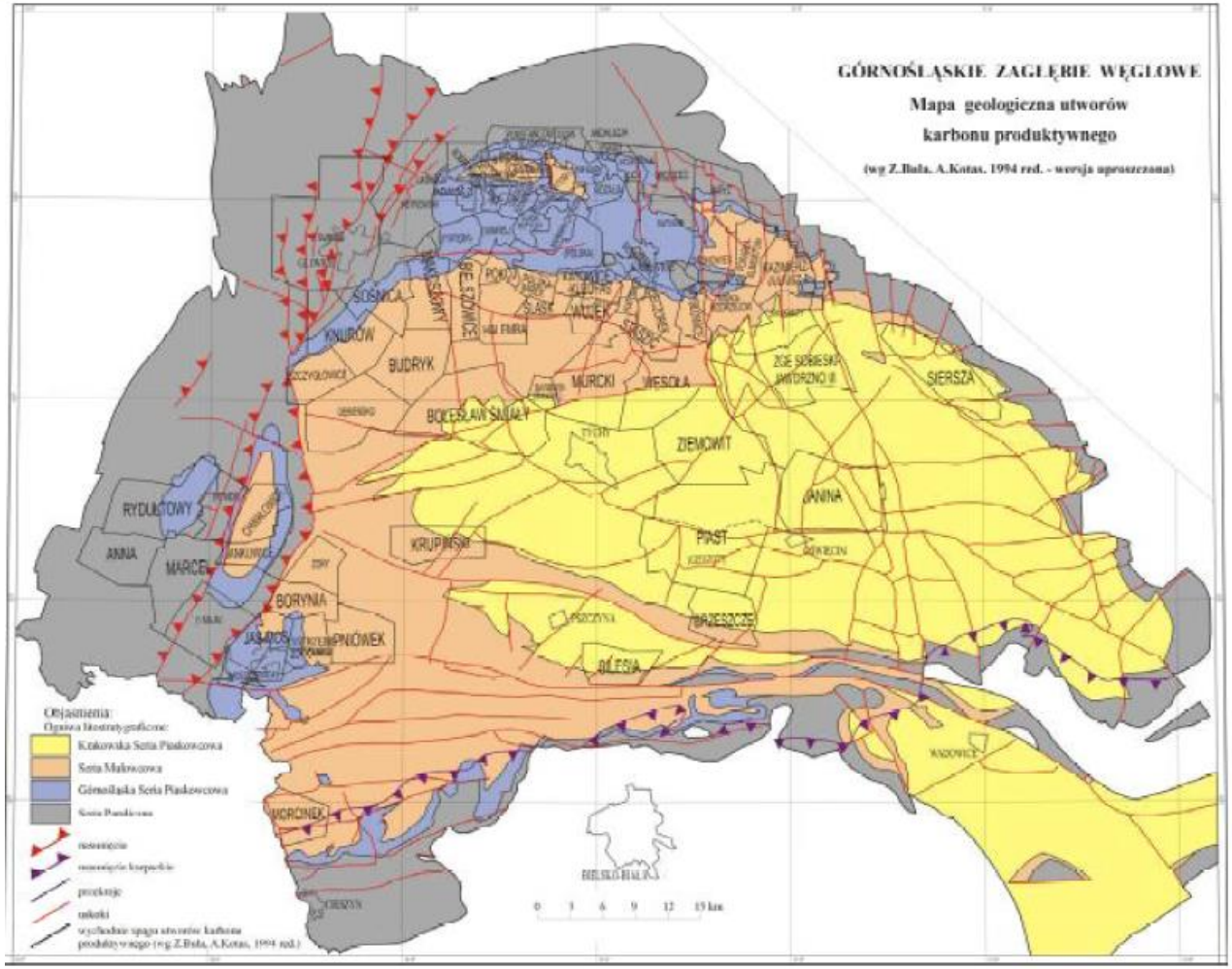
Methane emissions to the working faces

- Because of heterogeneity of rock strata and disruptions of the geologic structure as well as tectonic conditions, the methane emissions to the working faces will vary during the mining operations.



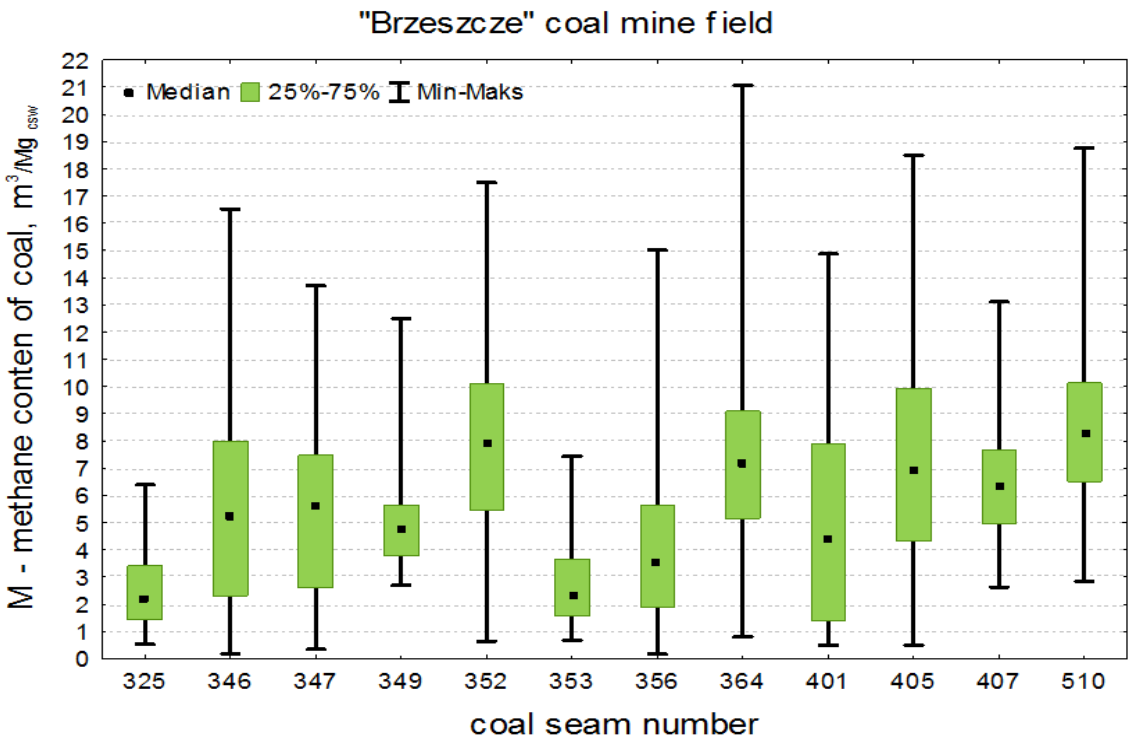
The gas conditions of the hard coal deposit in Silesia basin

For the methane content in the seams, an hole method for determining natural methane in coal is used.



Geological map of Carboniferous deposits

Introduction

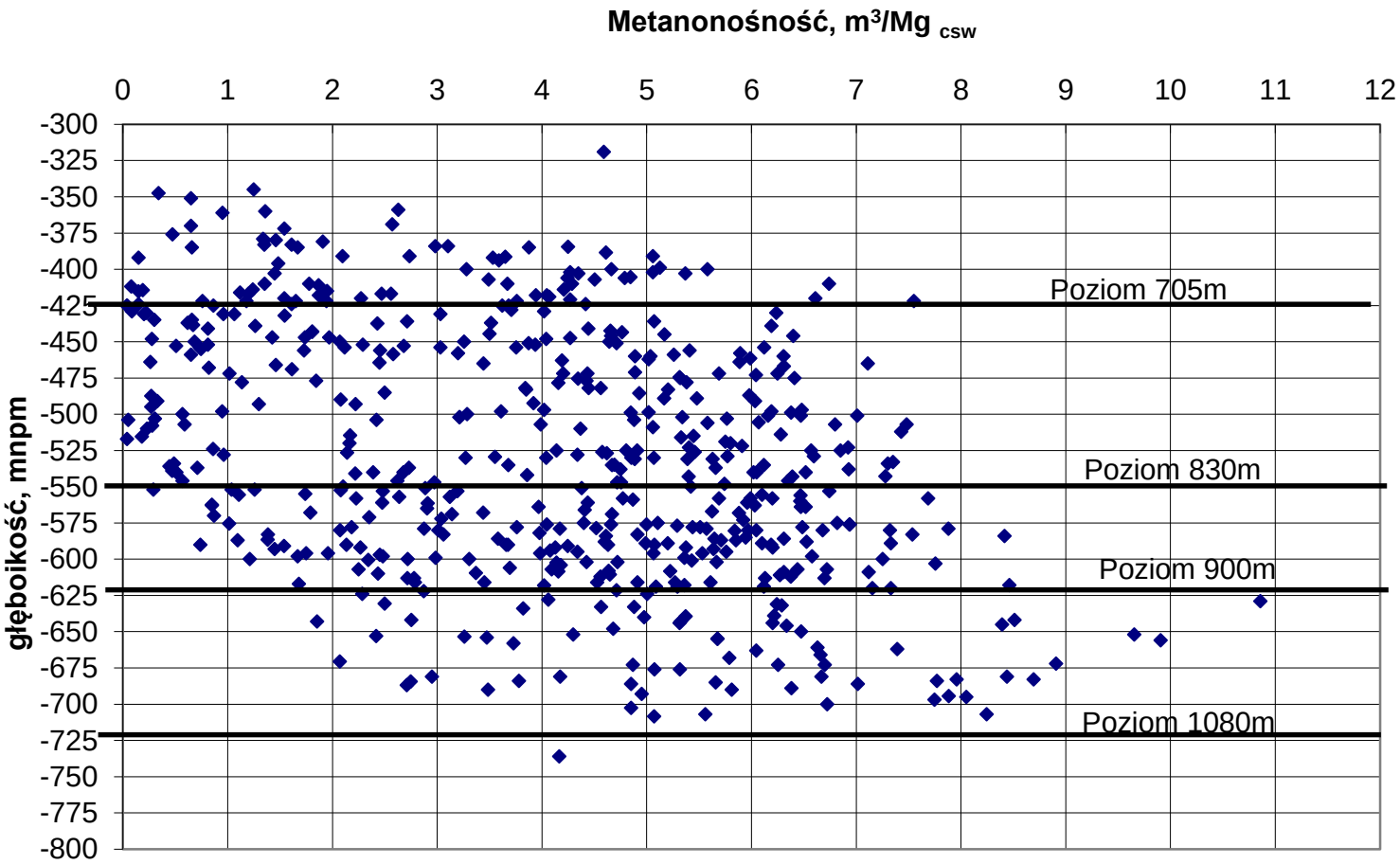


The box-and-whisker plot presents the **central trend of methane content median** (middle value - point).

