Session: Methane from mines - legal conditions, monitoring, capture and disposal

Ograniczenia emisji metanu do atmosfery z powietrza wentylacyjnego

Limiting methane emissions to the atmosphere from the ventilation air

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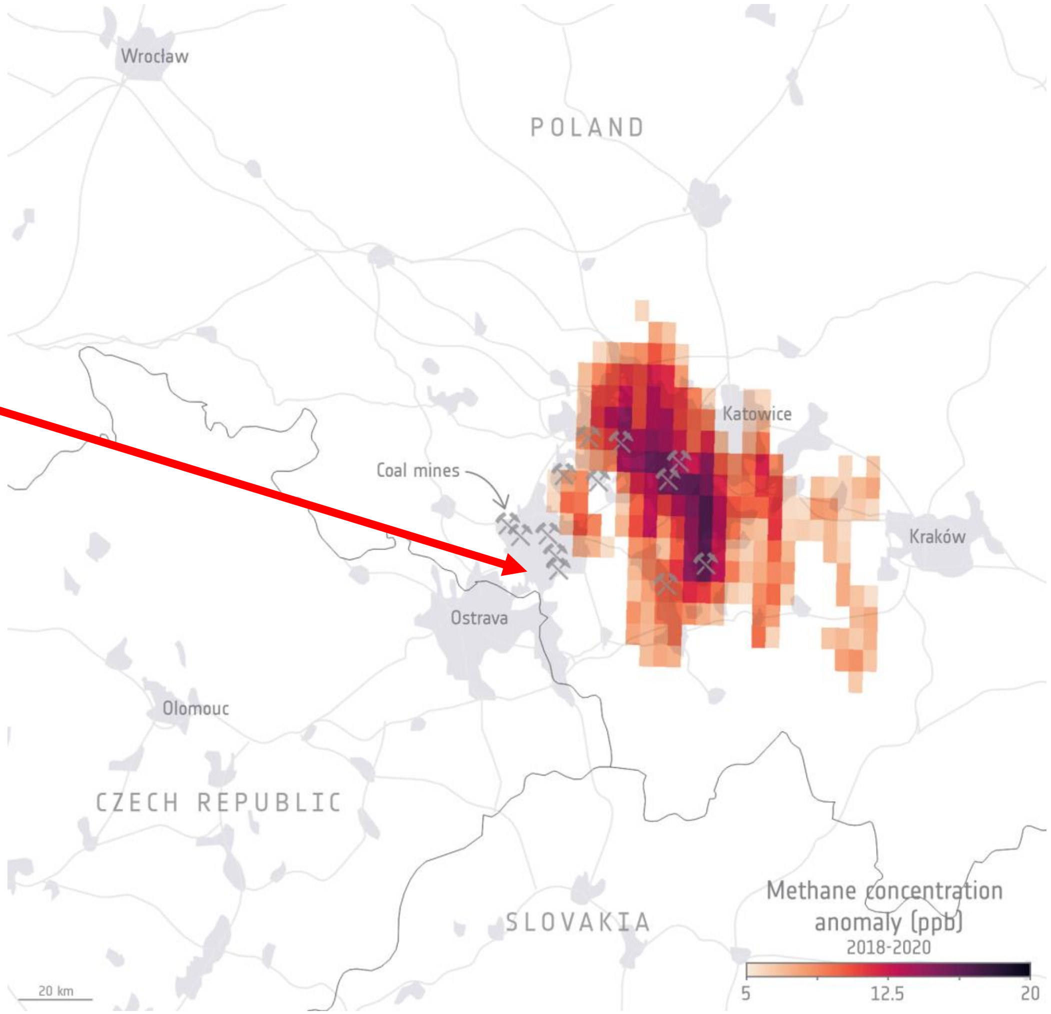
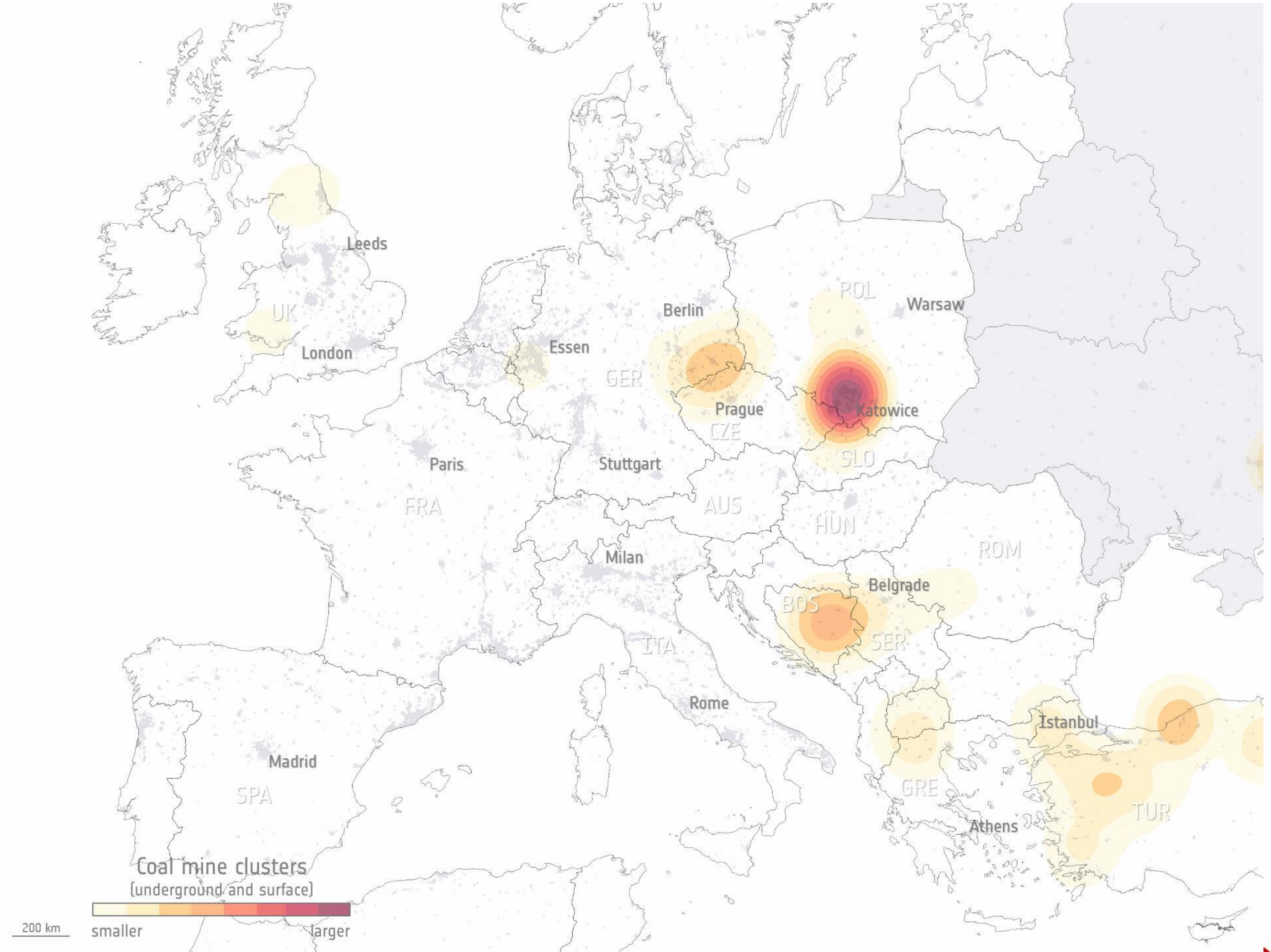
Problem: Methane in the air around mine areas



Methane concentrations over southern Poland

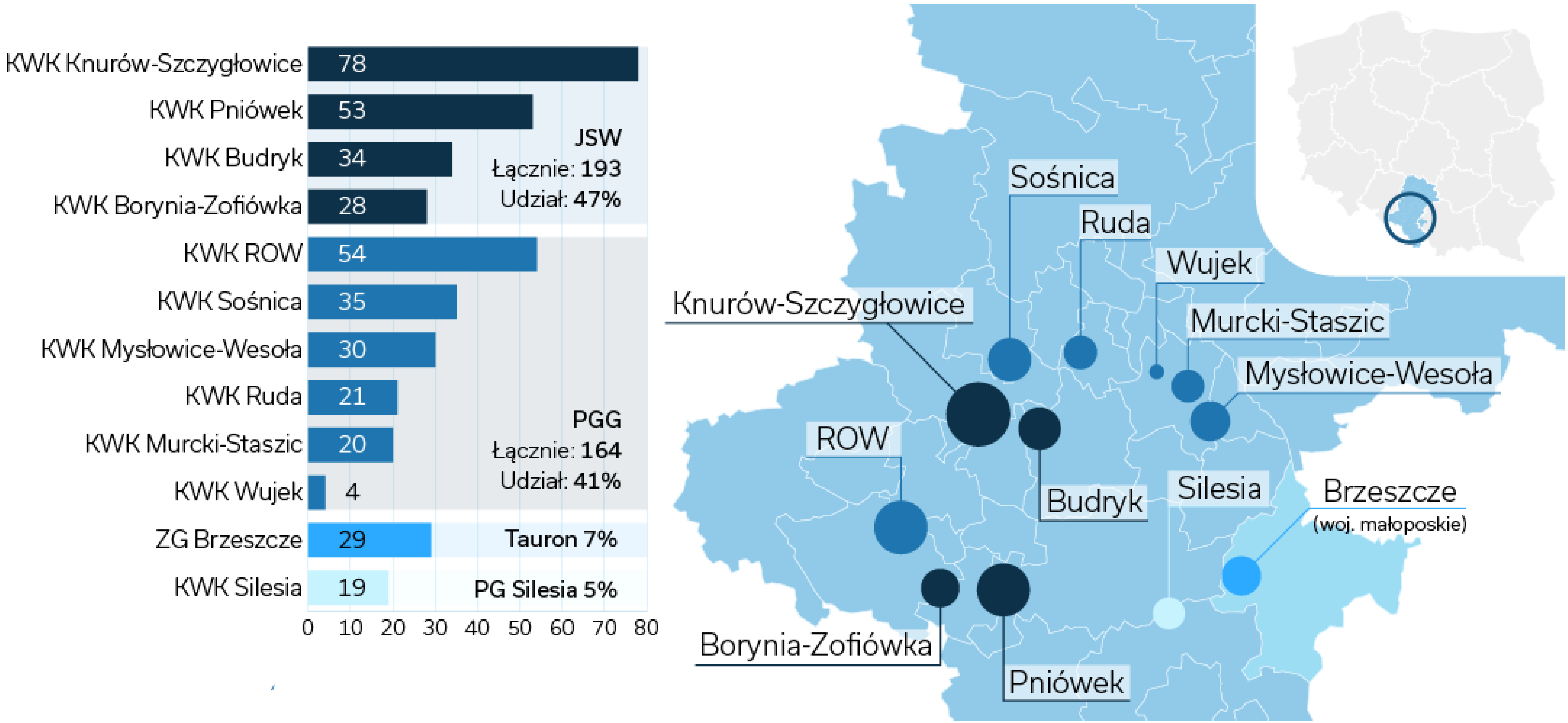
Source: ESA (contains modified Copernicus Sentinel data (2018-20), processed by University of Leicester

