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

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# The STATE OF METHANE HAZARD IN POLISH COAL MINES

- ✓ In Poland in 2018, coal extraction amounted **65 million tons** and was conducted in 30 coal mines (according to Industrial Development Agency).
- ✓ The annual output from methane seams was **52 million tons** (it is 80% of total output) and from non-methane seams was 13 million Mg (20% of total output).
- ✓ During coal production about **900 million cubic metres** of methane is generated in Polish coal mining industry (absolute methane bearing capacity).

# Methane risk assessment

» In Polish hard coal mine, the amounts of methane emitted to excavations and headings are determined by empirical prognosticating methods, based on methane contents of coal seams or methane pressure in the seam.

The computation procedure is supported by:

» maps of the seams

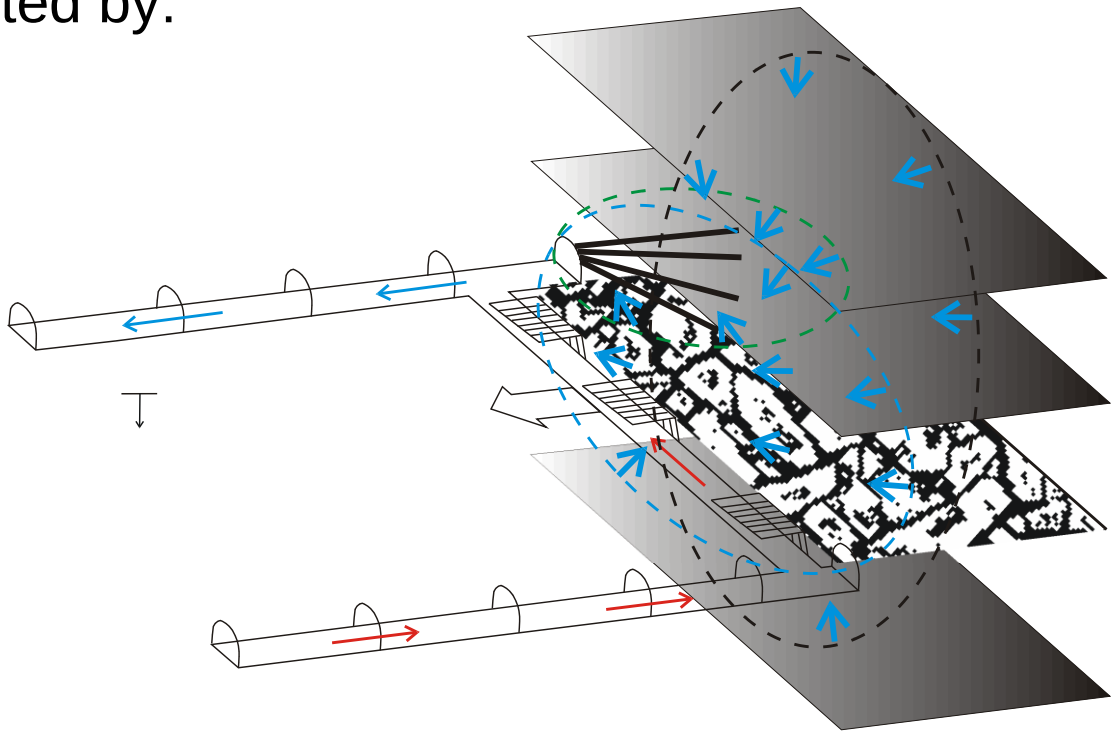
» geologic profiles of the seam

» borehole profiles

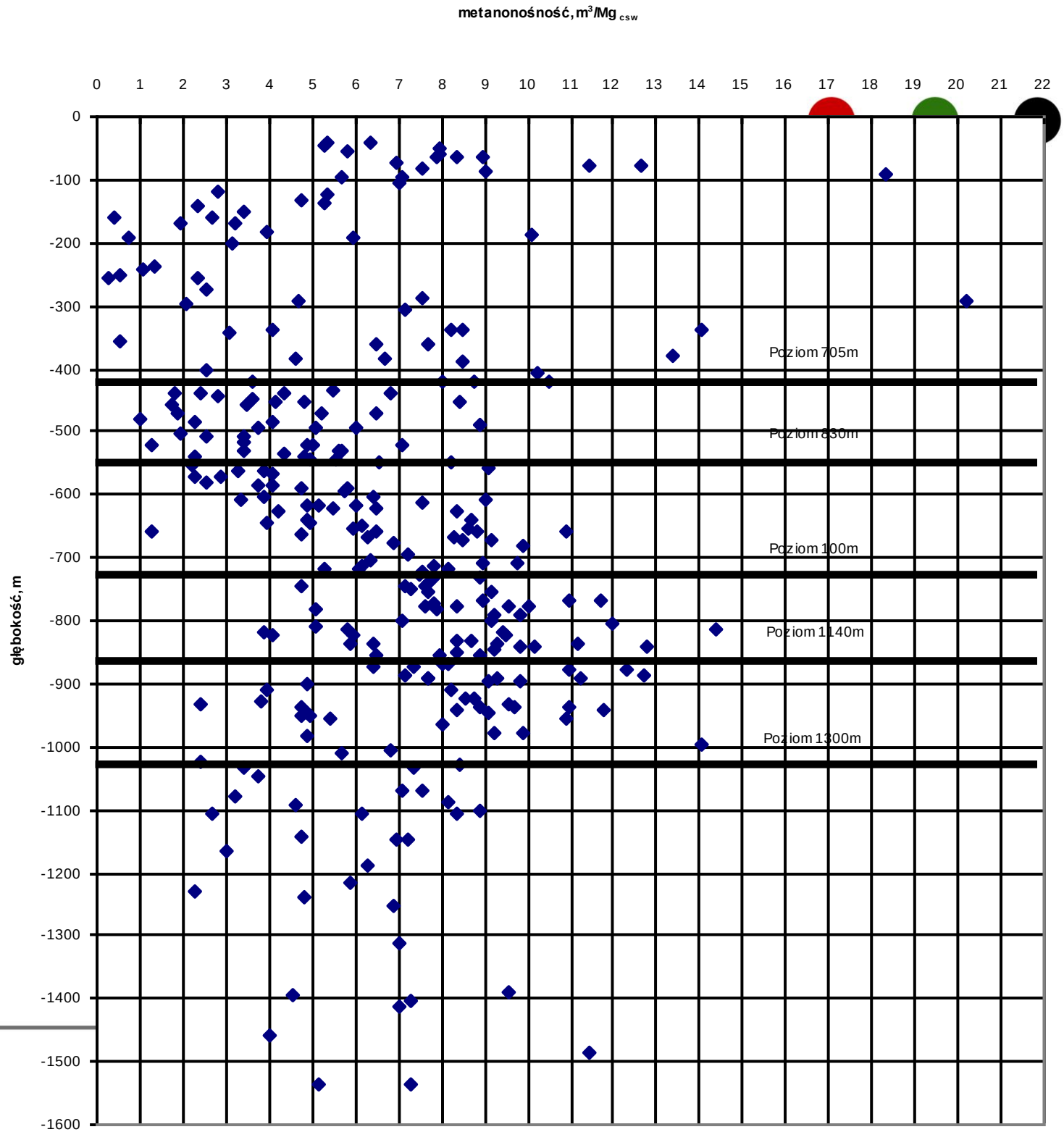
» methane content data

» operational data on the designed longwall

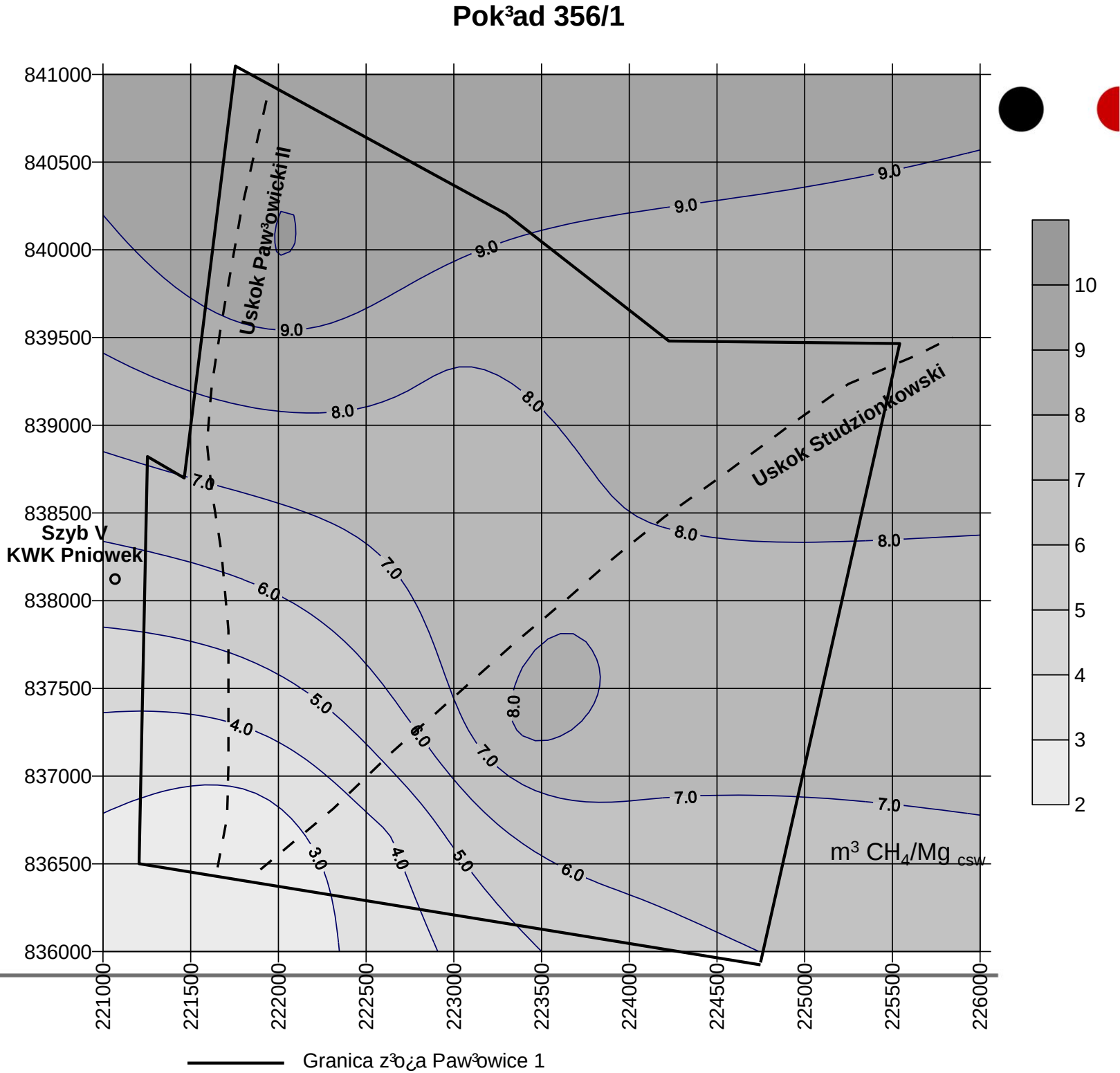
» methane content data in previously worked seams