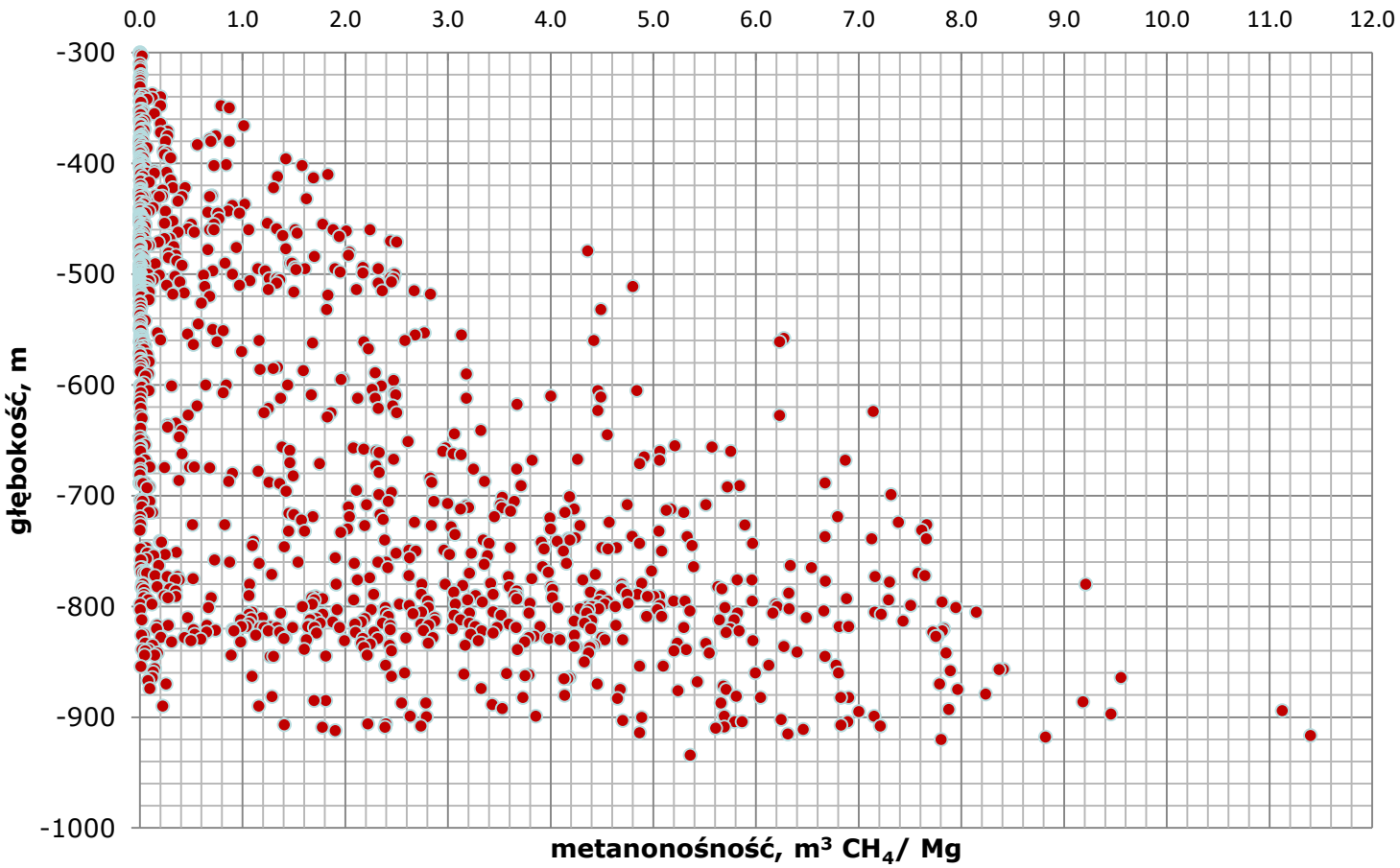
Methane content spread is shown in the graph by quartiles (25 and 75 percentiles) as well as by minimum and maximum values.

Box-and-whisker plot of changes in methane content (measured in coal seams) depending on particular coal deposit