Methane concentrations over Europe



Source: ESA (contains modified Copernicus Sentinel data (2018-20), processed by University of Leicester

Methane emissions from hard coal mines in 2020 (thousands of Mg)

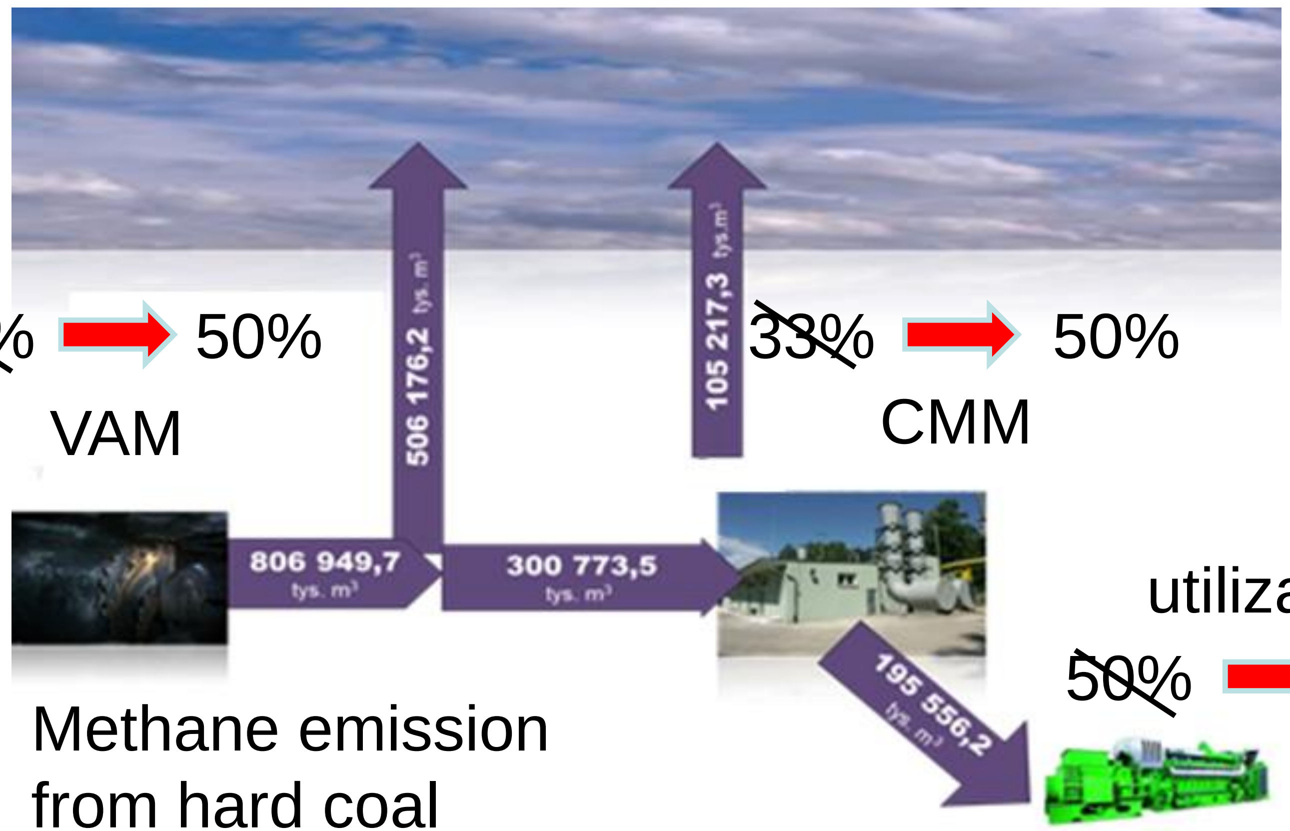


Źródło: Instrat | styczeń 2022

Methane emission from hard coal deposits

- The nature of methane emission to mine workings is complicated, as it depends on many geological and mining factors.
- The occurring pressure gradient causes the movement of the gas mass towards the excavation, where the pressure is lower than the pressure of the gas contained in the rock mass.
- The distribution of pressure changes deep into the rock mass is a transient and spatial process.

Structure of methane emissions from underground workings



~~66%~~ → 50%

VAM

~~33%~~ → 50%

CMM

utilization

~~50%~~ → 95%

Methane emission from hard coal beds

Underground sources of methane emissions

The amount of methane released to mine workings, in particular to the exploitation pit, depends on:

- methane emitted from the seam exploited from both mined and transported coal and exposed carbon solids of the mining face,
- methane emitted from the adjacent seams lying in the ceiling, floor, and within the range of operational impacts.

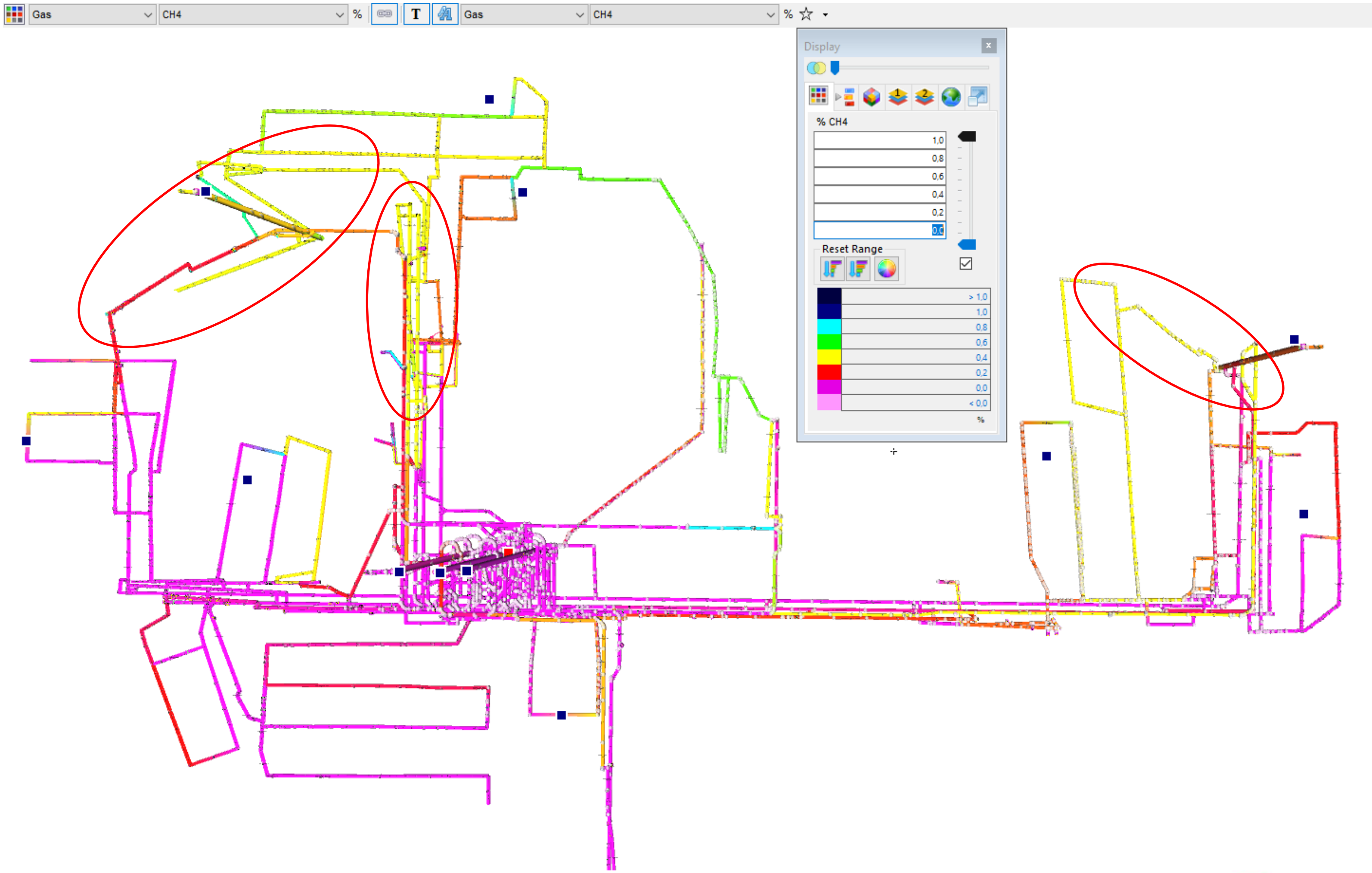
The extent and amount of rock relaxation depend both on the method of controlling the roof (filling, caving) and the nature of the rocks (rigid, plastic rocks).