# Distribution of methane content with depth



# Map of methane isolines



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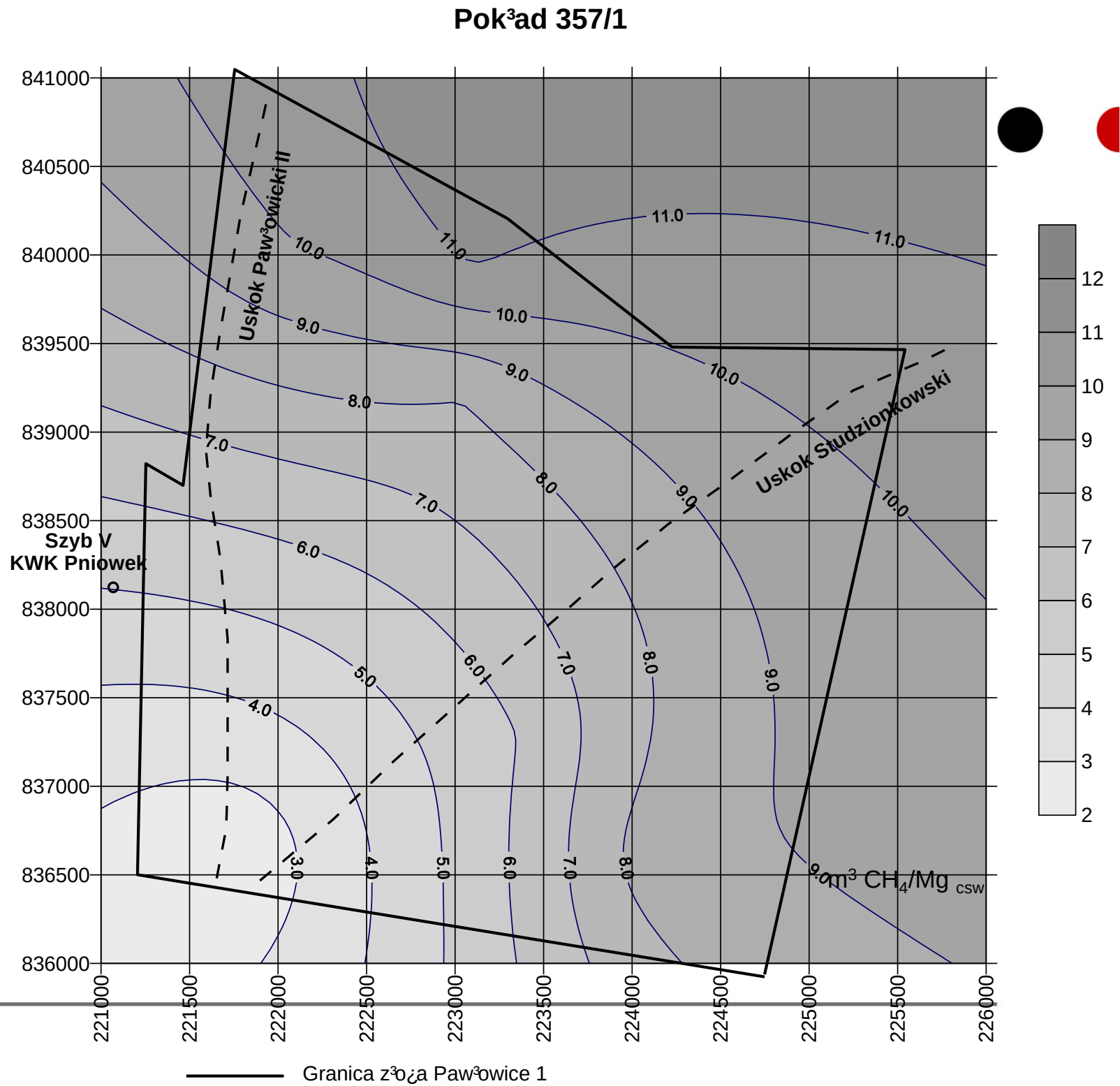

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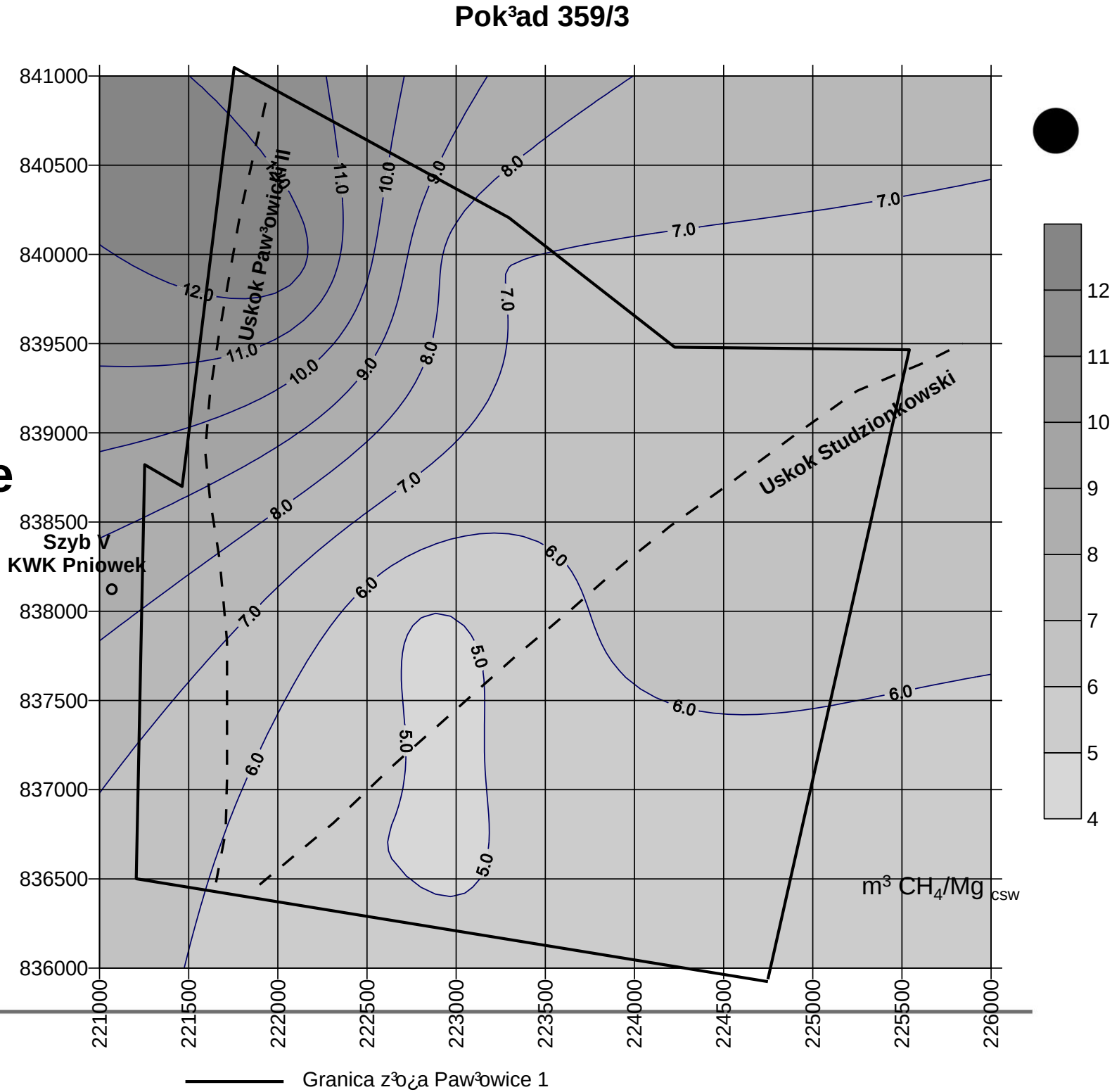

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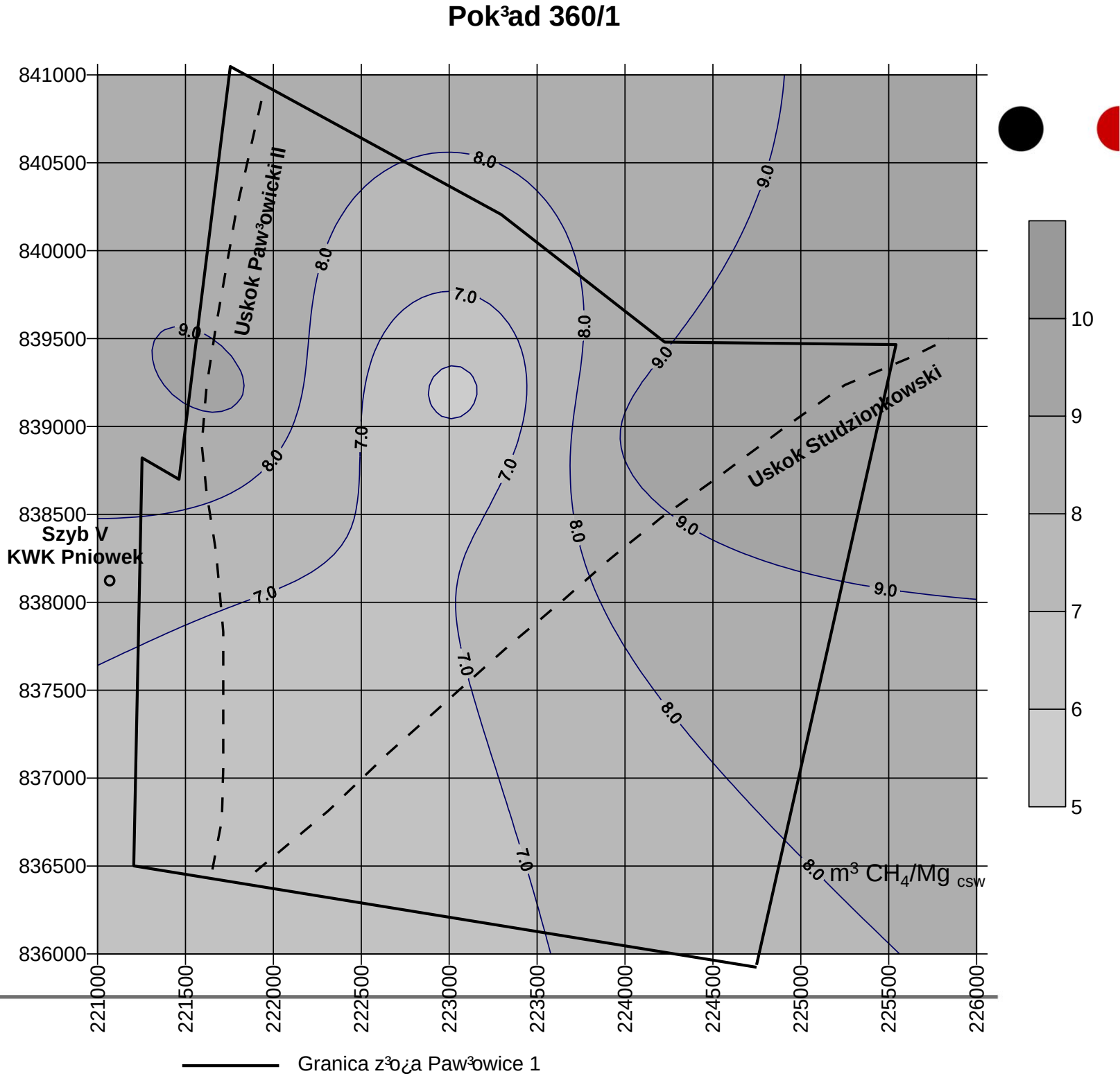