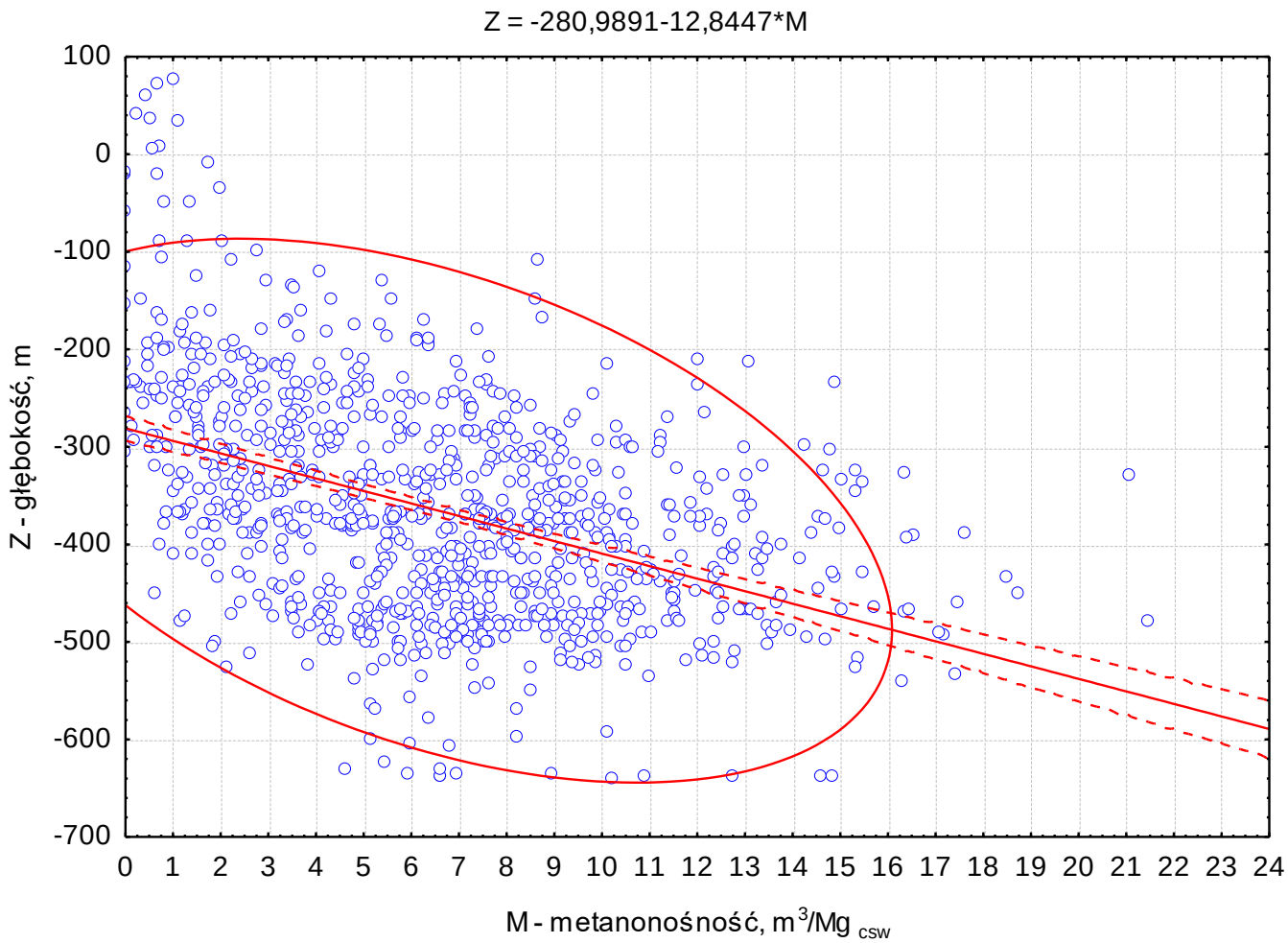
Methane content with depth Coal Mine Z



Methane content with depth Coal Mine R

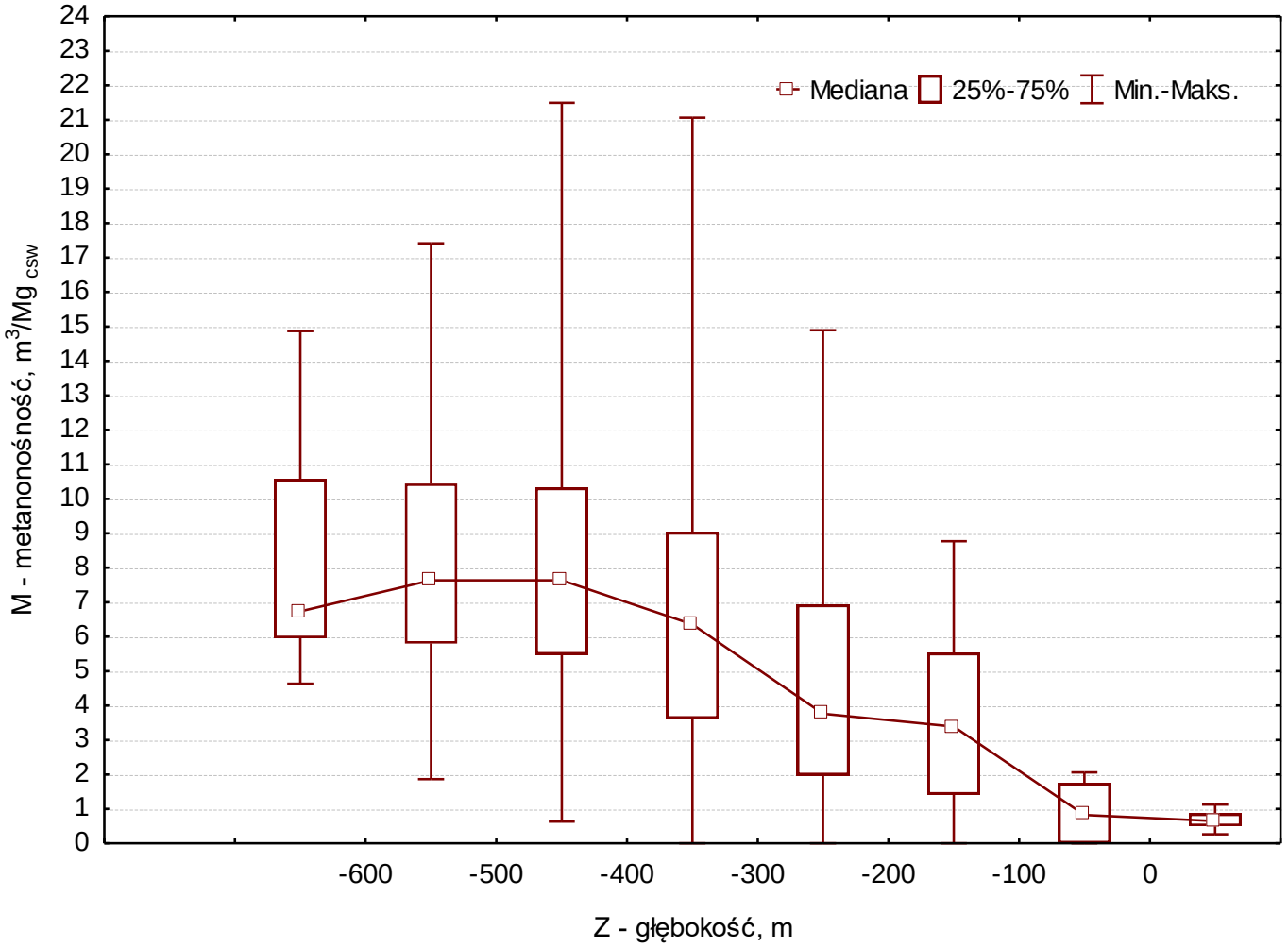


Dependence of methane content with depth Coal Mine B



A frame chart of the dependence of methane content from the depth, coal mine B

Generally, methane content increases with increasing depth



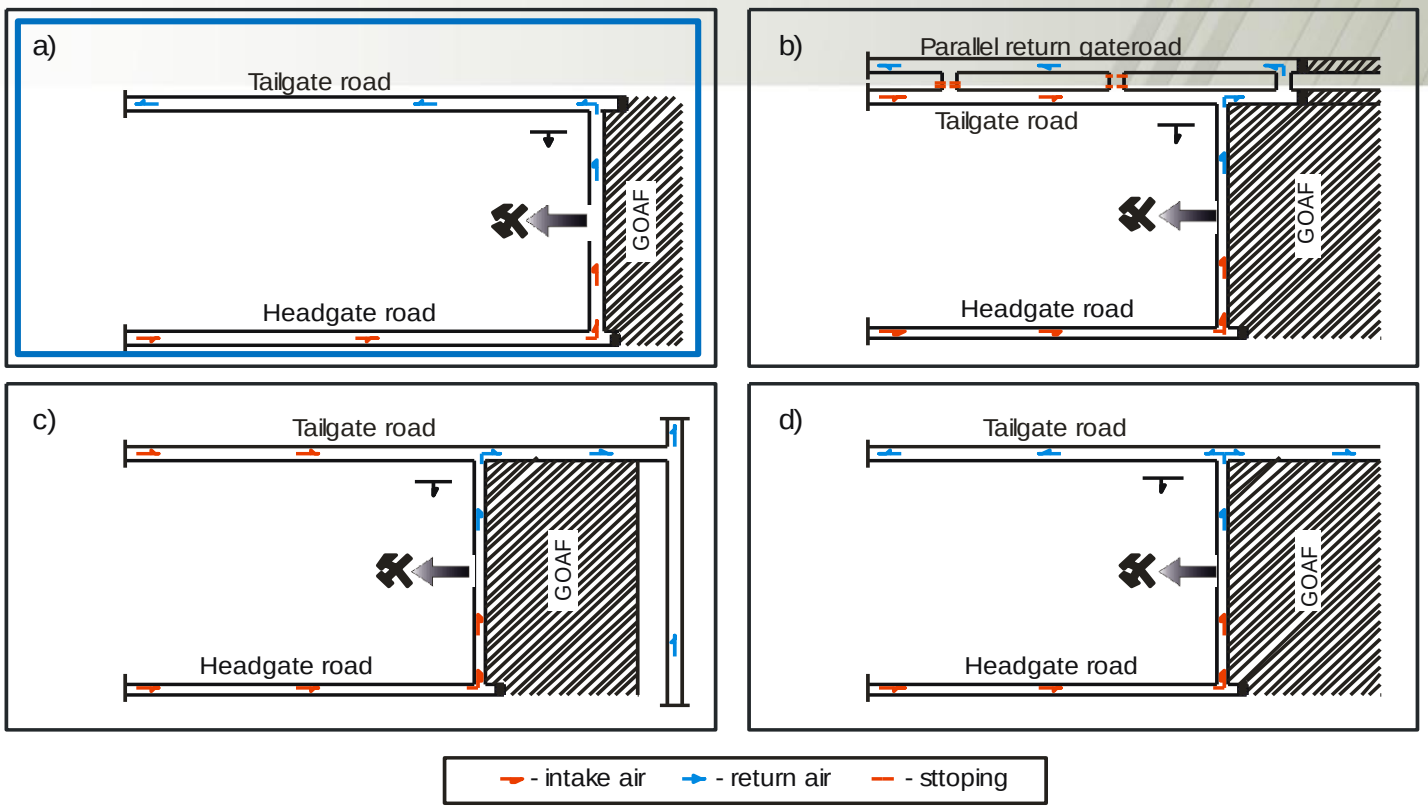
Introduction

- Methane present in coal seams has a bad influence on safety in underground mines as it is emitted during mining works.
- In order to conduct mining in gaseous mines it is necessary to take special technical measures not to allow methane concentrations in mine air to be exceeded.
- The main method is using ventilation systems which aim at ensuring the required air stream
- Ventilation systems are frequently not sufficient enough and it is necessary to drain methane from coal seams and surrounding rocks

The main preventive actions in underground coal mines are:

- effective ventilation that prevents forming of methane fuses or placed methane accumulation in roadways and in headings with auxiliary ventilation,
- **methane drainage using boreholes that are drilled from underground excavations or from the surface**,
- methanometry control of methane concentration in the air;
- additional ventilation equipment used in places of lower intensity of ventilation and places where methane is concentrated.

LONGWALL VENTILATION SYSTEMS

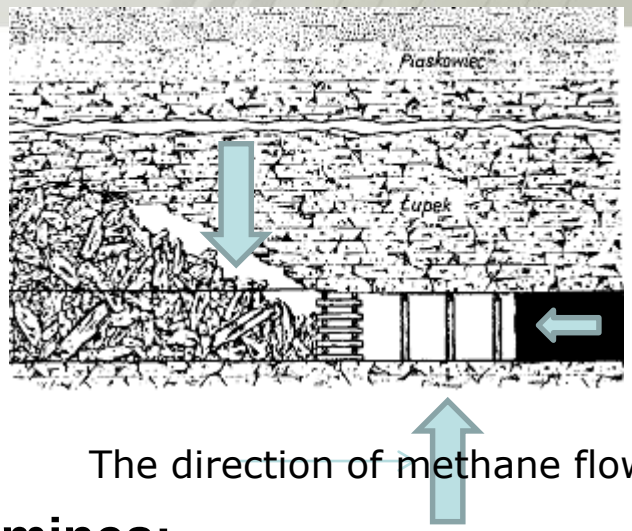


The most popular panel ventilation systems in Polish hard coal mines

a) **U** ventilation system, b) **Y** - return side ventilation system with **parallel** return gateroad c) **Y** - return side ventilation system, d) **Y** - return side ventilation system (**bleeder system**),

Methods for methane drainage in Polish coal mines

Geological conditions of coal seams (porosity, permeability, reservoir pressure, diffusivity), seam methane content and **low desorption** of Polish coal seams result in low gas emission **not disturbing the structure of rock-mass**.



Methods for methane drainage in Polish coal mines:

- methane drainage in development headings, — very low effectiveness
- pre-mining drainage, — low effectiveness
- mining methane drainage, — good effectiveness
- post-mining methane drainage. — satisfied effectiveness

Methane drainage with increased permeability

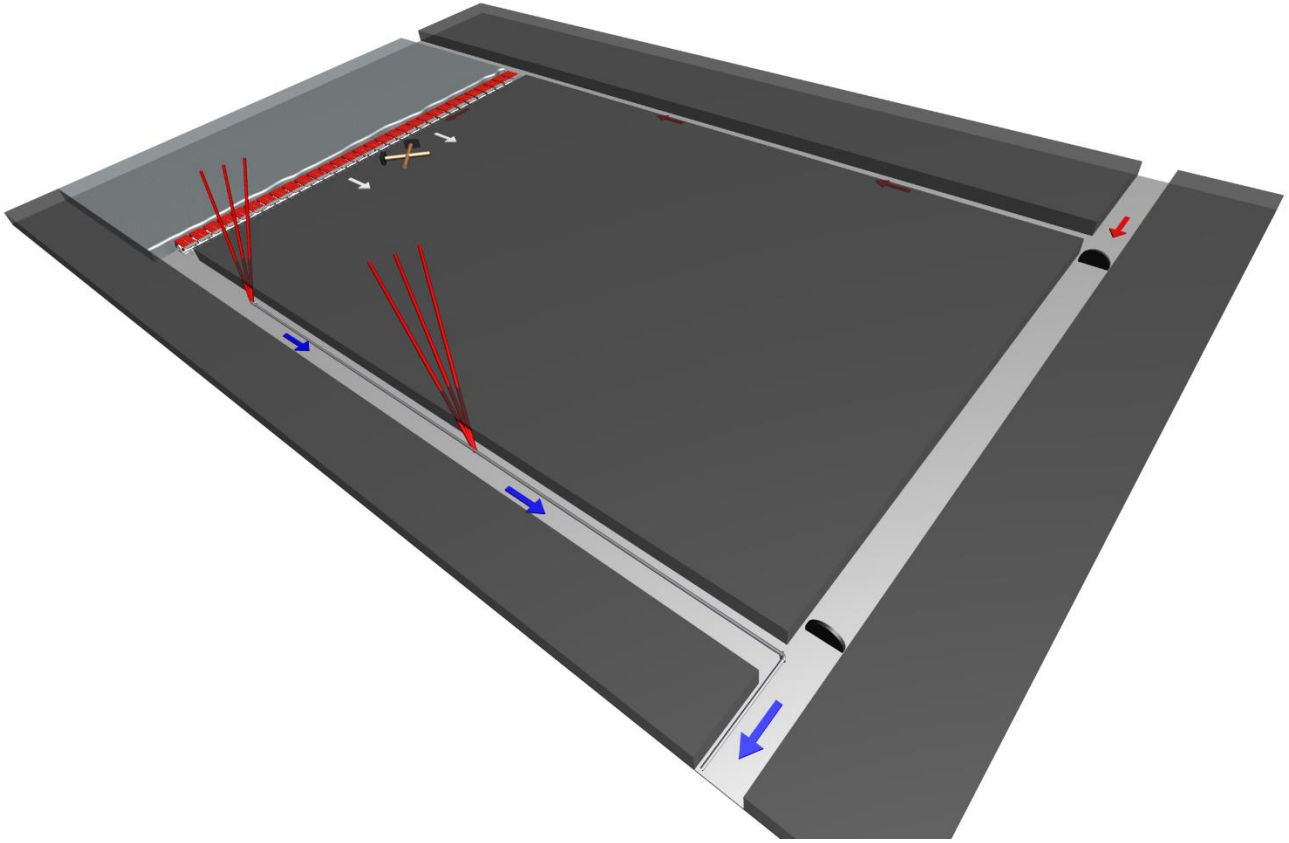
- **Methane drainage methods used in Poland are based first of all on a seam relaxation by mining and an increase in permeability.**
- In order to increase permeability it is necessary to take some steps regarding fractures of rock mass and reduction in stress states.
- **Both when current and pre-mining methane drainage is used it is necessary to affect a rock mass in order to increase permeability.**
- The amount of methane drained due to methane desorption depends on rock crushing (fractured rock mass) and its permeability.
- **Changes in stress states caused by mining result in an increase in rock strength**
- In favorable conditions self-destruction processes are likely to happen and they lead to an increase in permeability in fractured rocks.