Emission and flow of methane in the rock mass and mine workings

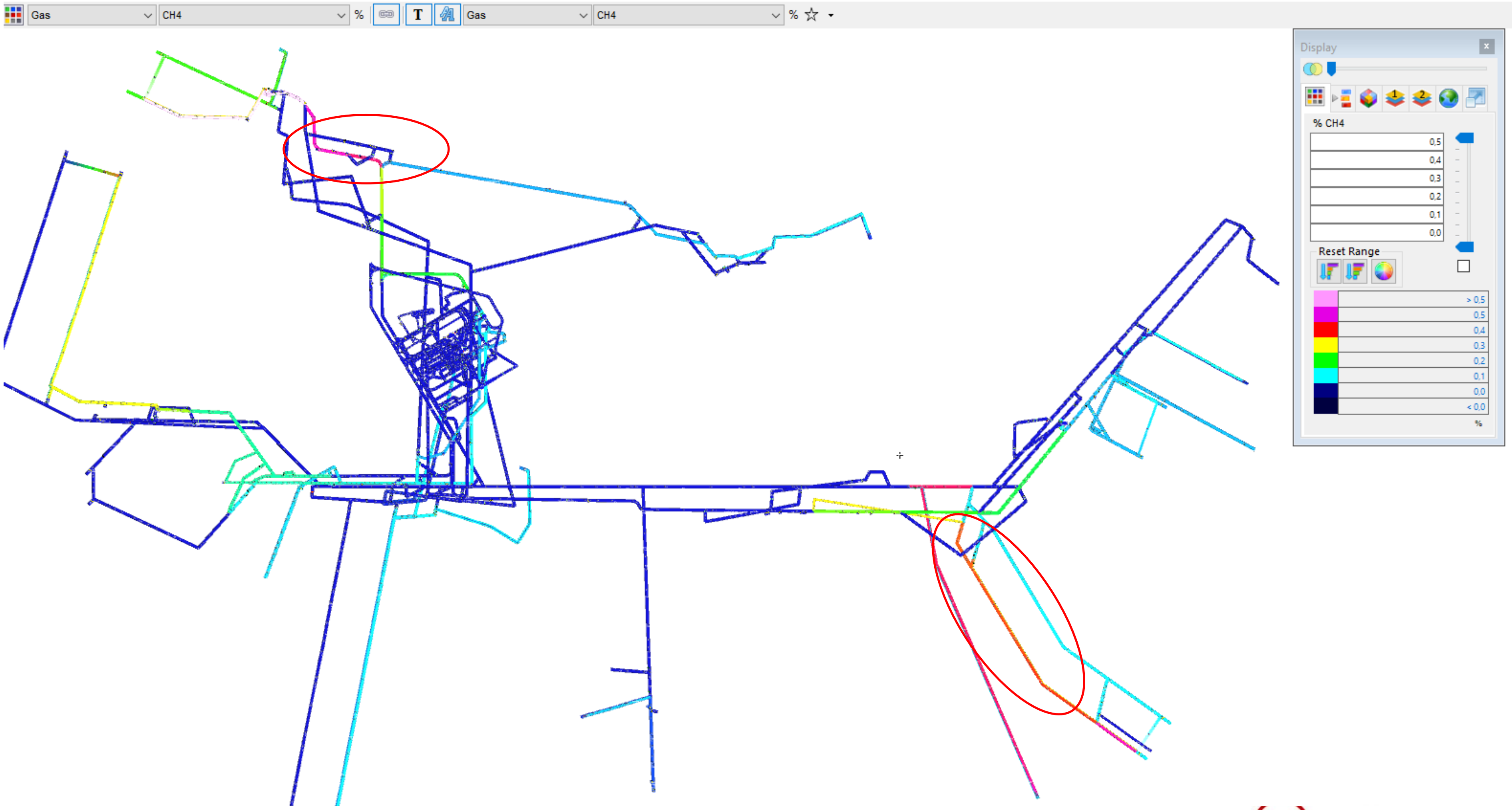
At a given point (place) of the rock mass/mining excavation, the three sources of depression (negative pressure) interact to a different extent each other:

- deposit pressure,
- the depression produced by main fans and natural depression,
- the depression produced by the methane drainage station.

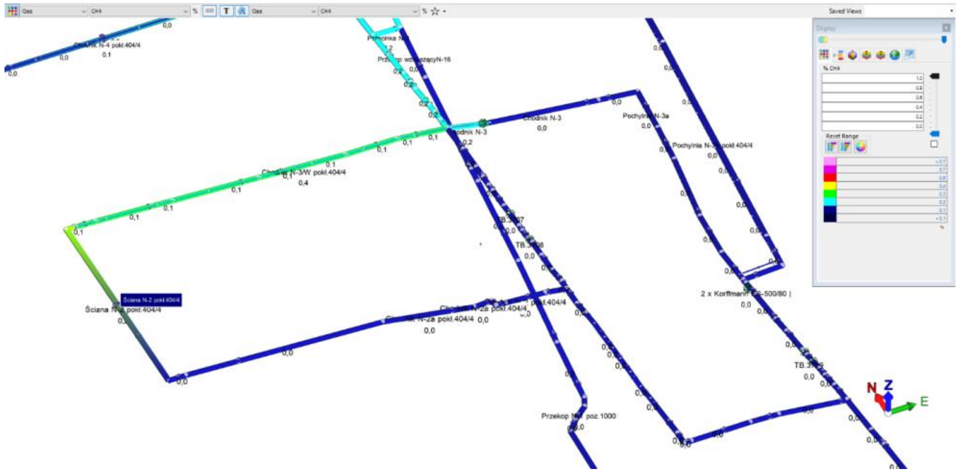
Methane emission to mining workings example 1