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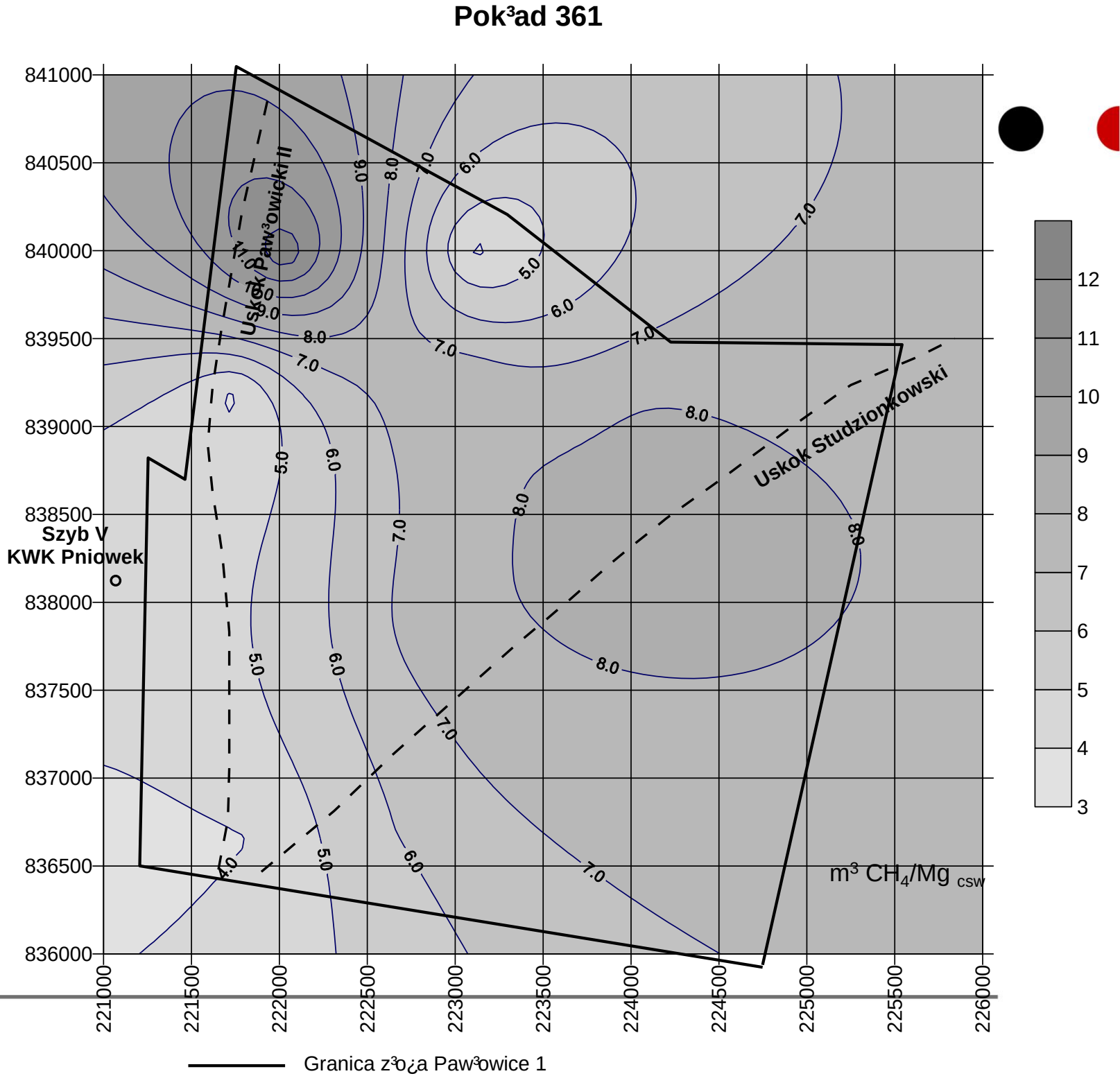

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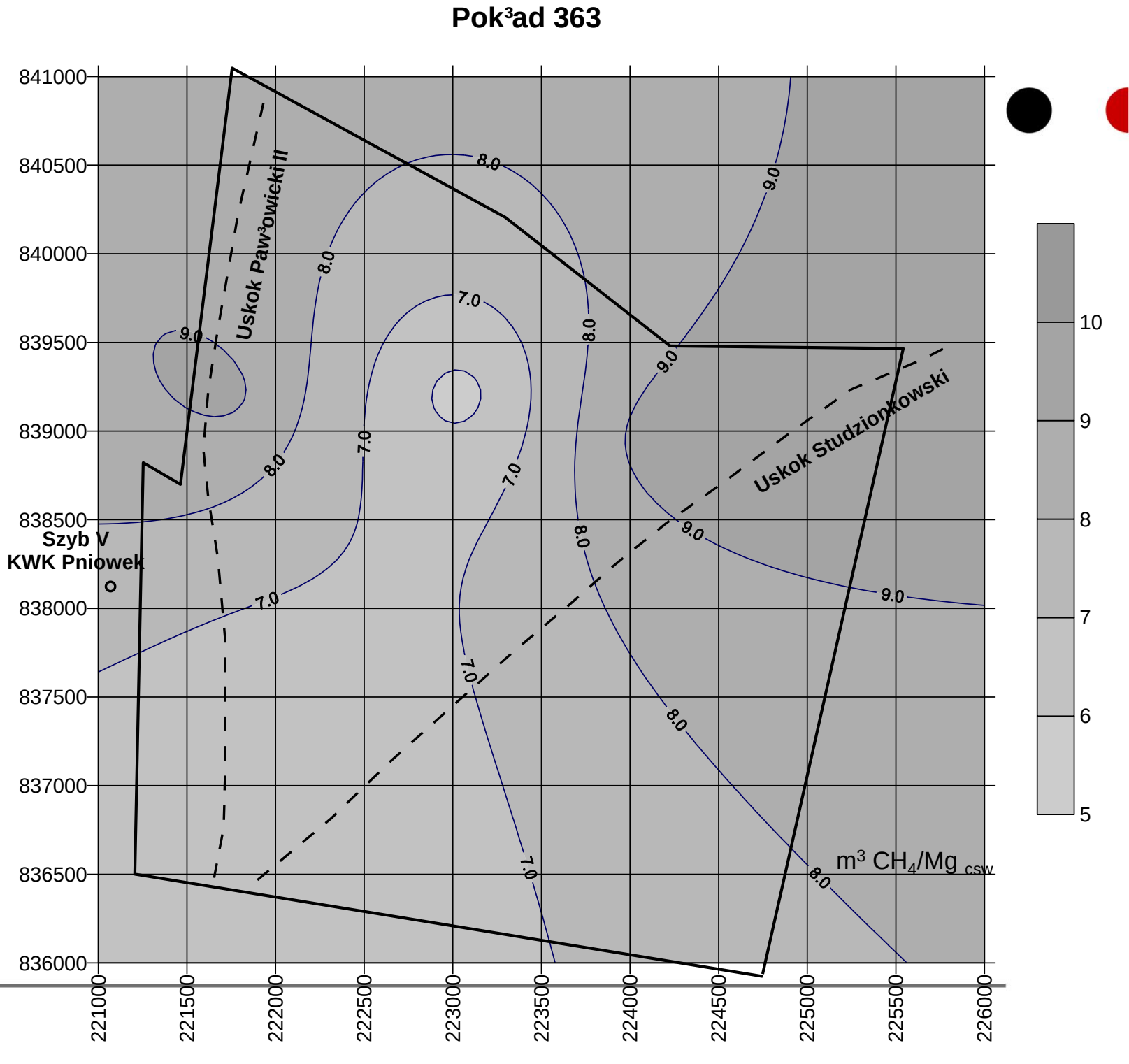
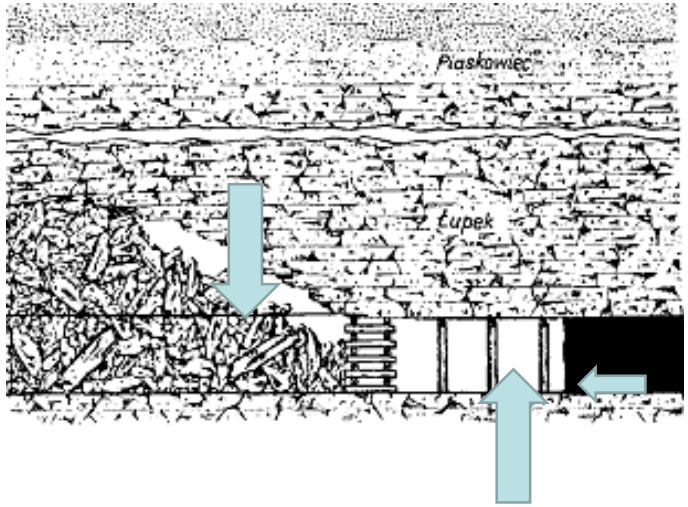