Methane drainage in Polish coal mines is carried out taking into account the following conditions:

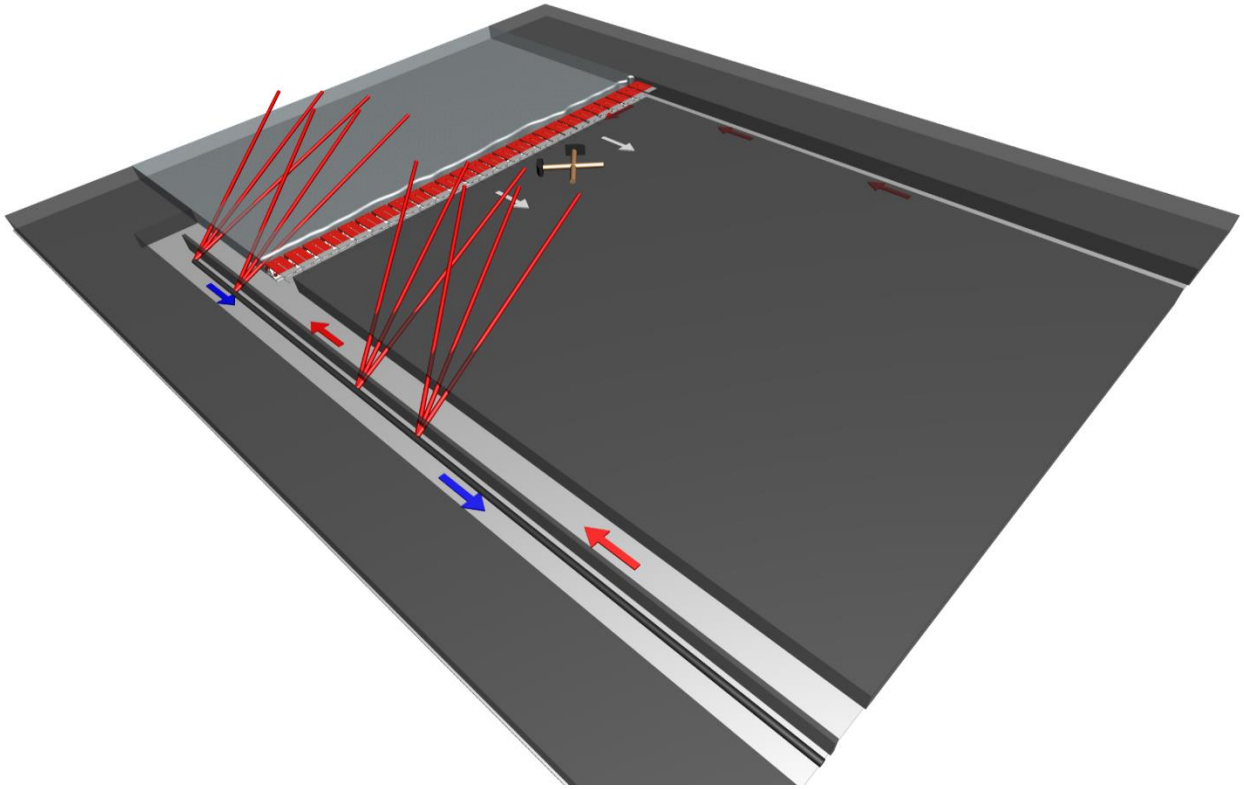
- location of a drilling rig – methane drainage with in-seam boreholes (underground)
- time of methane drainage – methane drainage can take place prior to and during coal production,
- way of increasing the gas permeability of coal – methane drainage without fracturing,
- length of the boreholes – methane drainage using short borehols up to 200m.

THE LONGWALL DRAINAGE SYSTEMS

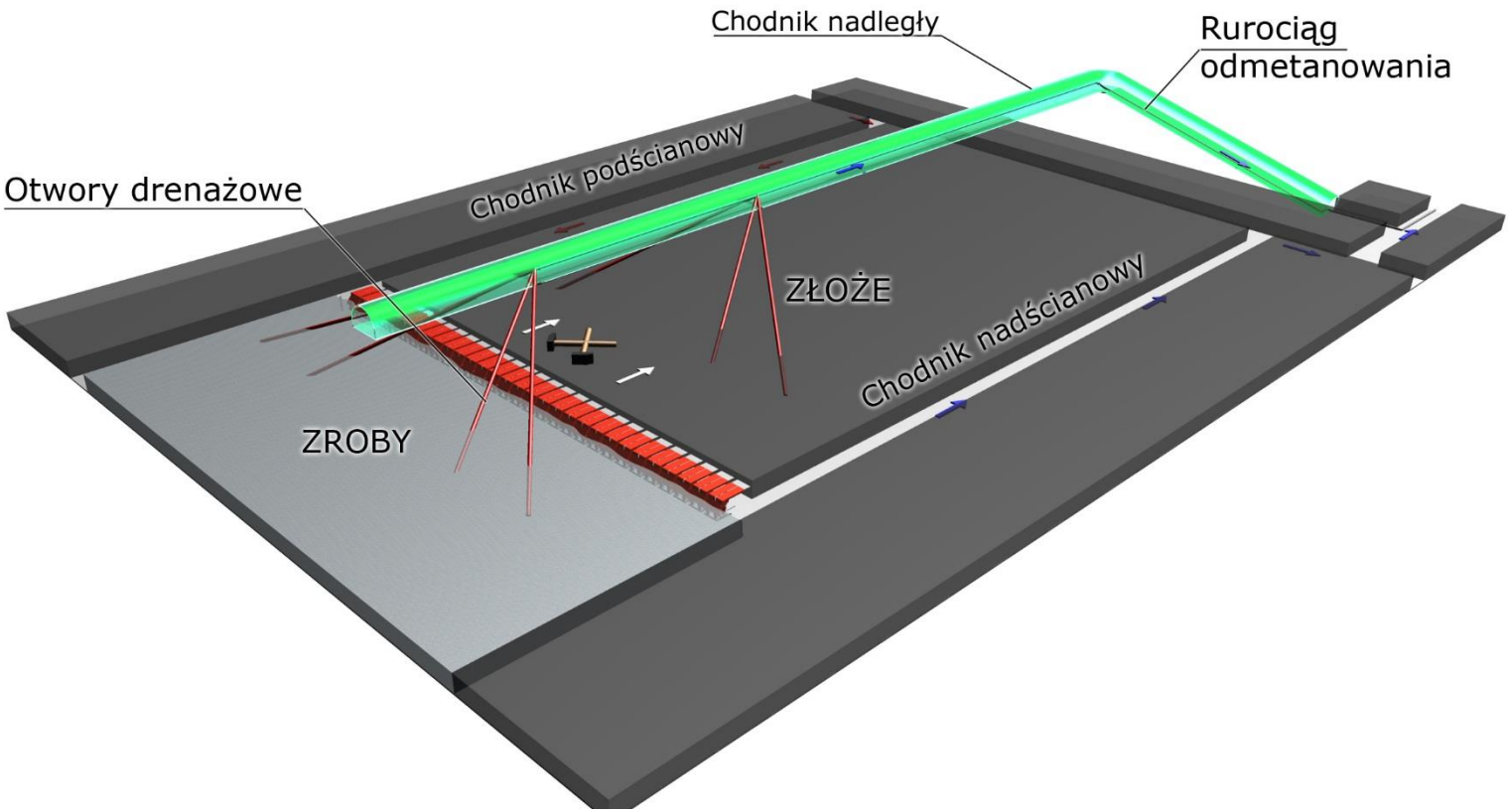
The longwall from the field is ventilated with the U system