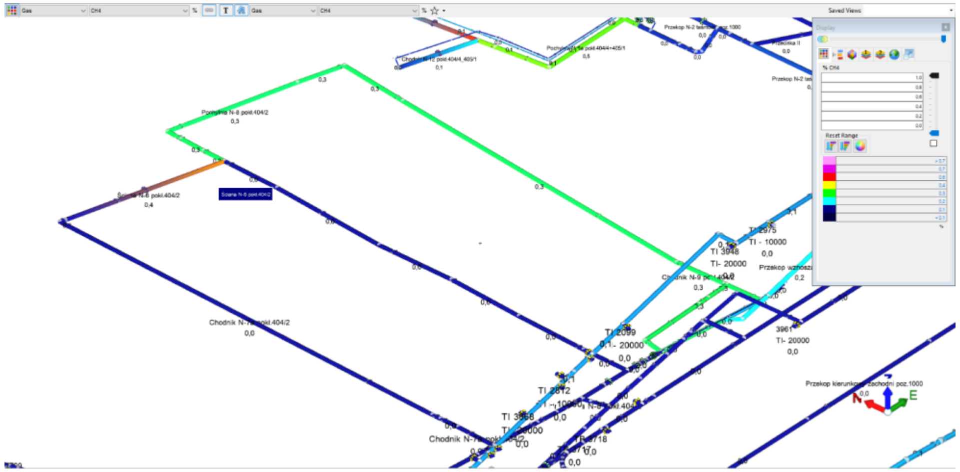


Methane emission to mining workings example 2

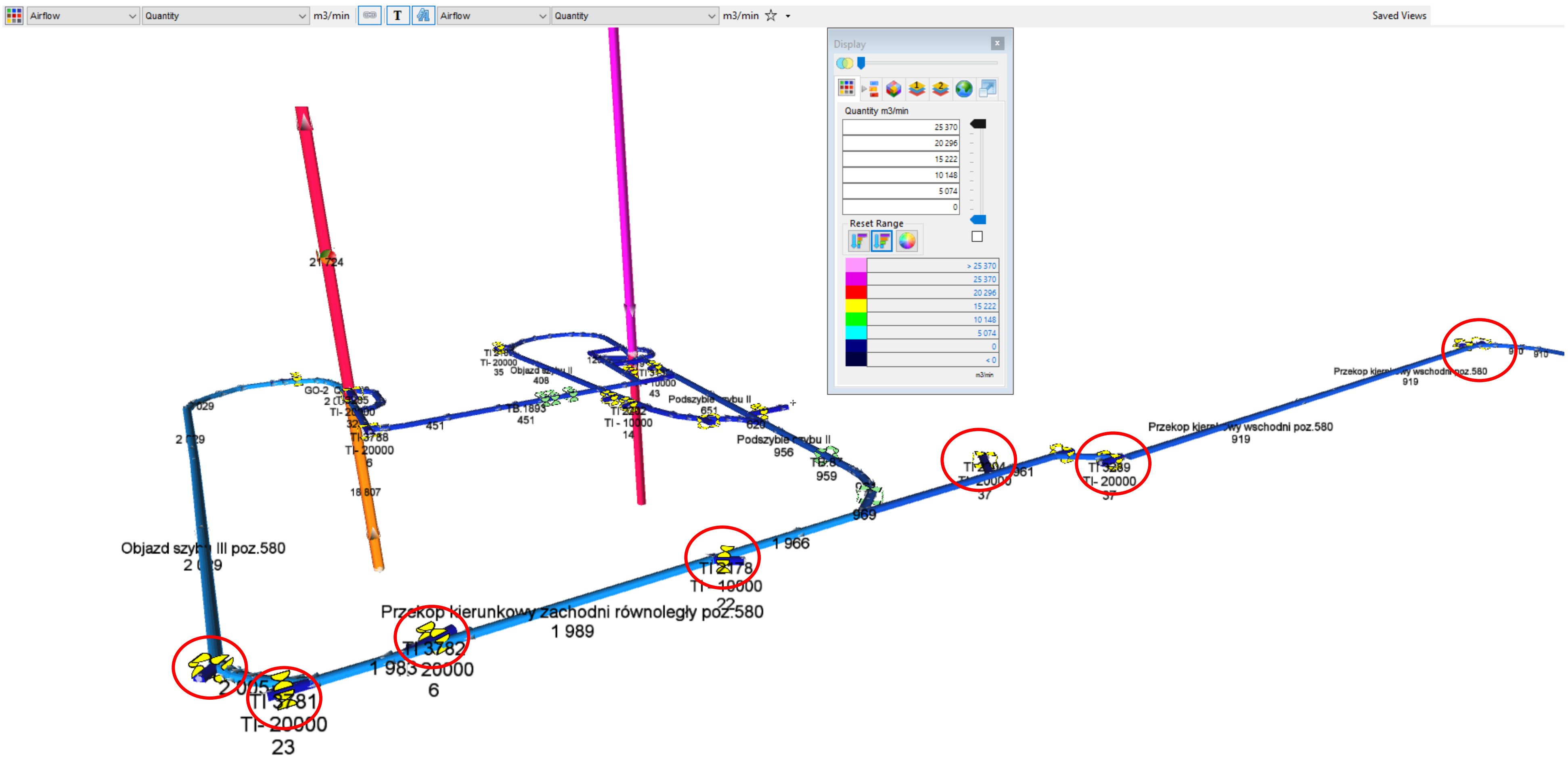


The concentration of methane in mining excavations





Methane emission to mine workings through insulating dams

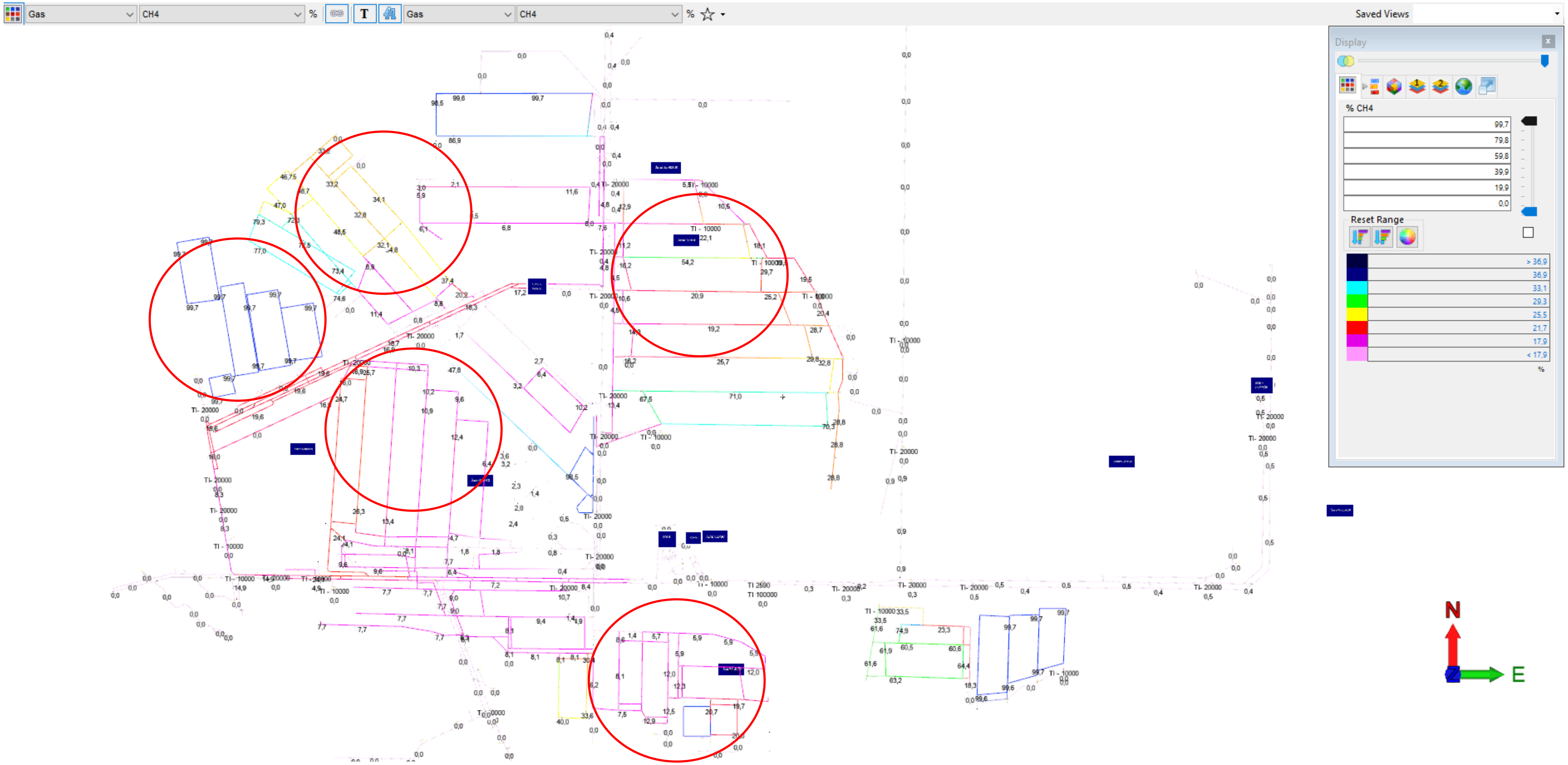


Methane emission to exploited goaf areas

Under the influence of the exploitation of coal seams, methane is **released**, which will be **released into workings** and **collected in the selected area of goafs**.

The methane hazard in the exploitation of coal seams is related to the distribution of methane concentration in the collapse zone, which depends on the **type of roof rocks** (their compressive strength) and the wall **ventilation system**.

Methane emission to selected goaf areas



Factors influencing methane emission to mine workings

- Method of ventilation of mining works and methane drainage from the rock mass,
- Method of operation/mining technique,
- Rapid drops in atmospheric pressure,
- Operation of the system of auxiliary devices to actively combat the methane hazard,
- Maneuvering dams separating air currents,
- Poor strength of roof rocks/embankments,
- The occurrence of rock mass tremors,
- The action of the so-called "piston effect" of the shaft cage.

The unevenness of methane emissions to mine workings and from/to selected spaces

» due to **discontinuity of the relaxation processes and a roof collapse** in goafs related to:

– disturbances in the thickness and deposition of the seam as well as mechanical properties of coal,

– the filtration and mechanical properties of individual rock layers above and below the exploited seam,

– the discontinuous operation of the shearer caused by technological breaks and failures in the operation process,

– uneven wall progress due to the displacement of the longwall casing.

» due to **the heterogeneity of the methane-bearing capacity distribution** along and in the field of the longwall as well as the adjacent and subordinate seams,

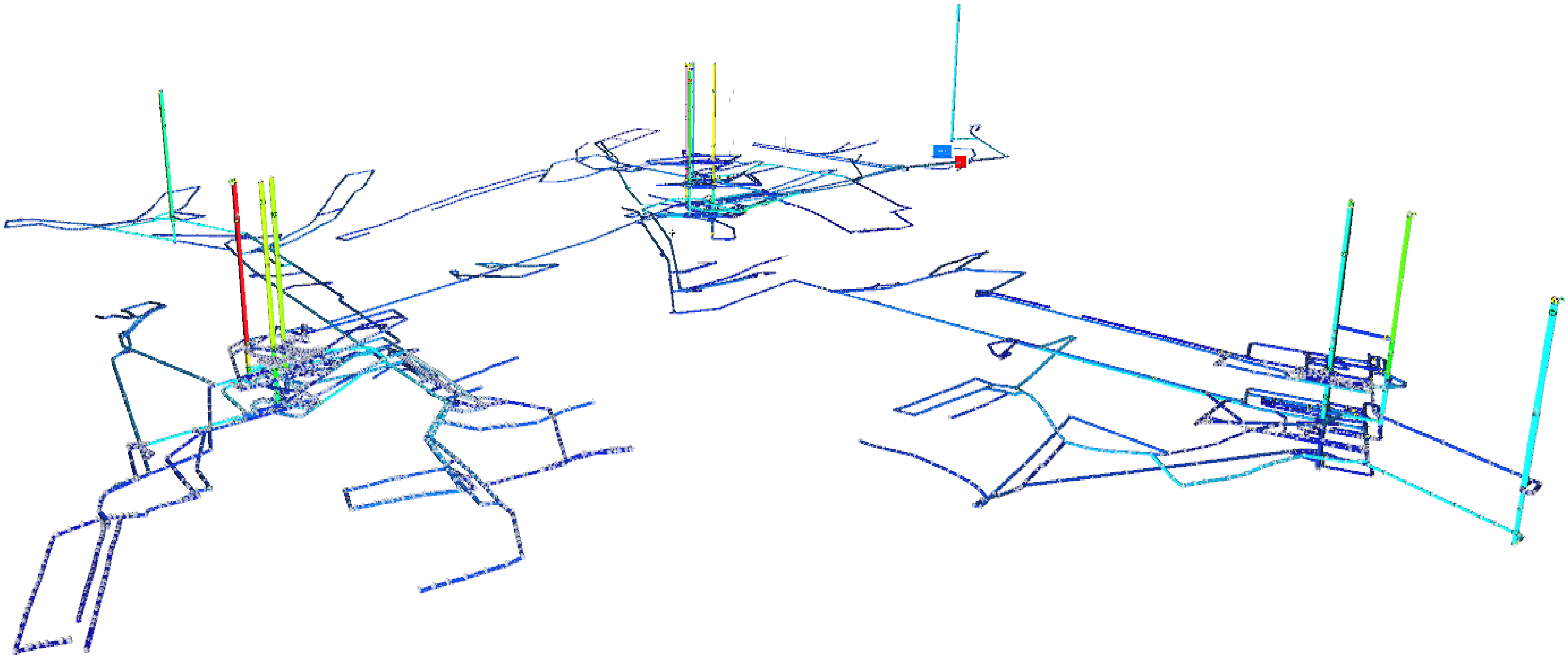
» due to **airflow changes**,

» due to **changes in barometric pressure.**

Influence of ventilation on methane emission

- directly from coal (e.g., a wall or face), with direct, **independent of the ventilation conditions**, emission of methane to the mixing zone in the mining excavation,
- from the collapse zone, or the so-called old goafs, with an indirect methane emission to the mixing zone located in the mining excavation, through the filtration zone, and **depending on the ventilation conditions**,
- from mined coal, an outflow of methane from the excavated material.