# Methane emissions to the working faces

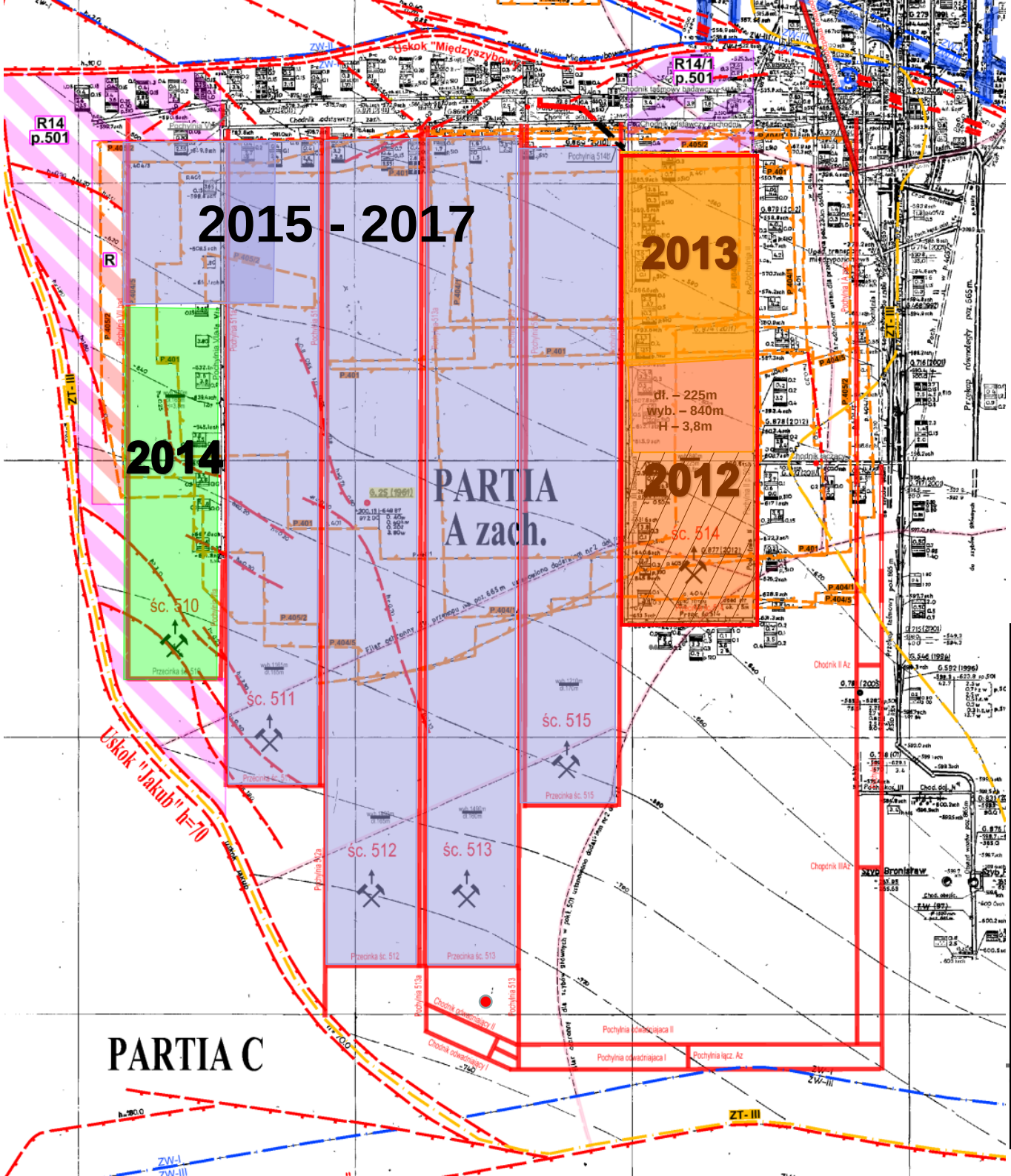
Geological conditions of coal seams (porosity, permeability, reservoir pressure, diffusivity), seam methane content and **low desorption** of Polish coal seams result in low gas emission **not disturbing the structure of rock-mass**.




The direction of methane flow

**Methods for methane drainage in Polish coal mines:**

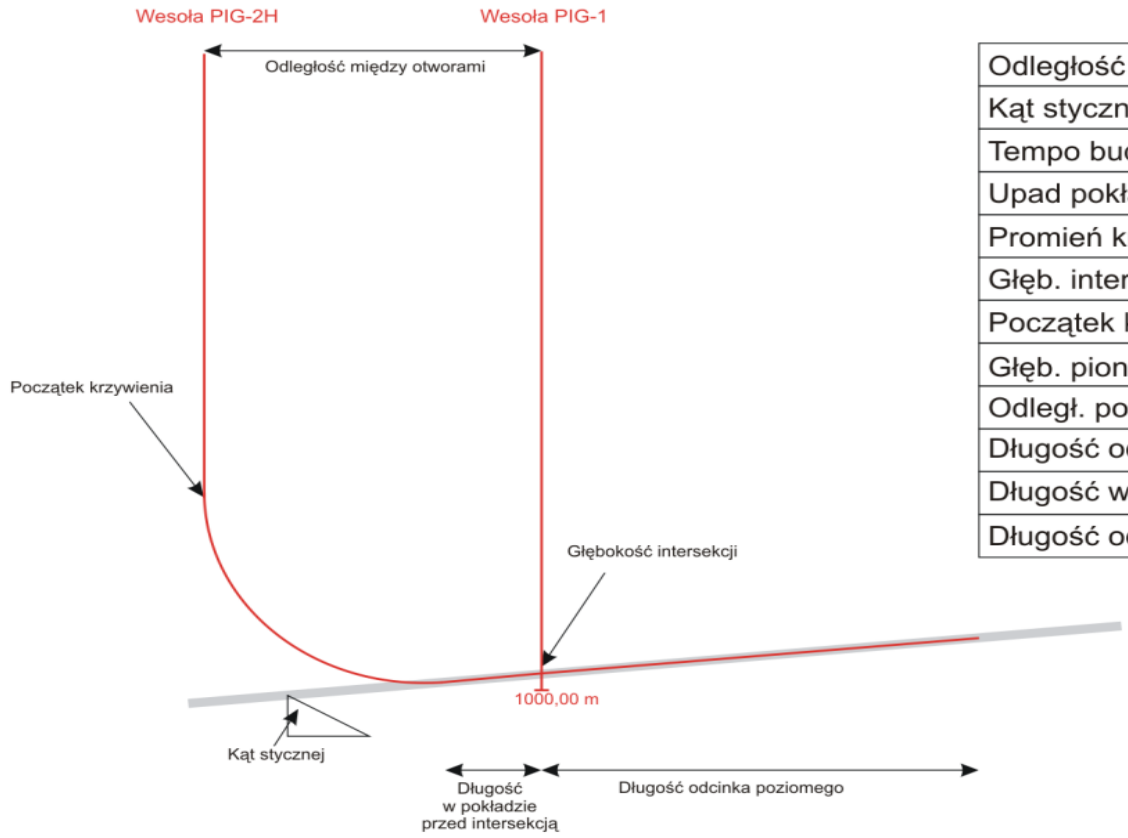
| | |
|---|---|
| •methane drainage in development headings, | very low effectiveness |
| •pre-mining drainage, | low effectiveness |
| •mining methane drainage, | good effectiveness |
| •post-mining methane drainage. | satisfied effectiveness |



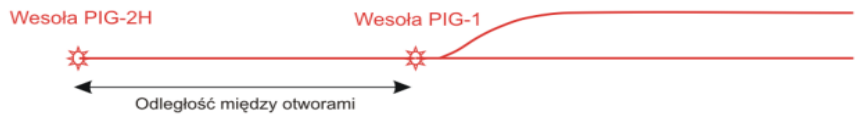

# Pre drainage methane

| PARTIA Az | |
|---|---|
| POKŁAD 501 | |
| ZASOBY OPERATYWNE | 7941 tys. Mg |
| POKŁAD 510 | |
| ZASOBY OPERATYWNE | 32560 tys. Mg |
| ZASOBY METANU DLA CAŁOŚCI ZŁOŻA WESOŁA | |
| Desorbowalne kat. B | 1061,438 mln m3 |
| Desorbowalne kat. C | 863,075 mln m3 |

# Pre drainage methane
# - hydraulic fracturing project




| | |
|---|---|
| Odległość między otworami | 460 m |
| Kąt stycznej | 60° |
| Tempo budowania krzywizny | 6° na 30 m |
| Upad pokładu | 6° |
| Promień krzywizny | 291 m |
| Głęb. intersekcji | 968 m |
| Początek krzywienia | 695 m |
| Głęb. pion. wejścia w pokład | 986 m |
| Odległ. poz. wejścia w pokład od 2H | 322 m |
| Długość odc. krzywionego | 488 m |
| Długość w pokładzie przed intersekcją | 138 m |
| Długość odcinka poz. | 600 m |