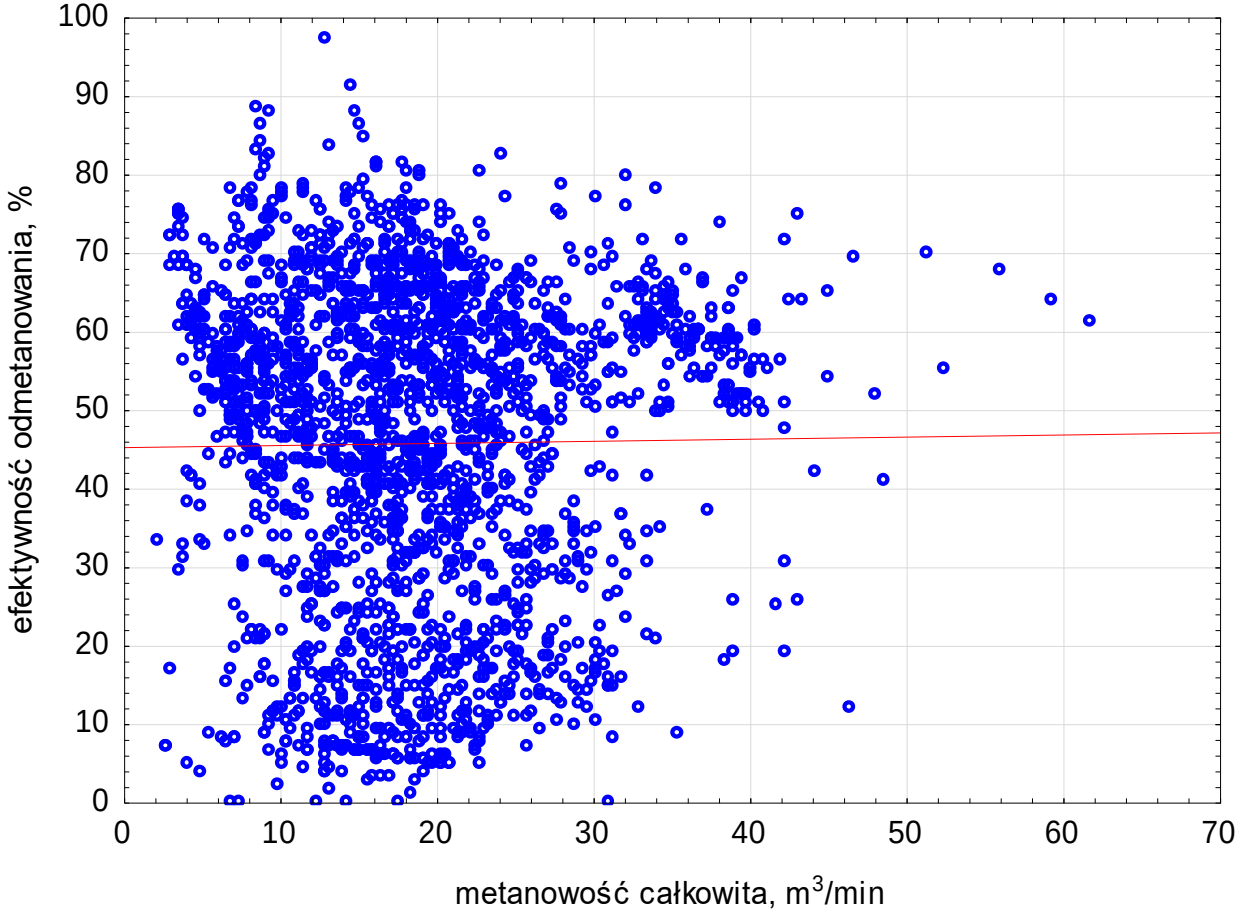
The Longwall from the field is ventilated with the Y system from parallel return gateroad



Systems for drain gas exploitation longwalls - using the overlying excavation



The effectiveness of the methane intake depending on total methane emission U system



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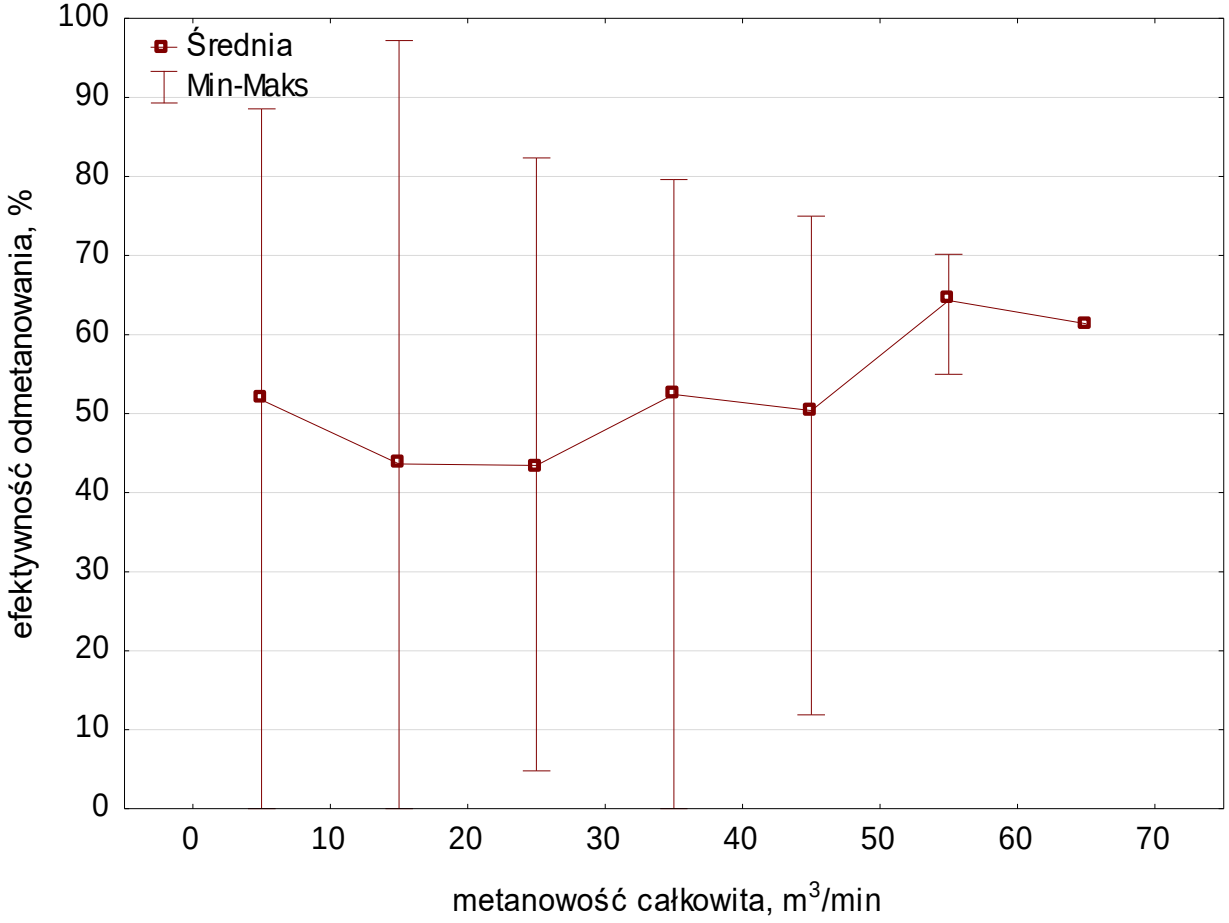