Mine ventilation networks of mining excavations presented on 3D models in a 1: 1 scale

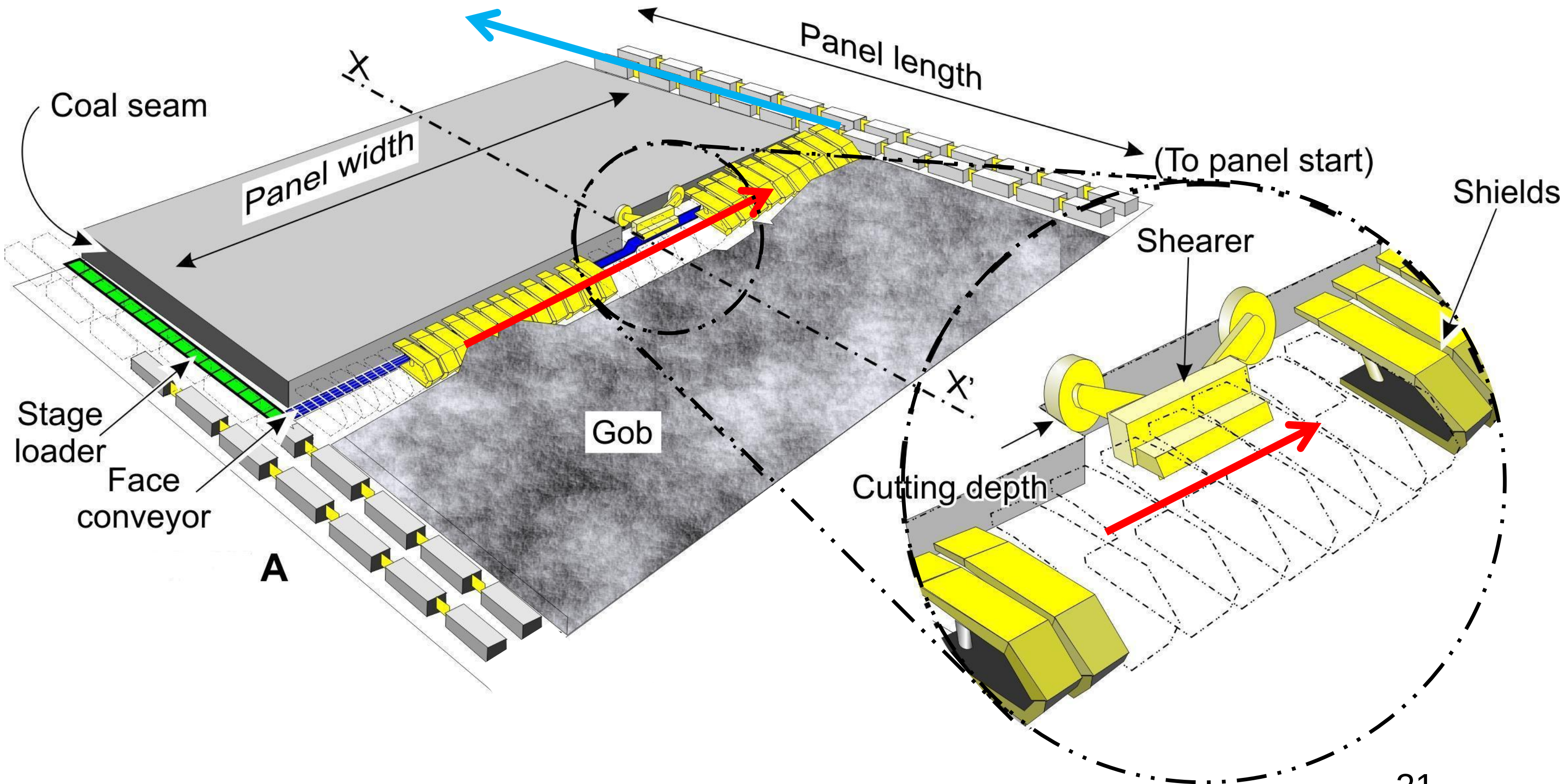


The structure of mining excavations with Z coordinates (depth)

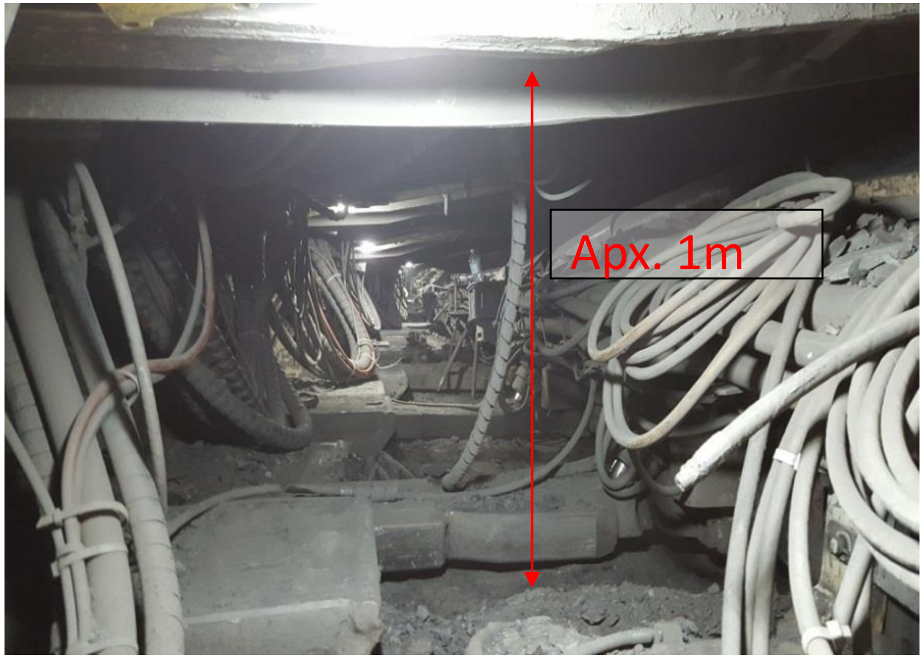
Influence of the air stream and the method of ventilation of mining works excavations

- The extent of the influence of ventilation into the relaxation zone of the infarction depends on **the permeability of goafs**.
- The value of this permeability coefficient of goaf depends on the **type of roof rocks** forming the goafs. Ceilings with different delamination resistance create different conditions for the air flowing through them.
- As the delamination resistance increases, the permeability coefficient of the goaf increases, and the volume flow of air flowing through the caving zone increases as well. Observations show that migration covers the direct infarction zone.

Method of operation/mining technique - the so-called shearer wall



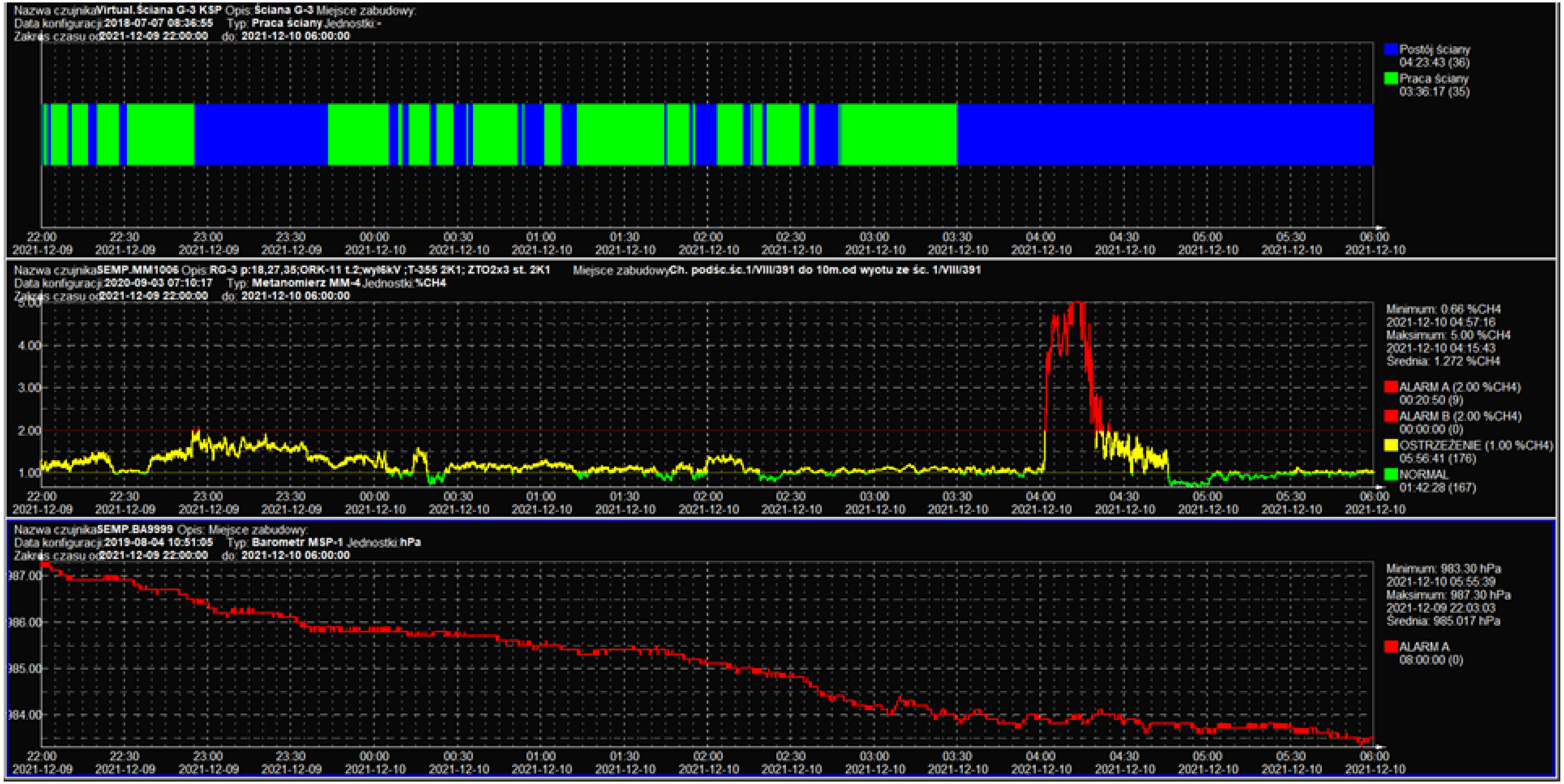
Method of operation/mining technique - the so-called plow wall