# Pre drainage methane
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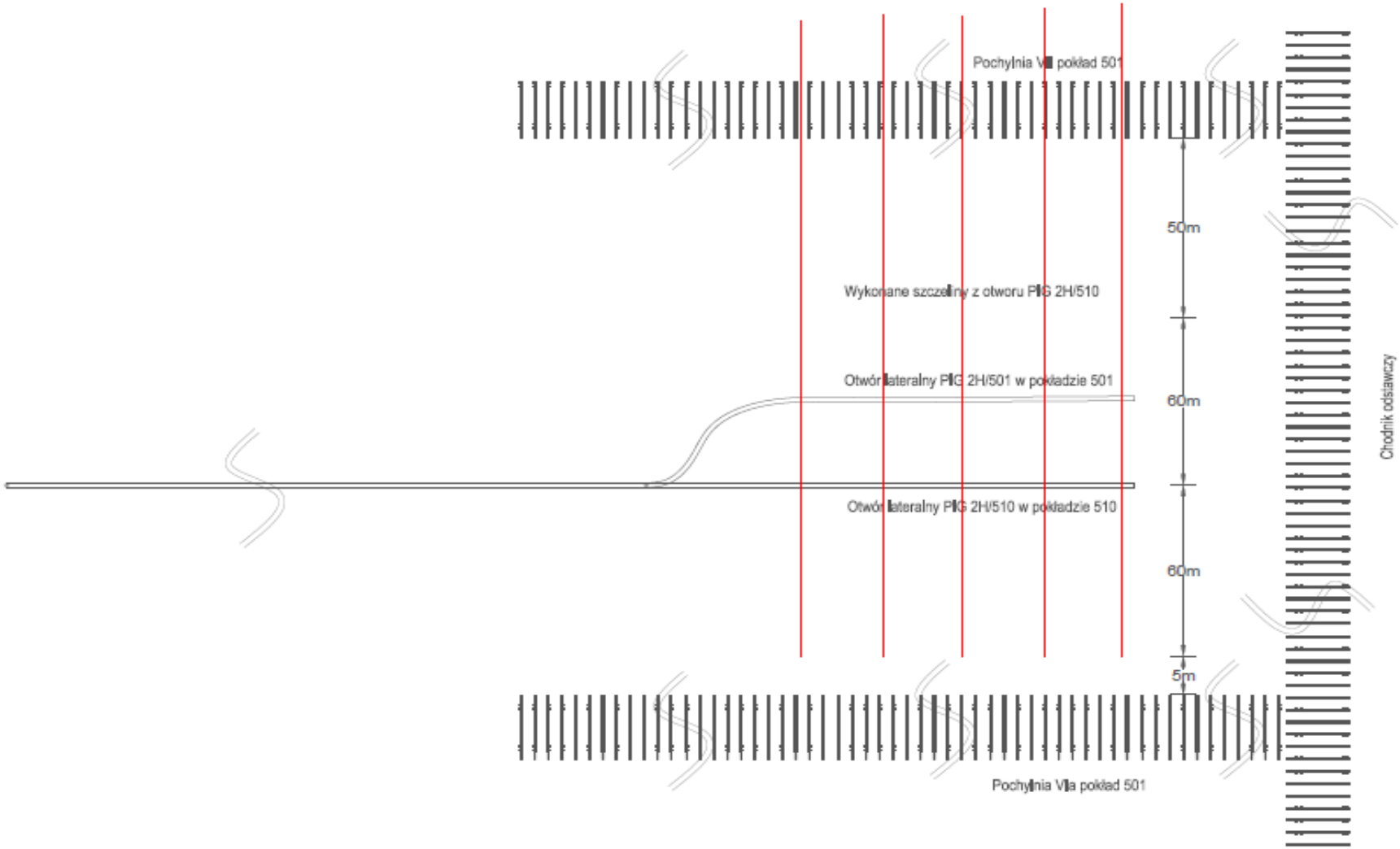
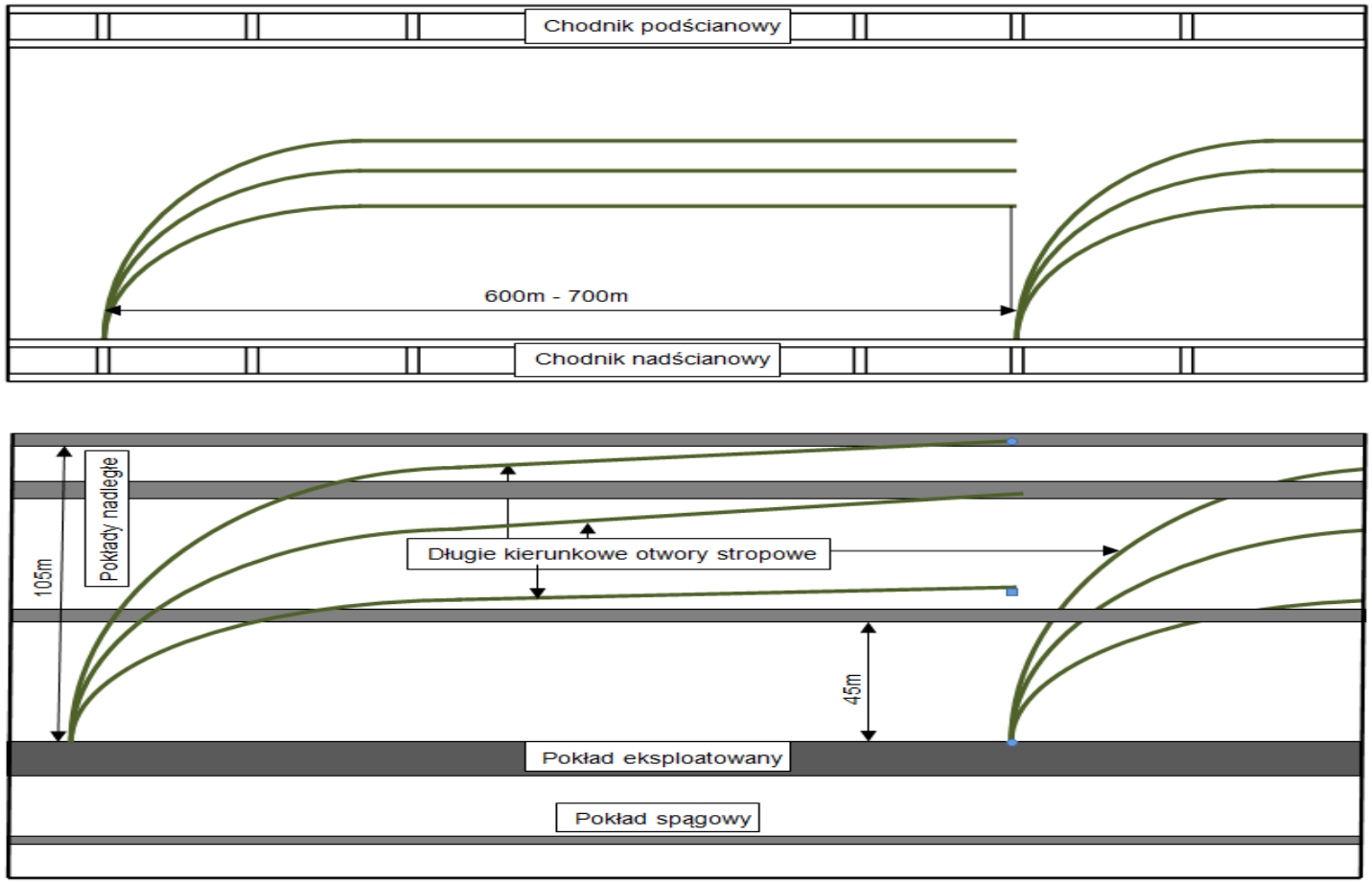


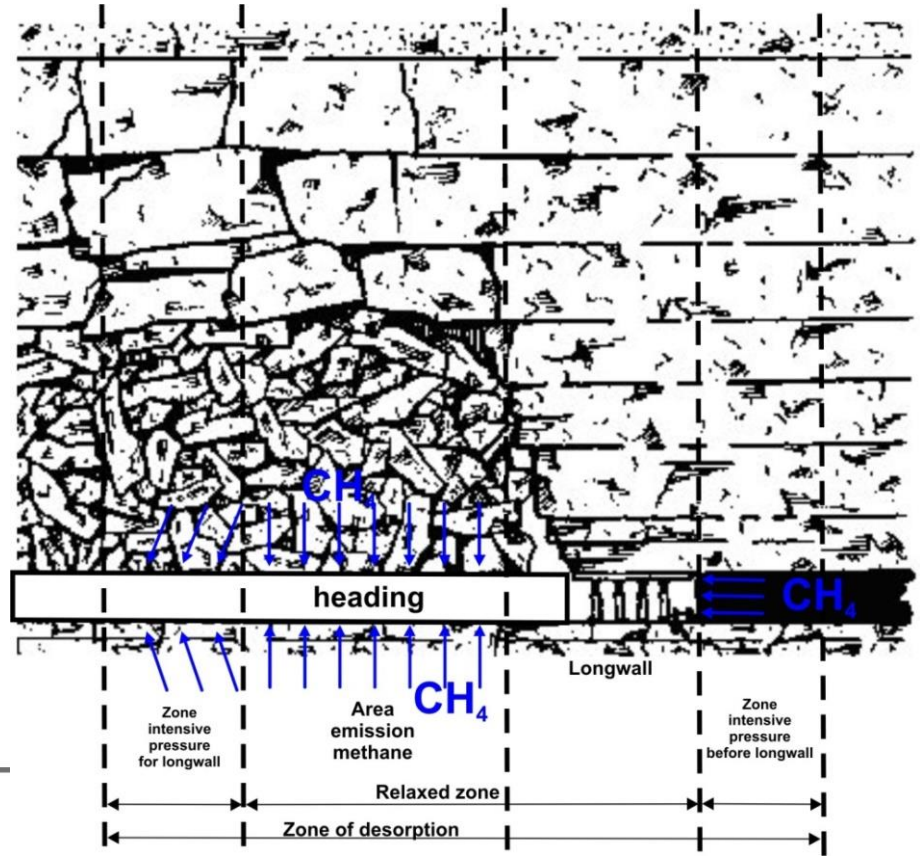
# Schematic diagram – methane drainage with long boreholes



# 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 essential part of methane is released during the exploitation of coal seams



# The Role of Ventilation Systems

The maximum rate of coal extraction that can be safely achieved on a gassy working coalface is determined primarily by the combination of four factors:

1) the mine ventilation system's capacity to dilute gaseous pollutants to acceptable concentrations,

2) the efficiency of the mine's methane drainage system; using boreholes that are drilled from underground excavations or from the surface,

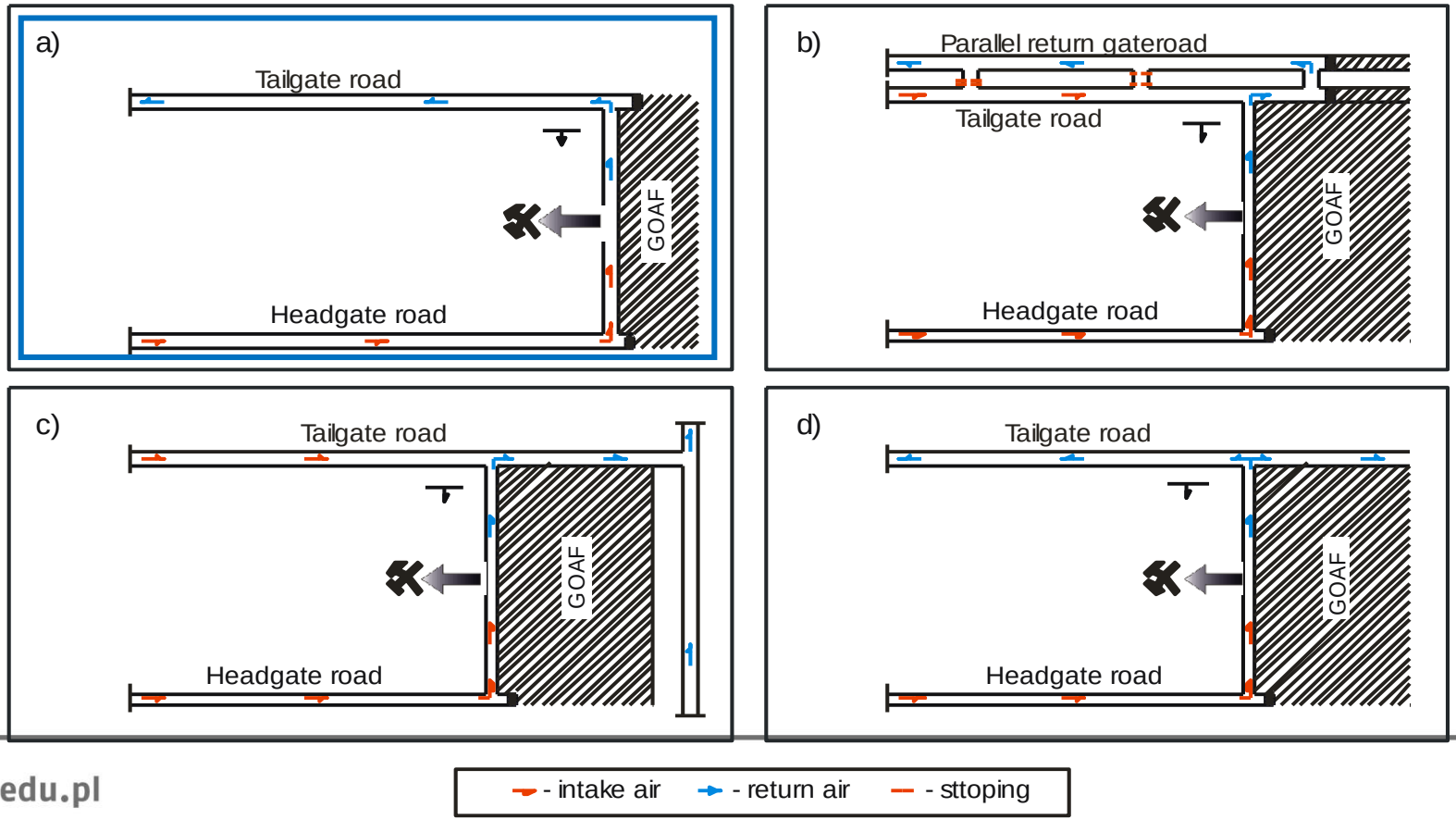
3) methanometry control of methane concentration in the air; location of the sensors is defined by law,

4) additional ventilation equipment used in places of lower intensity of ventilation and places where methane is concentrated.