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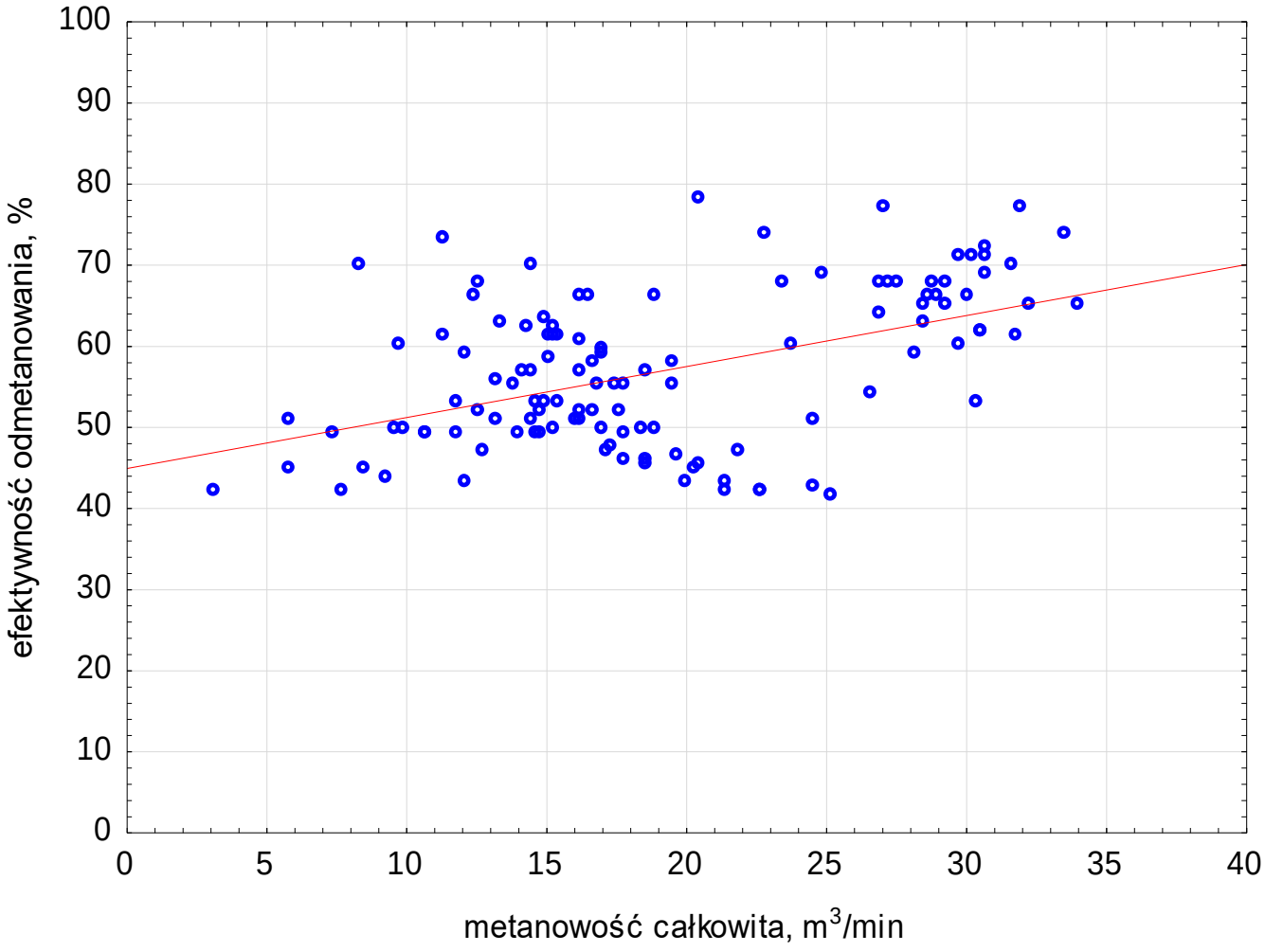
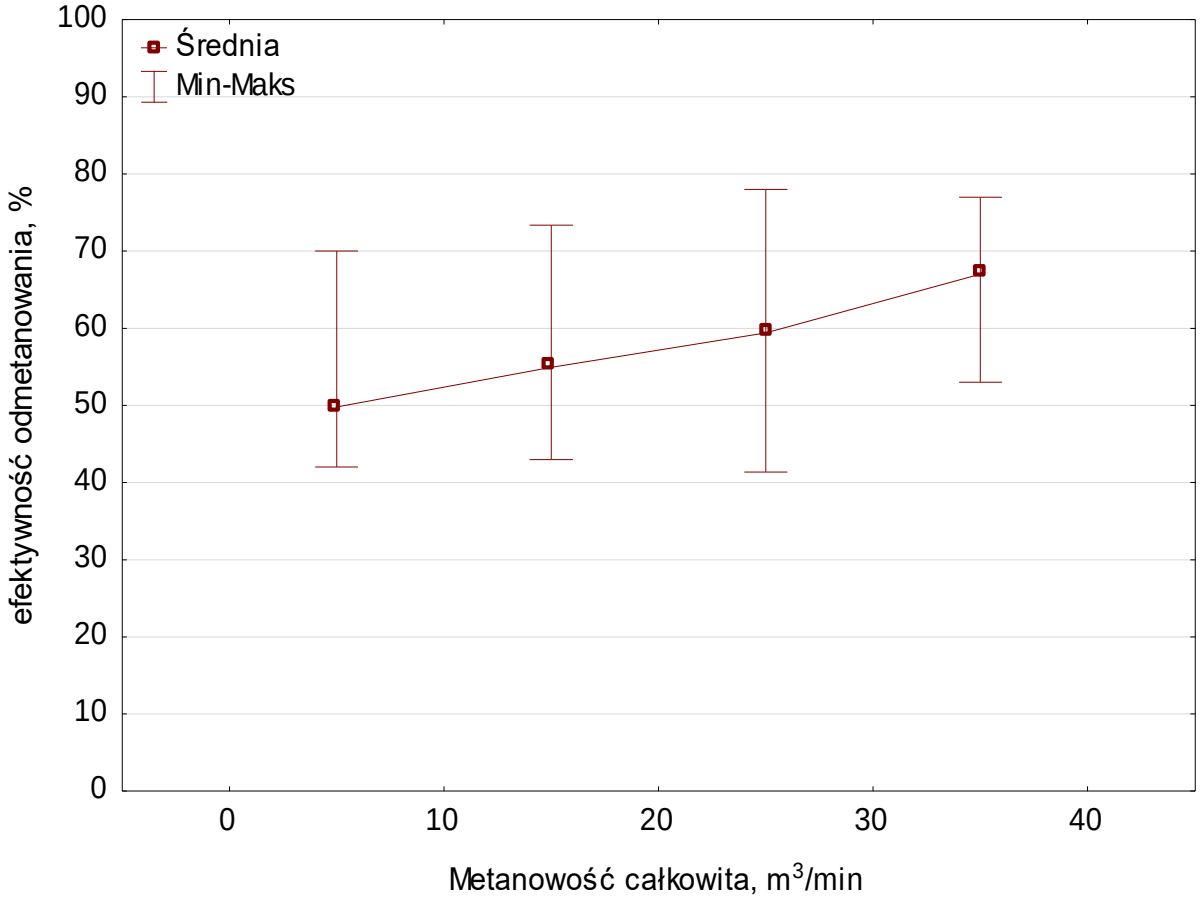
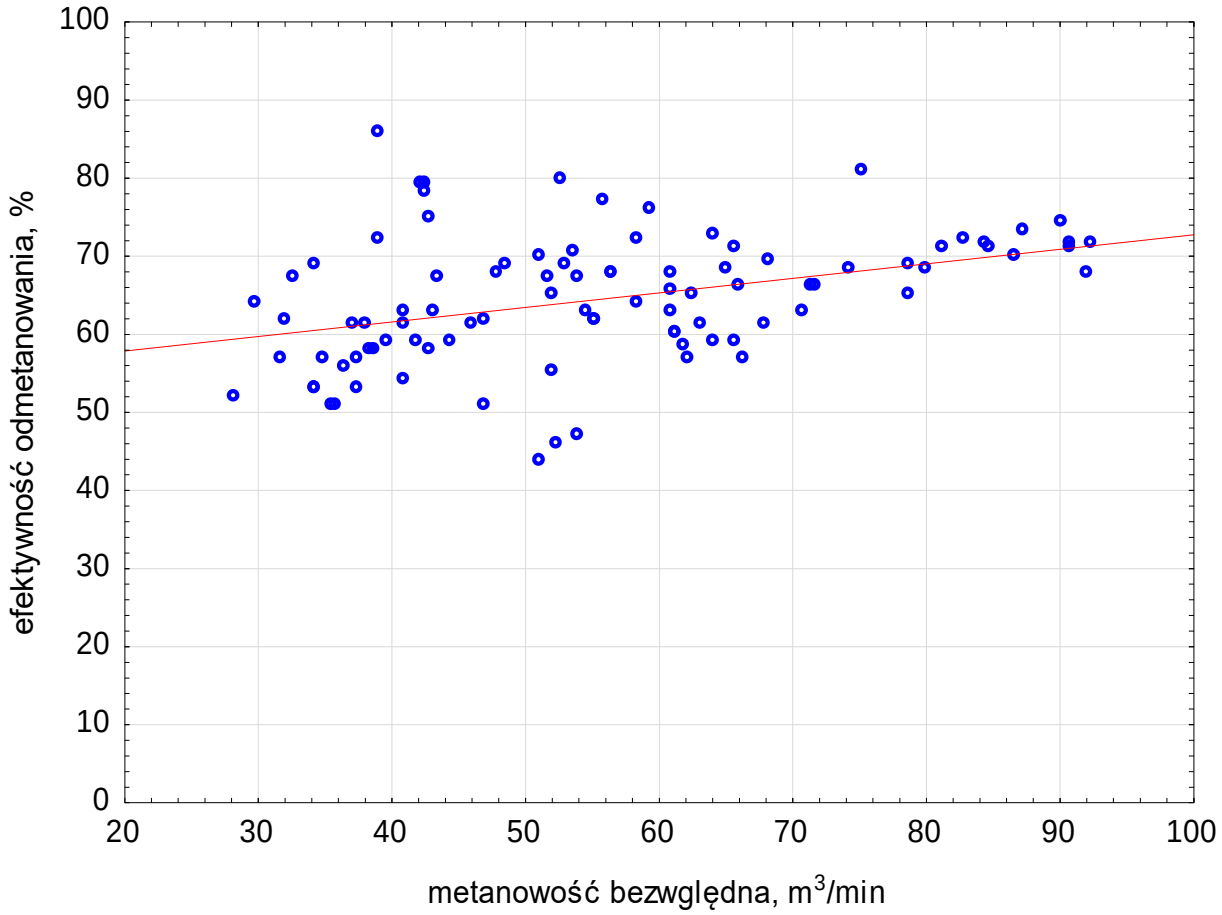


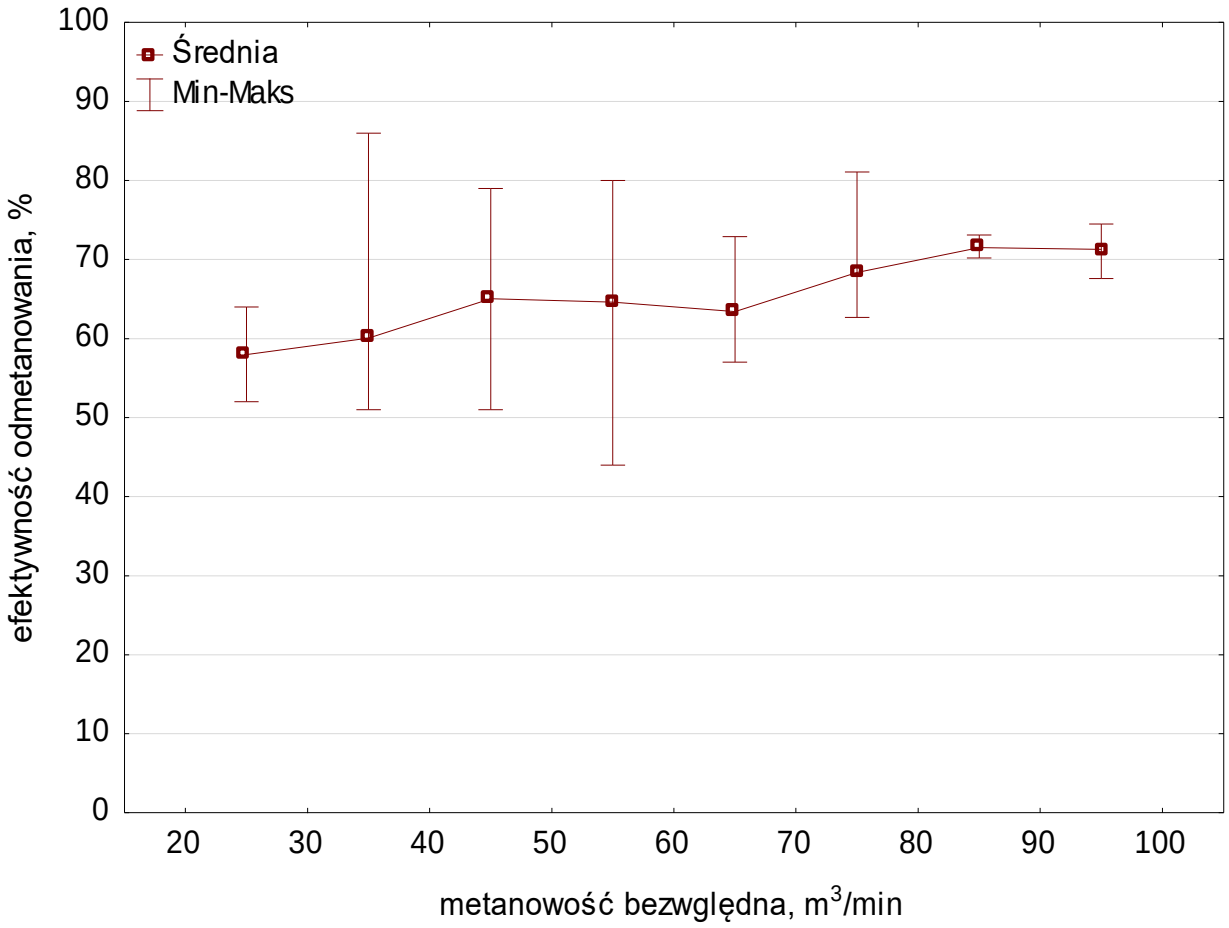
The effectiveness of the methane intake depending on total methane emission Y system