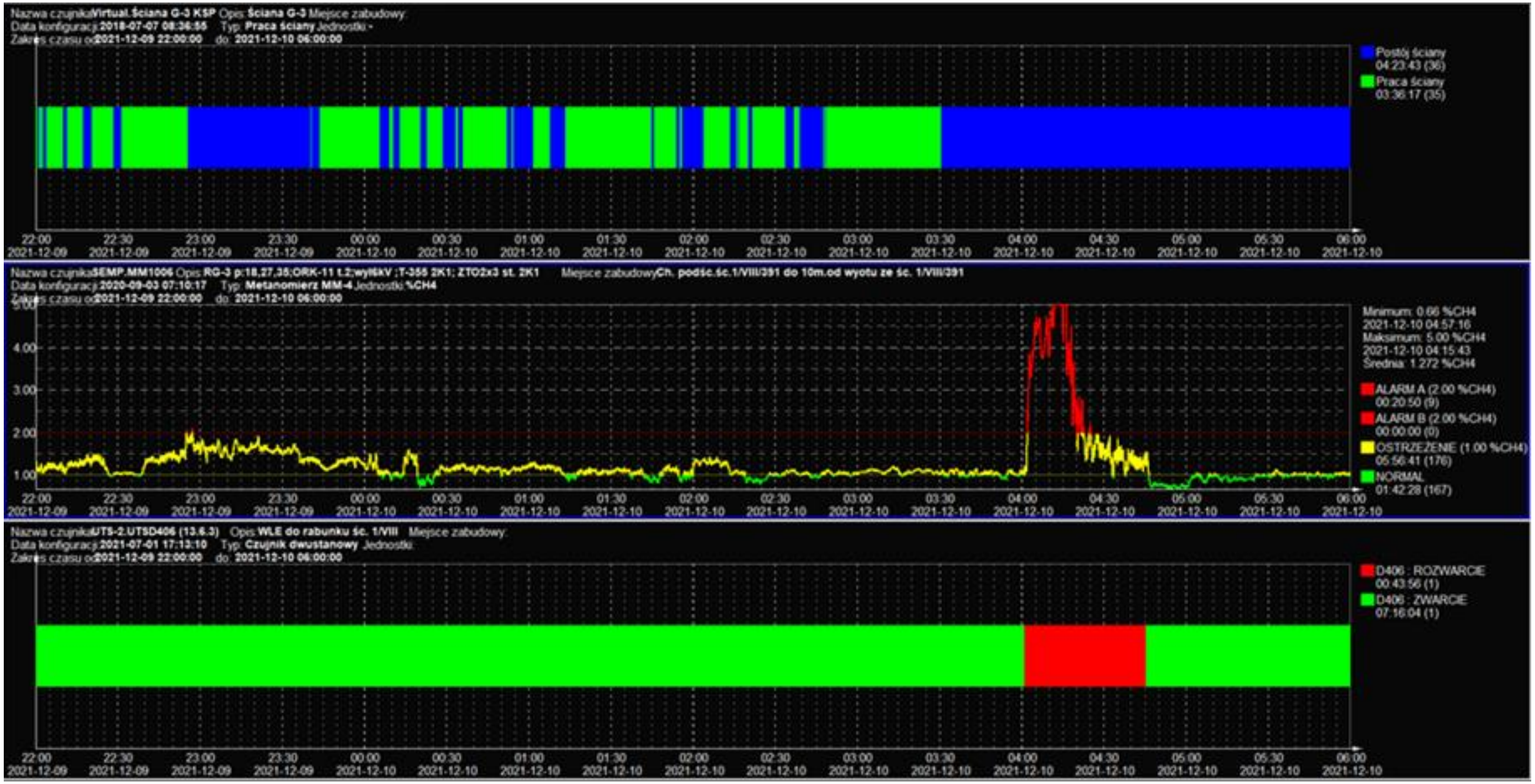
The influence of barometric pressure

- The amount of methane that filters from the body of coal to the exposed sidewalls is proportional to the difference in the squares of pressures.
- In the rock mass intact by exploitation, a slight change in air pressure in the excavation caused by the regulation of ventilation parameters or a change in barometric pressure does not significantly affect the amount of methane flowing into the excavation.
- In the exploited rock mass, a slight change in atmospheric pressure, caused by a change in ventilation parameters (e.g., dam regulation), can significantly change both the direction of methane flow in the rock mass and its amount. This is especially notable when large goafs are nearby or in the case of contact with more distant goafs.