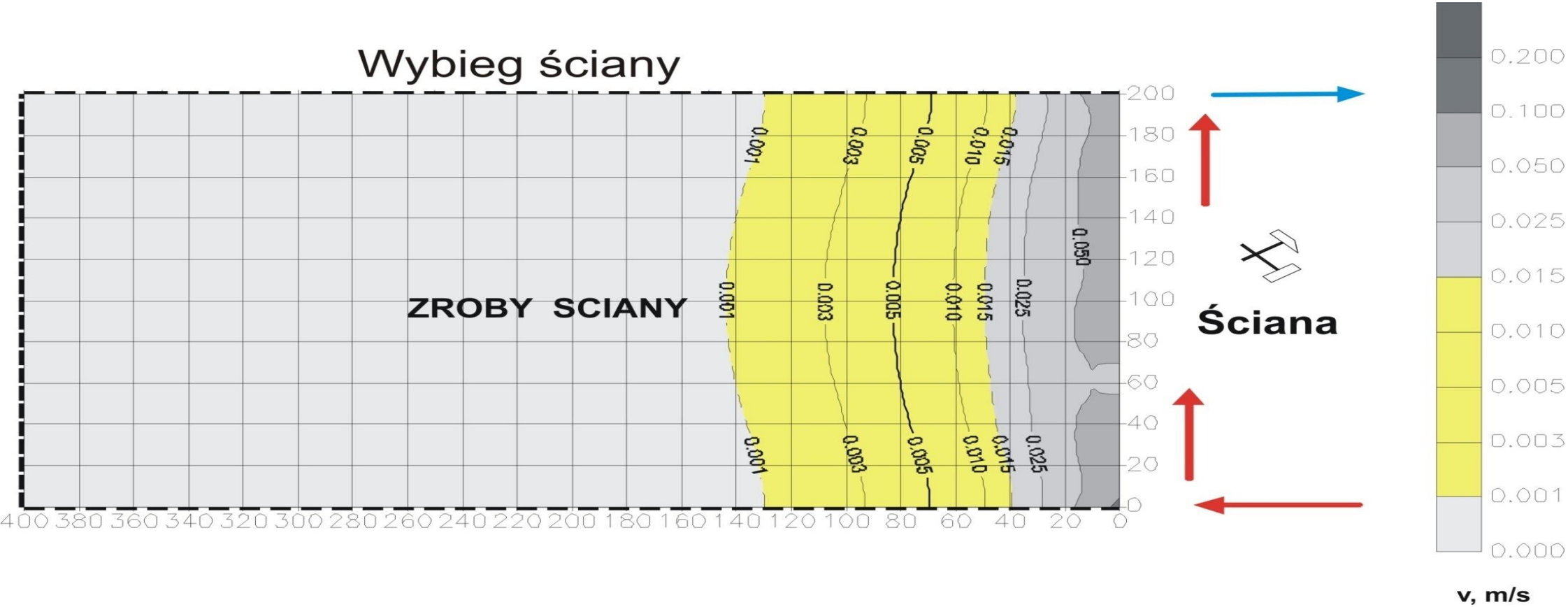
# LONGWALL VENTILATION SYSTEMS

The most popular panel ventilation systems hard coal mines

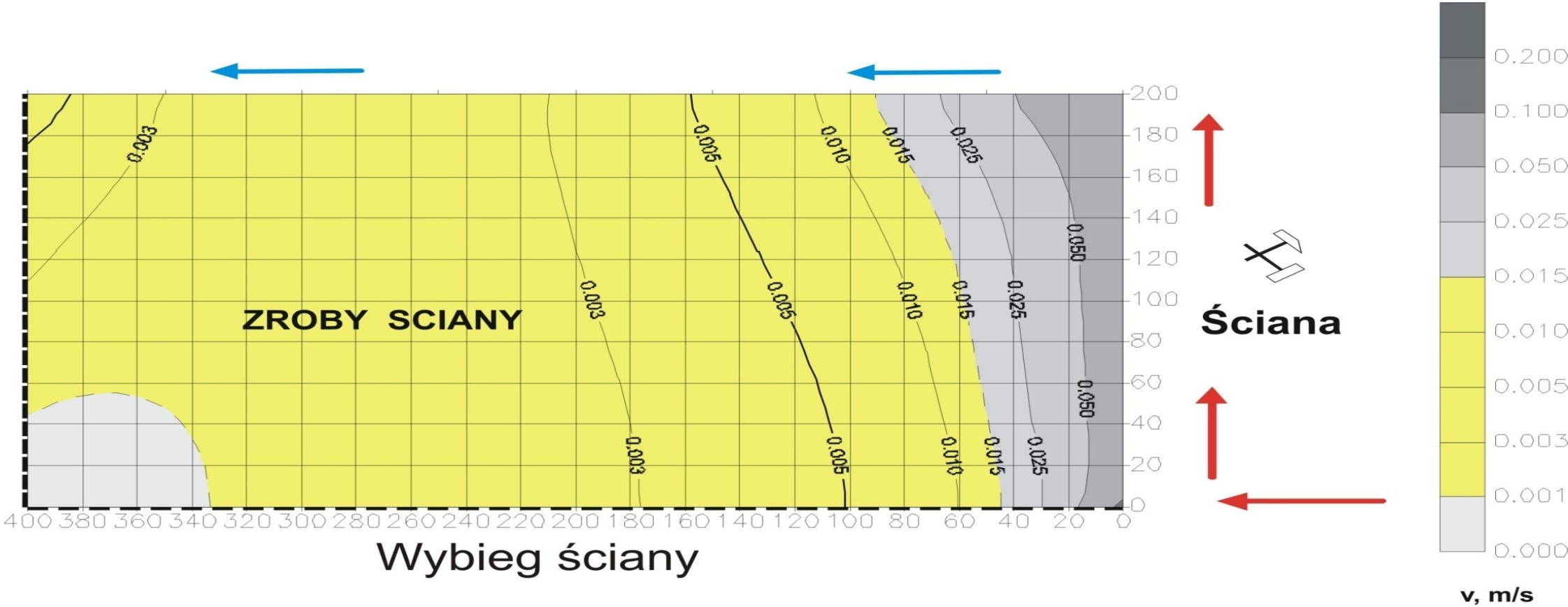
a) U ventilation system, c) Y - return side ventilation system, d) Y - return side ventilation system (bleeder system), b) Y - return side ventilation system with parallel return gateroad



# A map of the airflow in the goaf at longwall ventilation using the U system

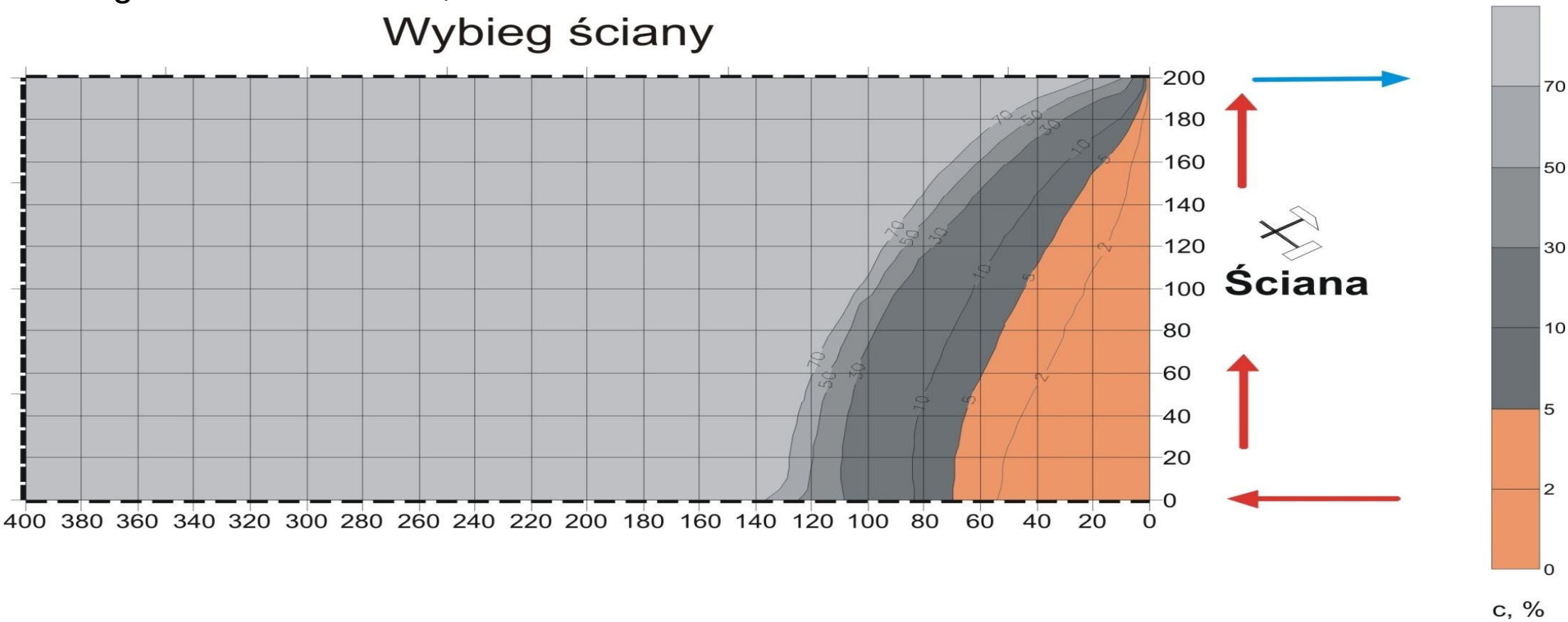


# A map of the airflow in the goaf at longwall ventilation using the Y system



# A map of isolines of methane concentration in goaf at longwall ventilation using the U system

methane emission in the size of 19.8 $m^3$ / min at its concentration at the longwall outlet of 1.1%,