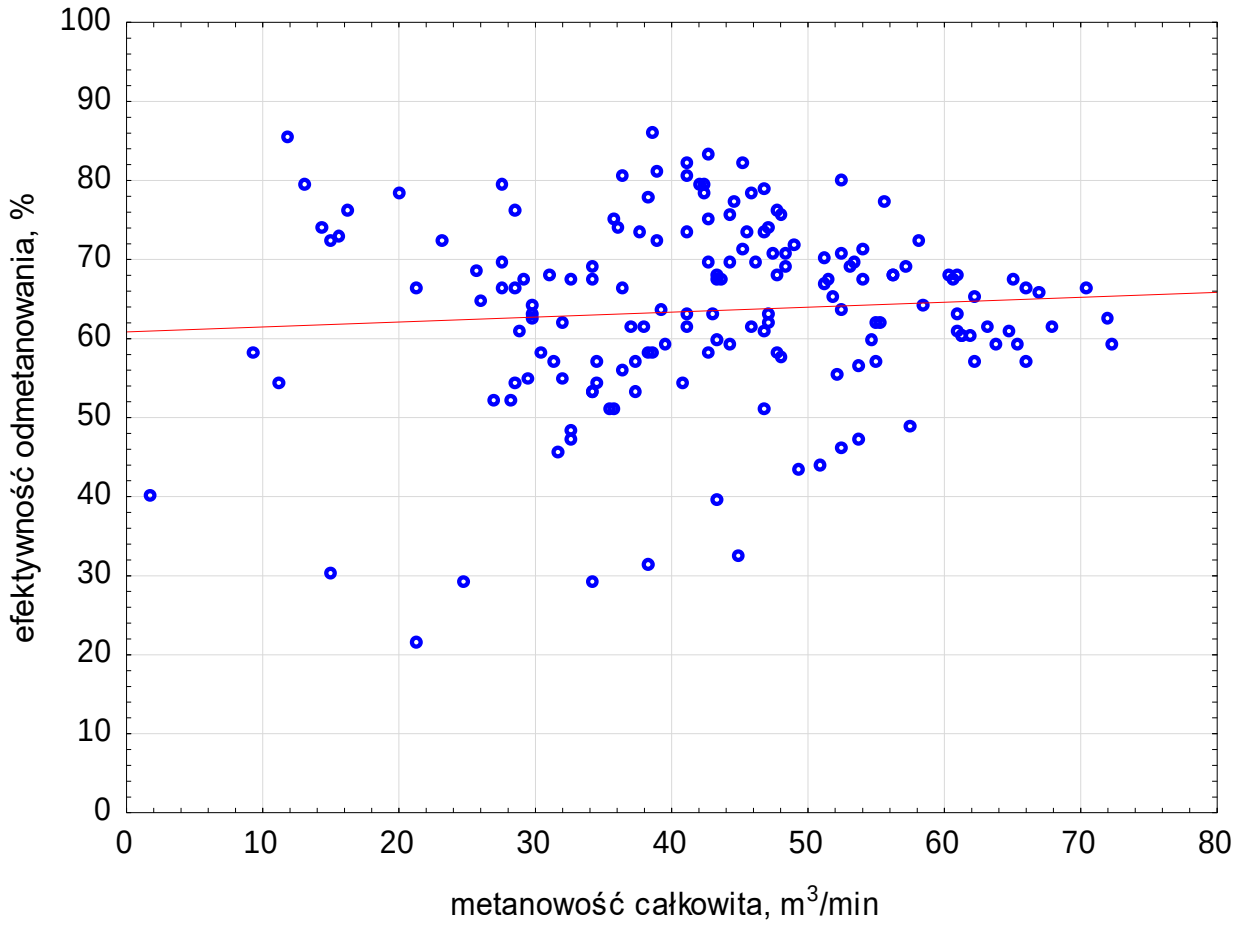
The effectiveness of the methane intake depending on total methane emission
U system with parallel excavation



The effectiveness of the methane intake depending on total methane
U system with parallel excavation



The effectiveness of the methane intake depending on total methane emission
U system with overlying excavation



The effectiveness of the methane intake depending on total methane emission
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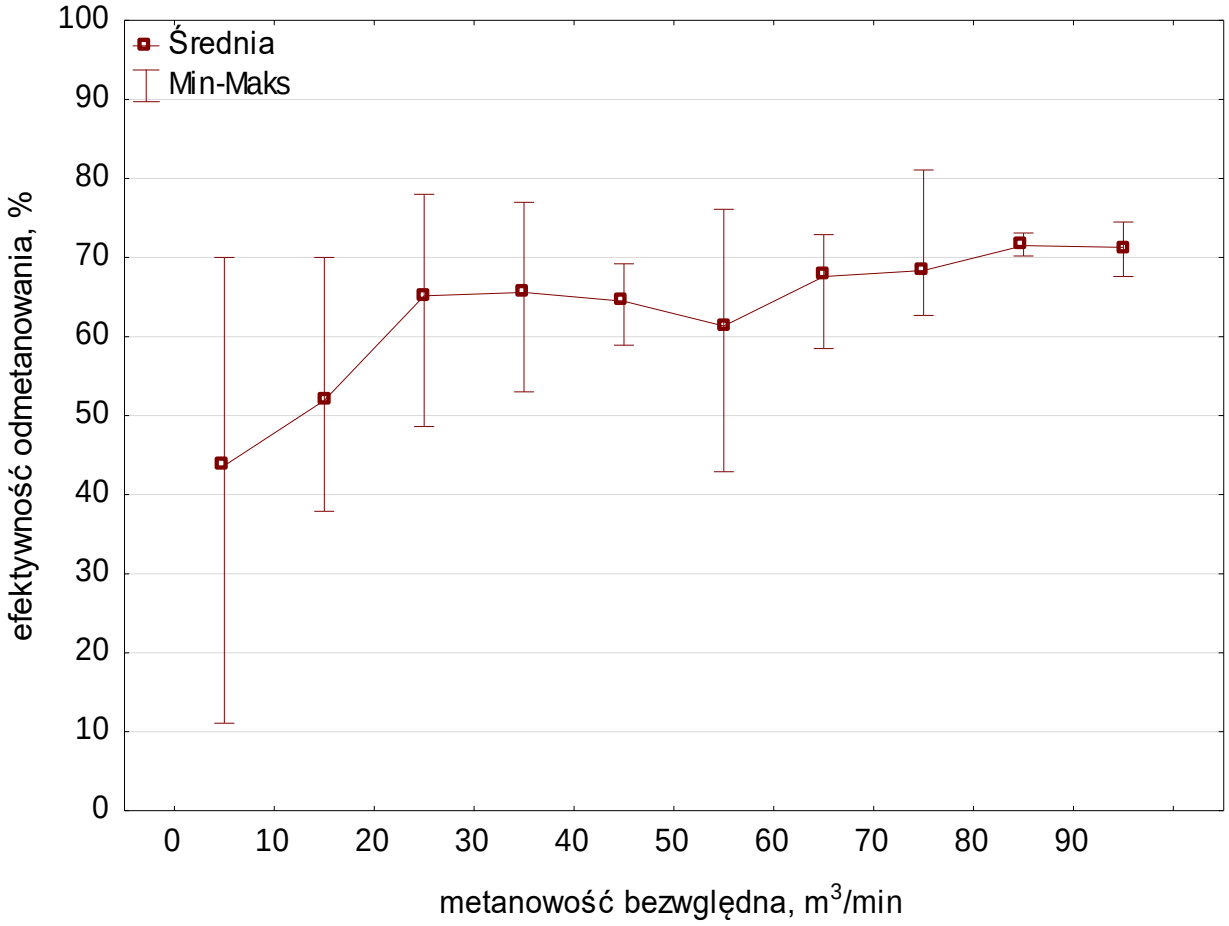


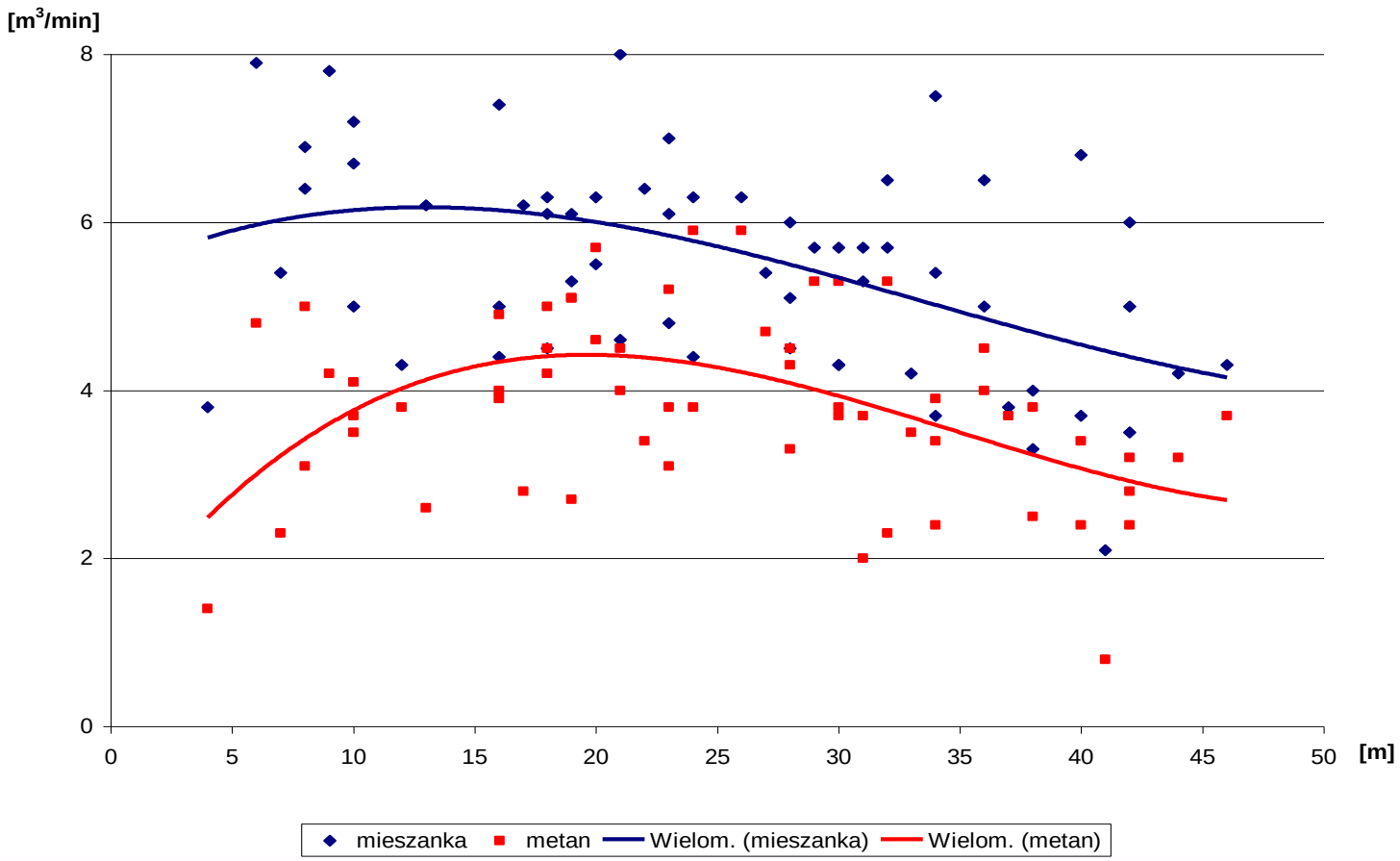
The relations between the efficiency of methane drainage in longwalls and the type of the ventilation and drainage systems in Polish coal mines in the last 10 years