The influence of barometric pressure

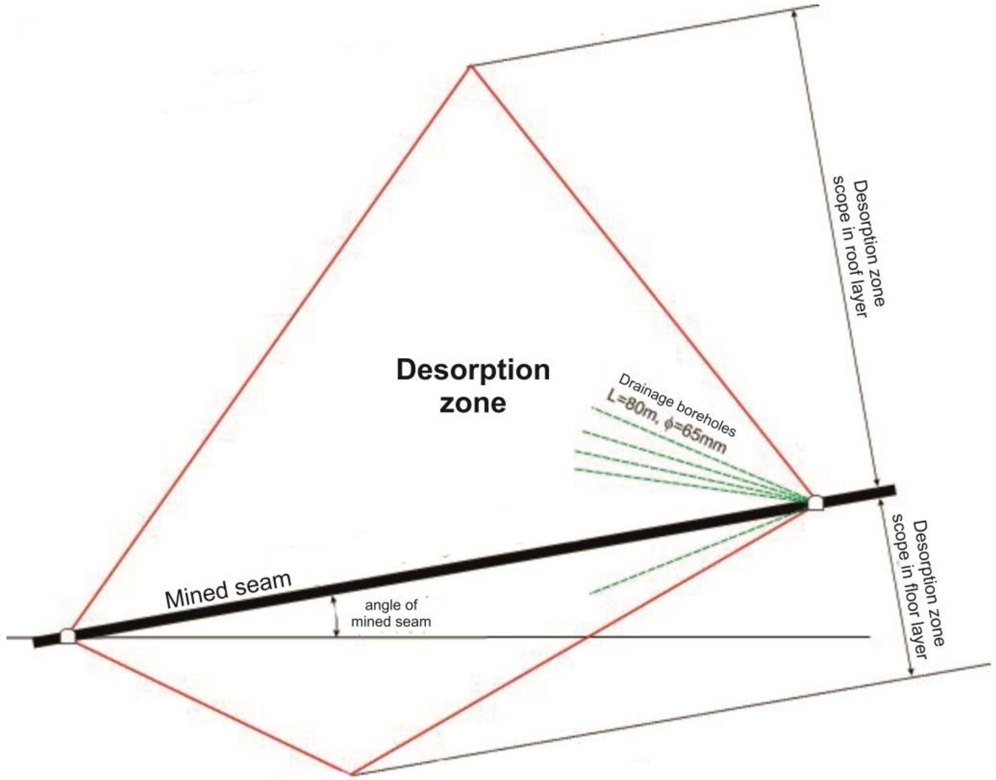


Maneuvering of dams separating air currents



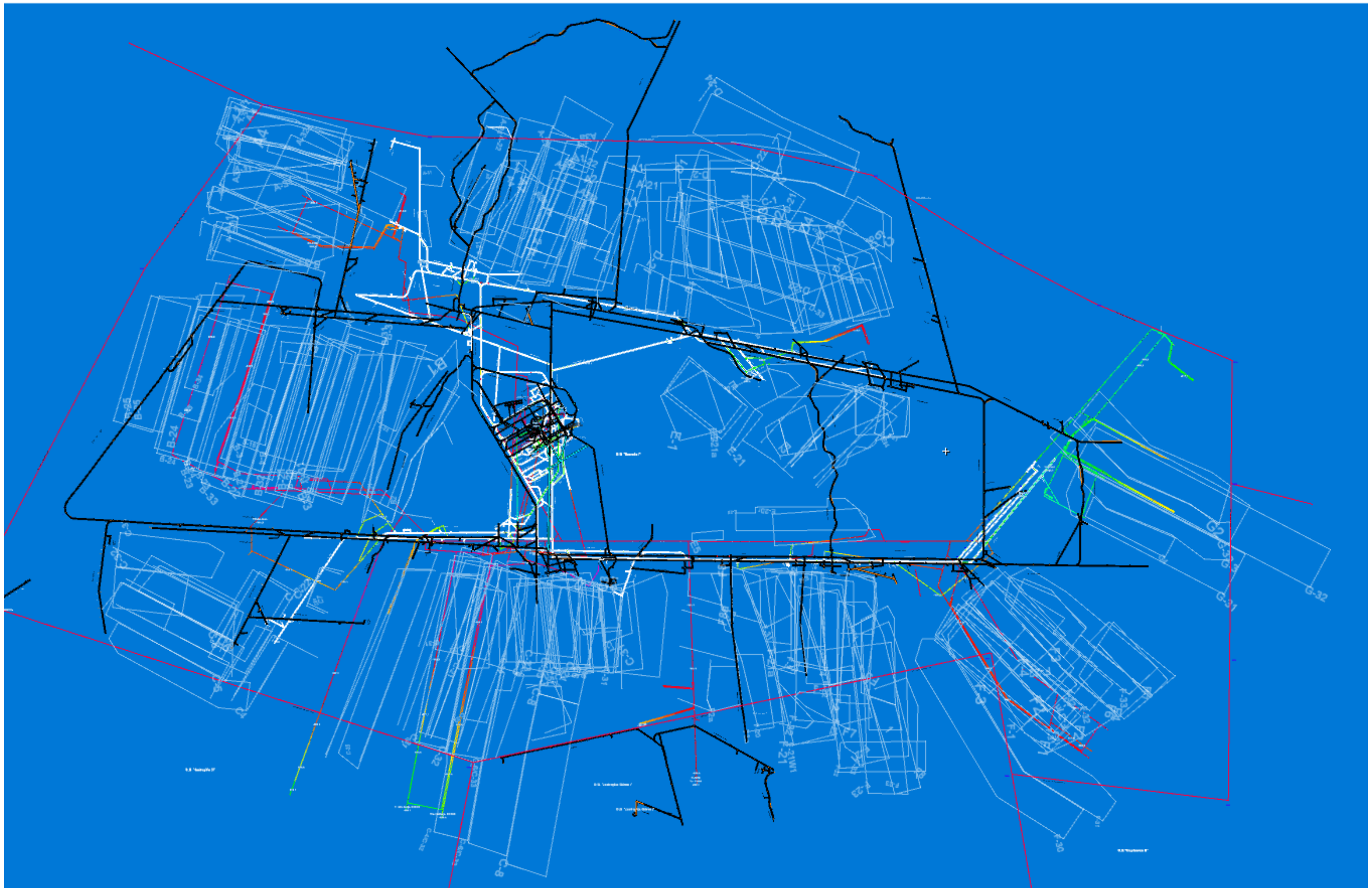
The impact of mining exploitation

The degree of degassing of the deposit depends on the length of the relaxation period (progress, volume of production). The amount of gas flowing into the excavation depends on the flow resistance (on the type of roof rocks).

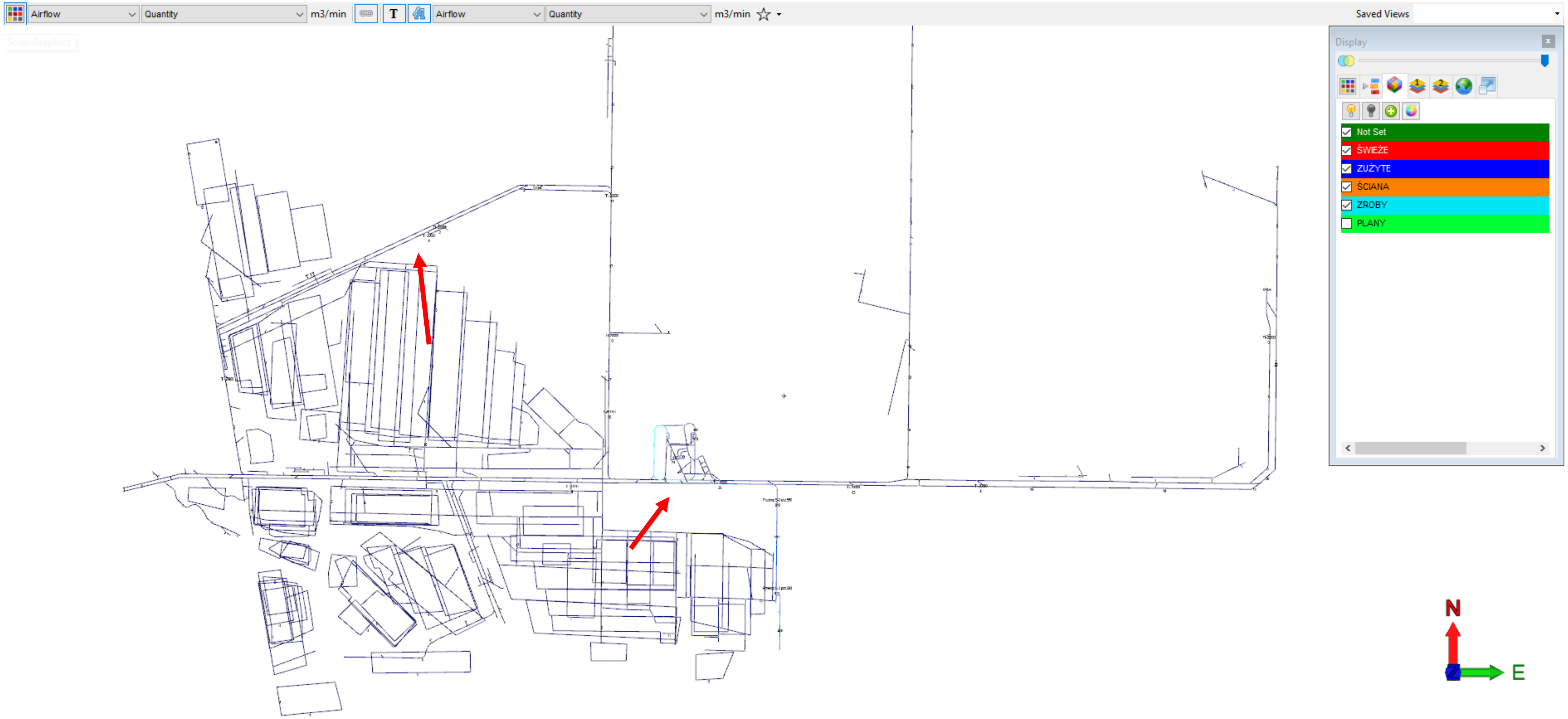


Methane desorption zone during longwall exploitation

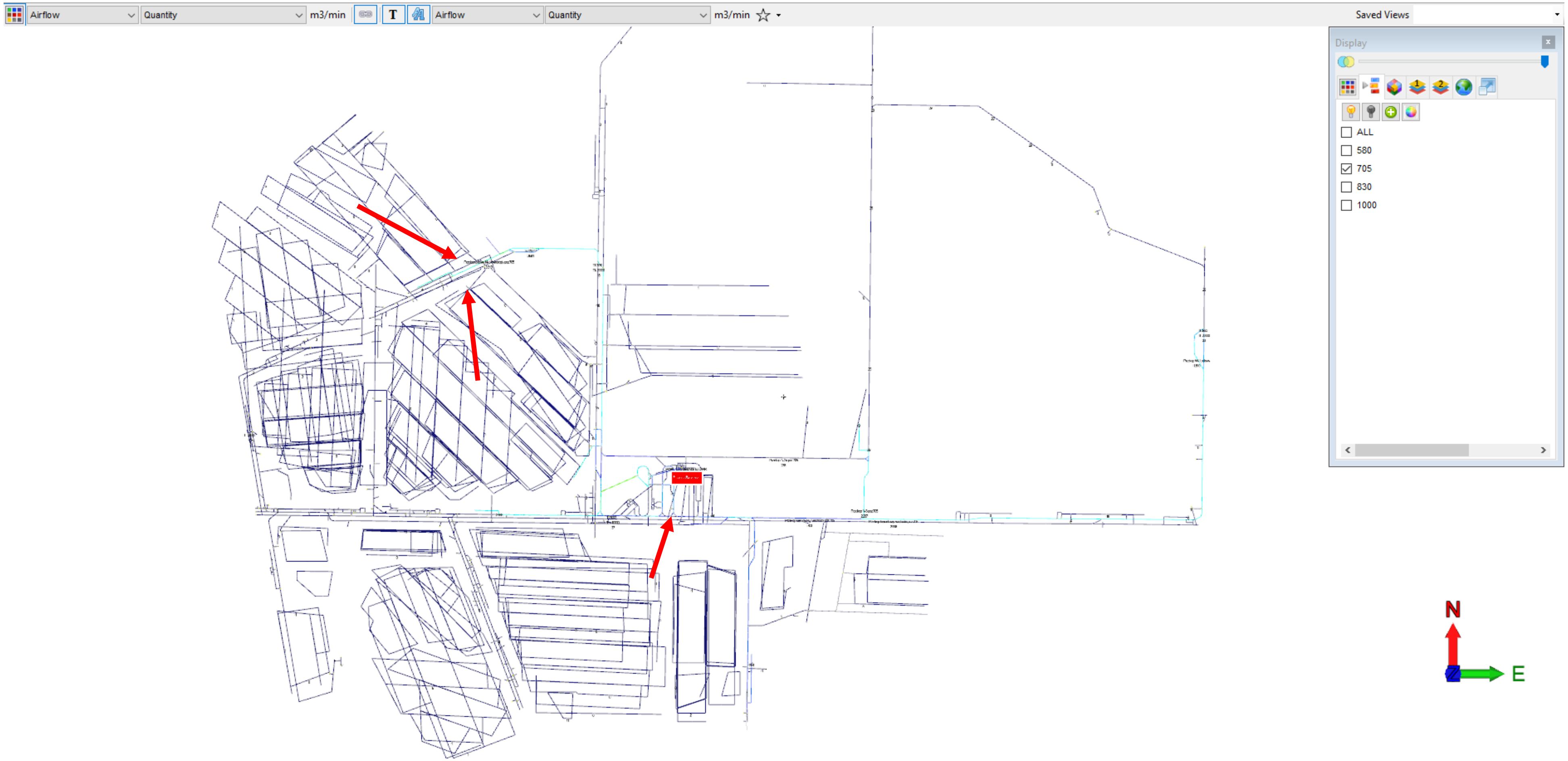
Basic excavations and contours of exploitation