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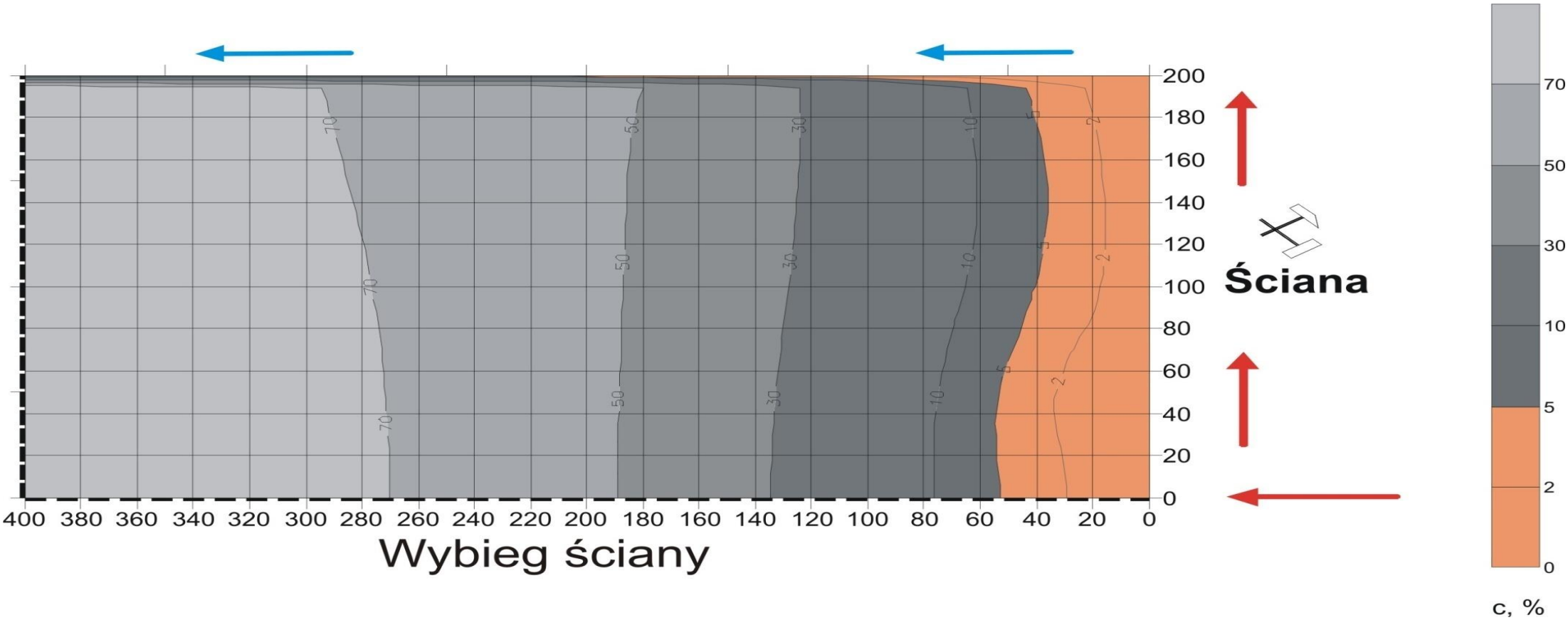
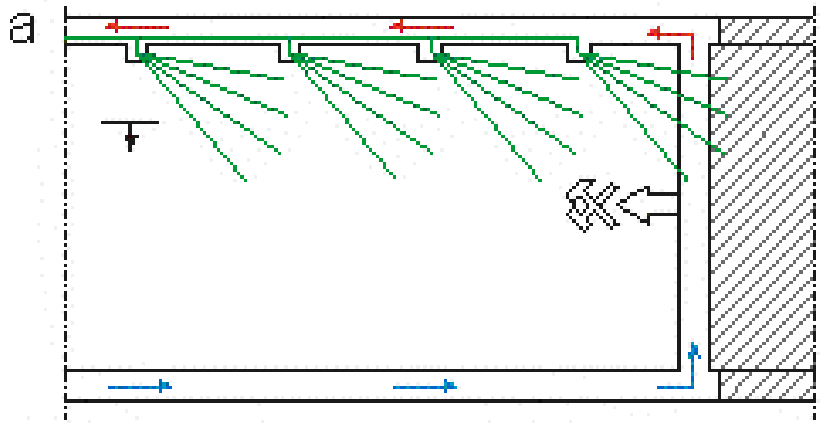


# The Role of Ventilation Systems

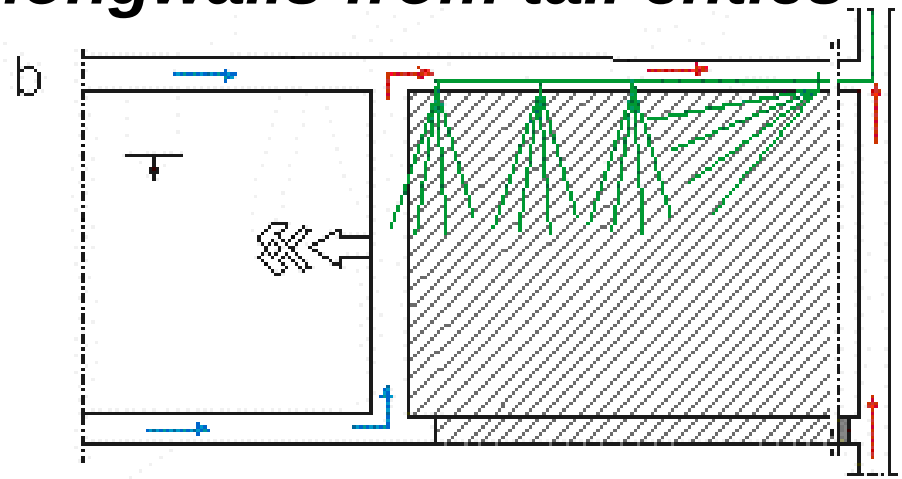
- Operating costs are a key driver in designing the overall mine degasification scheme. The power consumed in providing underground mine ventilation is among the most costly operational expenses at a mine; it is proportional to the airflow volume cubed.
- Therefore, introducing a gas drainage system—or increasing its effectiveness—often represents a lower-cost option than increasing ventilation air volumes.

# The most popular ventilation and methane drainage systems in Polish coal mines

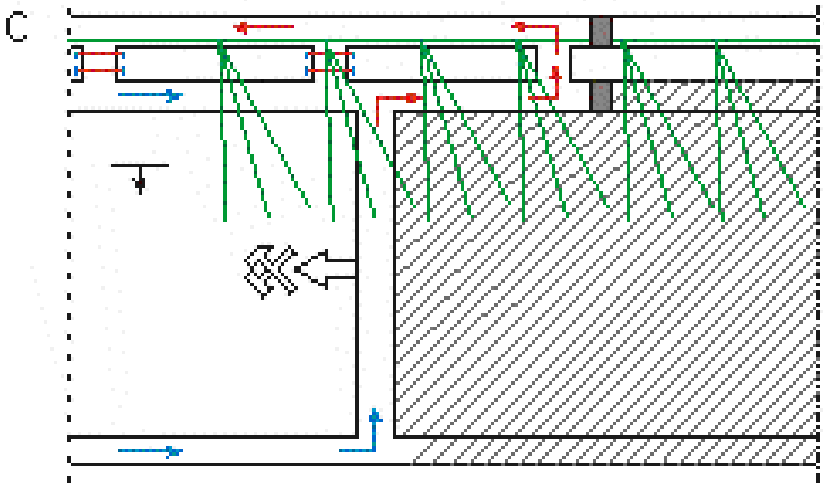
## *Methane drainage of longwalls from tail enties*