Breakdown	*Efficiency of methane drainage*									*Average drainage efficiency, %*
Total methane emission, m^3/min	<10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	>80	
Longwalls with a **U** ventilation system	38.5	39.0	40.6	38.3	48.8	64.0	x	x	x	**41.2**
Longwalls with a **Y** ventilation system	33.8	43.7	52.4	56.1	49.9	46.2	57.9	x	x	**48.7**
Longwalls **with a parallel** gateroad and U ventilation system	x	x	58.0	60.1	62.2	64.2	64.5	68.3	71.5	**63.9**
Longwalls with **overlying** drainage **gallery** and U ventilation system	49.0	58.6	60.2	62.6	68.4	64.7	68.6	68.8	76.0	**63.4**

INFLUENCE OF THE DRAINAGE HOLES LENGTH ON THE AMOUNT OF CAPTURED METHANE

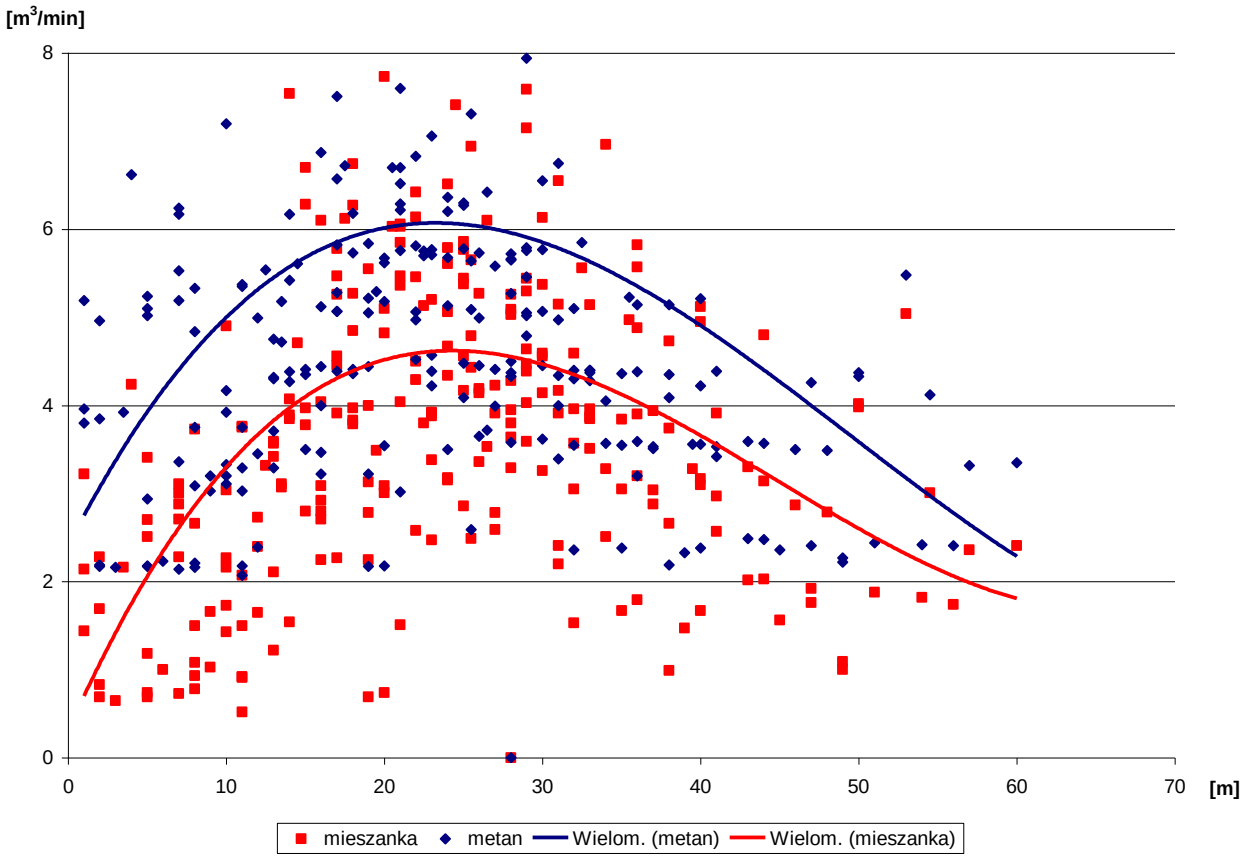
The influence of the distance of the drainage drainage hole from the longwall side - on the amount of methane captured

Longwall ventilated to "U" - from 60m long holes



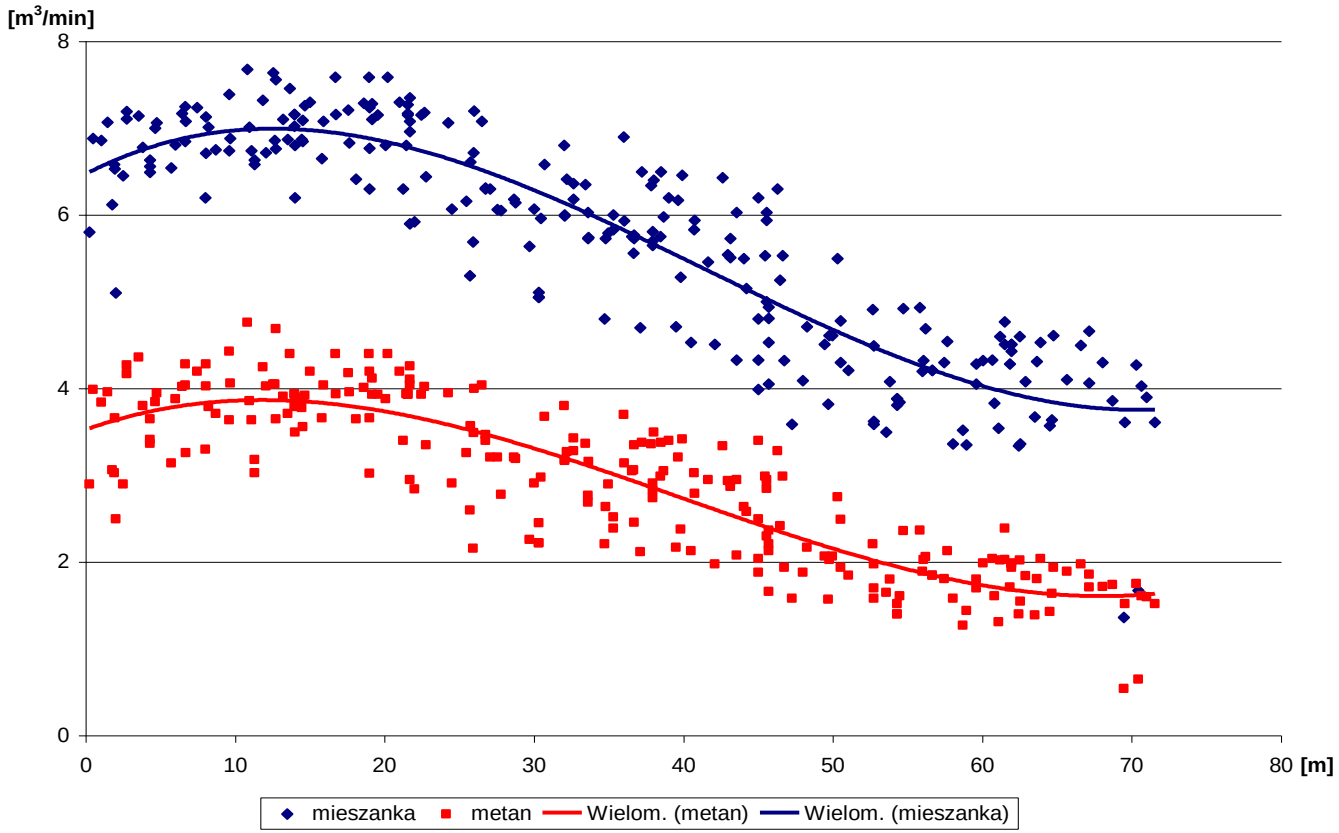
The influence of the distance of the drainage drainage hole from the longwall side - on the amount of methane captured

Longwall ventilated to "U" - from 80m long holes



The influence of the distance of the drainage drainage hole from the longwall side - on the amount of methane captured

Longwall ventilated to "U" - from 100m long holes



Conclusion

- Methane drainage of rock-mass is the most effective method of preventing methane hazard as it reduces the frequency of methane inflows into working areas and prevents or reduces occurrences such as outflows, sudden outbursts of methane and rocks, etc.
- In Polish coal mines, the effectivness of used methane drainage system is limited by low permeability of coal seams.

Conclusions

- On the basis of the results from the simulations it can be concluded that there are two groups of parameters responsible for methane emission in a borehole:
  - *The first group is technical parameters which we can influence when we plan methane drainage*
  - *The second group is parameters connected with rock mass properties responsible for gas filtration*

- Using a proper methane drainage system is strictly connected with time that can be found until mining is started.

Conclusions

The concept presented and the method allowing for increasing the effectiveness of methane drainage consists of:

- Determining places (relevant to specific geotechnical conditions) where the zones of breaking stresses will be located during the influence of the longwall face (both in a seam and in the surrounding rocks).
- Taking some actions aiming at “weakening” rocks (e.g. by means of blasting) in the zones of breaking stresses.
- Locating methane drainage boreholes in “weakened” zones.

THANK YOU
FOR YOUR ATTENTION