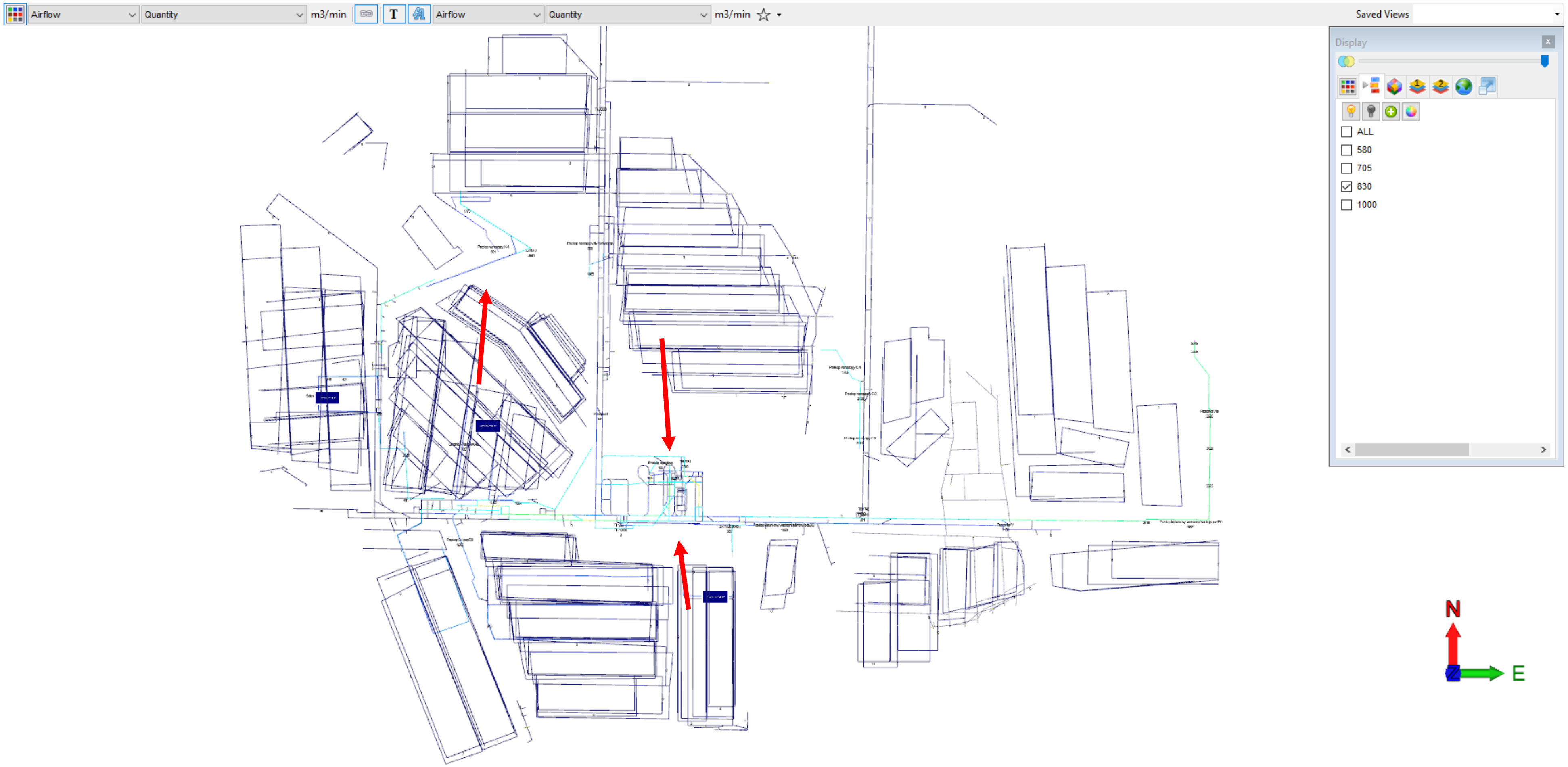
Selected spaces / goaf 580



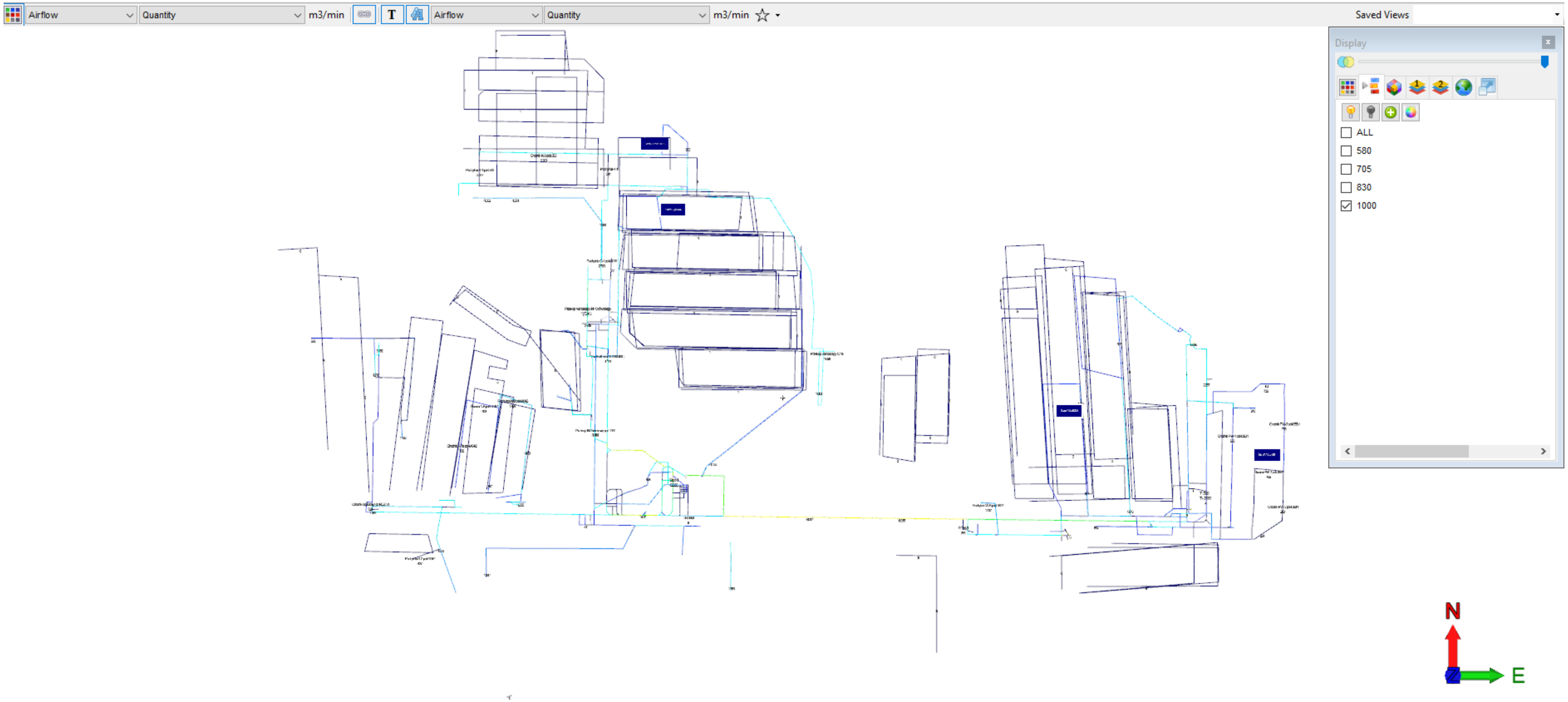
Selected spaces / goaf 705



Selected spaces / goaf 830



Selected spaces / goaf 1000



Conclusion

- Bearing in mind the concentration of extraction and also the reduction of methane emissions to the atmosphere, it should be aimed to **optimize the structure of the ventilation network in mining workings.**
- We should also strive for **proper air management in the ventilation network of underground workings.**

Conclusion

- The extensive and complicated structure of the ventilation network contributes to the emission of methane to mine workings. It results from the maintenance of the workings at higher levels while the operation is carried out at lower levels. **Maintaining such a state means that the effectiveness of methane drainage in mining works will not be high, as the pressure distribution makes it possible to migrate methane to higher levels.**
- Efforts should be made to increase the methane drainage efficiency of mining works to a value of at least 50%. It will allow the reduction of methane emissions to workings and then to the atmosphere.

Conclusion

- Recently, the share of methane intake from the areas of operation has decreased. Simultaneously, the share of methane emissions from drilled faces and from behind insulating dams has increased.
- **Therefore, it is necessary to re-inventory and verify the intakes to the methane drainage network in terms of the effectiveness of methane capture in underground workings.**

Conclusion

To reduce methane emissions to the atmosphere, the following should be taken:

» the inventory of insulation dams and attempt to connect insulation dams with methane concentration exceeding 30% to the methane drainage network;

» for the other insulating dams where the methane concentration between 20 and 30% was observed, connection to an alternative methane drainage network with a reduced concentration should be considered;

» the inventory of the sealing of insulating dams where the concentration of methane is less than 20%. Sealing of insulating dams can be performed by drilling holes along the contour and filling them with adhesives. If it is necessary to construct a new insulating dam, it should be with the slits filled with the binder (applies to all individual masonry dams). If there are gaps and cracks in the workings around dams, it is necessary to consider applying shotcrete on a certain section to increase the insulation around the dam.

Thank you for your attention