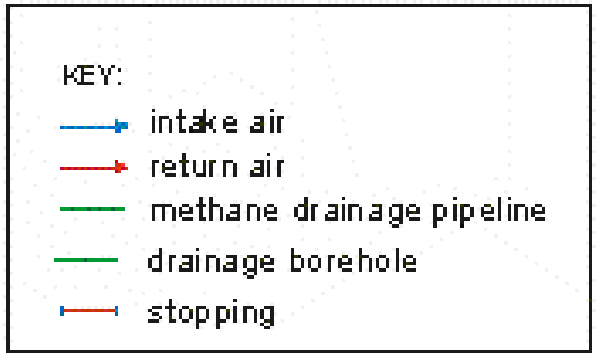

a) longwall with U ventilation system



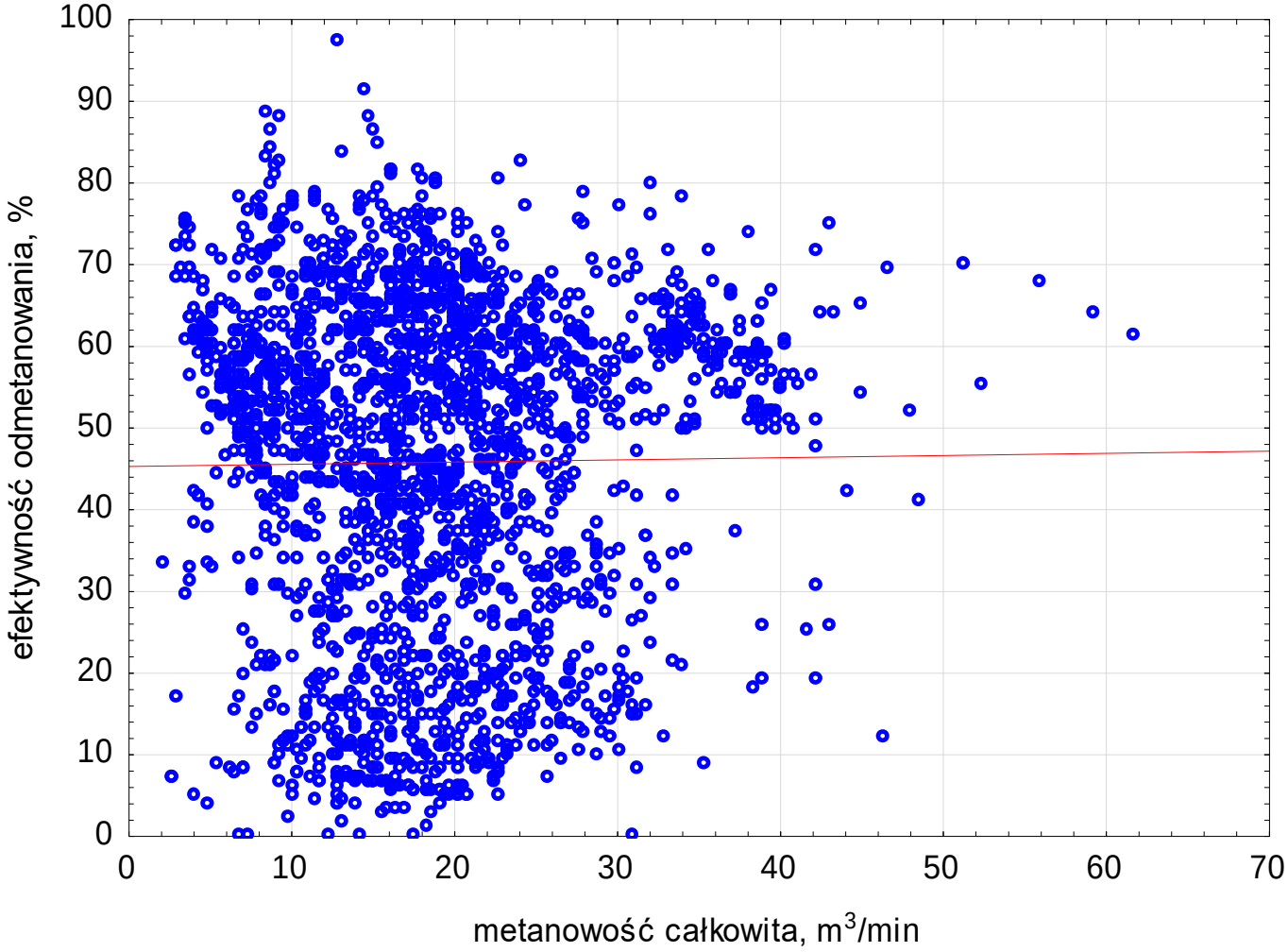

b) longwall with Y ventilation system,




c) longwall with parallel tail entry

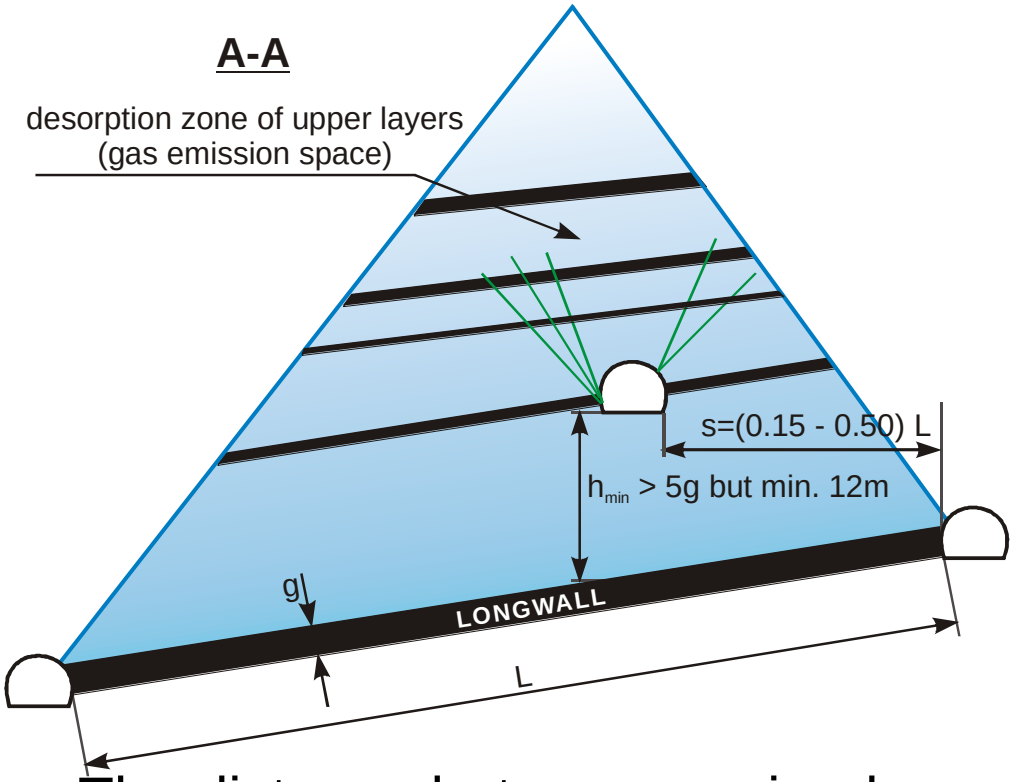


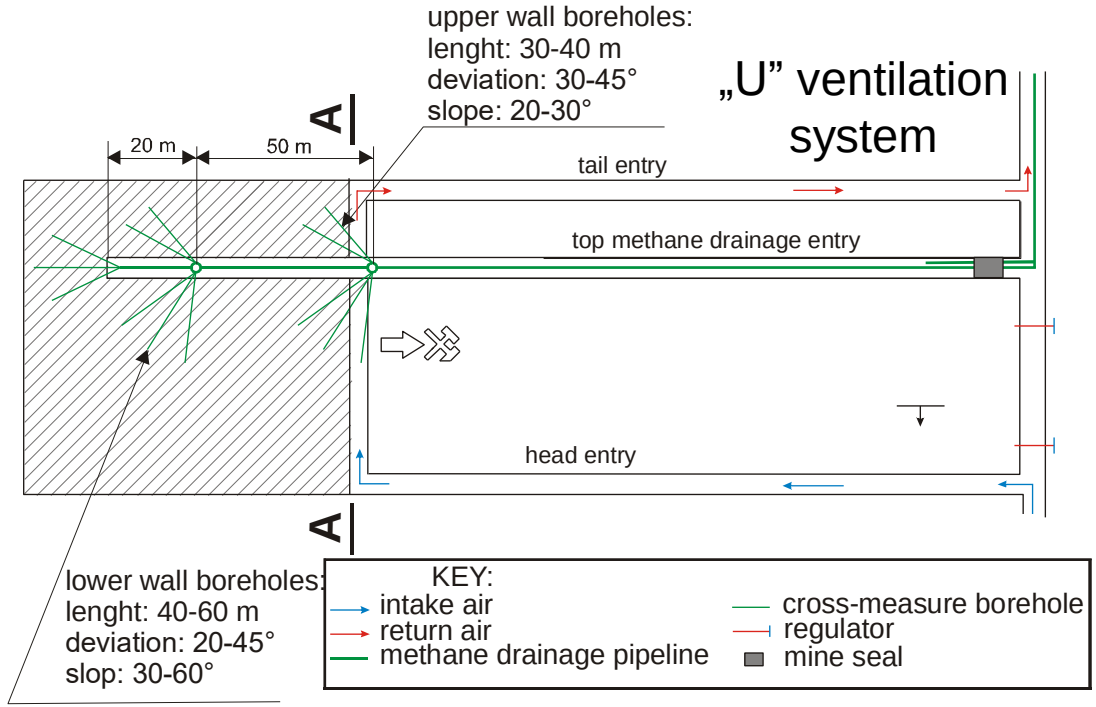
# The effectiveness of the methane intake depending on total methane emission U system



# The most frequently used methane drainage systems in Polish coal mines

## *Methane drainage of longwalls from top drainage heading*

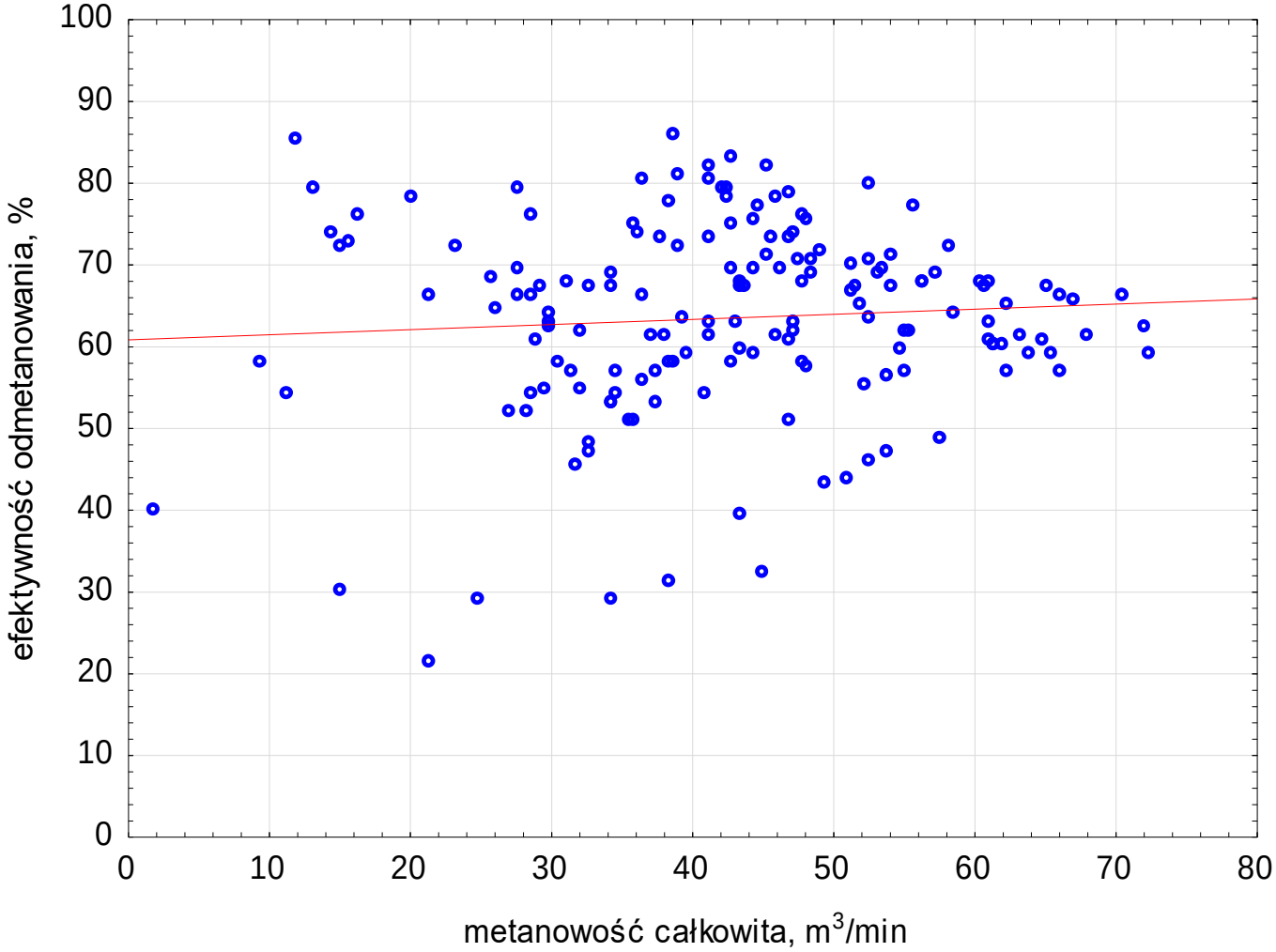



The distance between a mined seam and a drainage heading should not be smaller than five-times thickness of mined seam at the same time not smaller than 12 m.

# The effectiveness of the methane intake depending on total methane emission

## U system with overlying excavation



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

| ***Breakdown*** | ***Efficiency of methane drainage*** | | | | | | | | | ***Average drainage efficiency, %*** |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Total methane emission, m³/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** |

# Summary

- **Low capture efficiencies** of the drainage system and excessive ingress of air to the mine workings result from the selection of unsuitable gas drainage methods and from the poor **implementation of these methods**.
- The performance of methane drainage systems can be significantly improved through a combination of proper installation and maintenance, regular monitoring, and systematic drilling.
- Based on experiences in coal mines worldwide, investment in gas drainage systems results in less downtime from gas emission problems, safer mining environments, and the opportunity to utilise more gas and reduce emissions.