Sources of methane emission in underground coal mines.
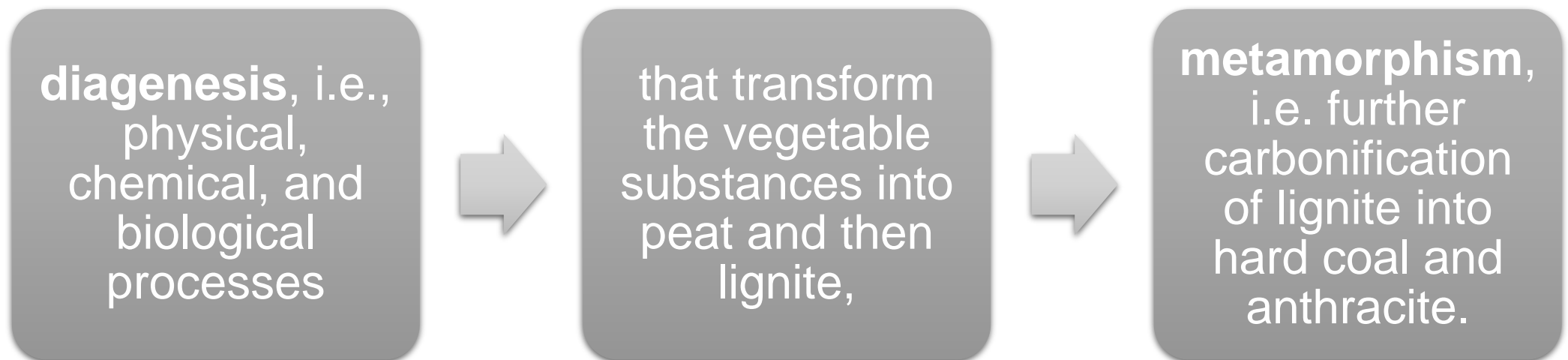
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15.10.2021

Methane and its relations with coal

CH_4 accumulated in coalbeds originates through the carbonification of vegetable substances. The following stages of this process can be identified :

diagenesis, i.e., physical, chemical, and biological processes

that transform the vegetable substances into peat and then lignite,

metamorphism, i.e. further carbonification of lignite into hard coal and anthracite.
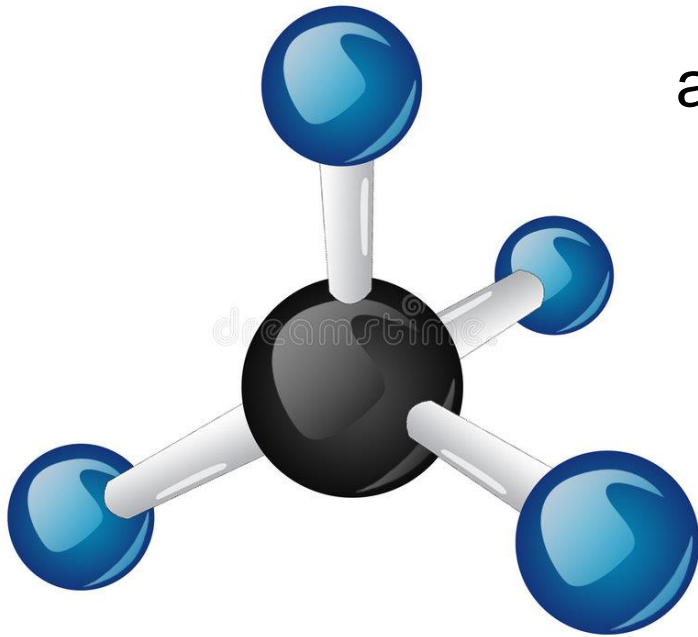
The diverse composition and structure of rocks have an impact on the variability of methane occurrence in hard coal deposits.

Methane and its relations with coal

Methane occurs in the rock-mass in an adsorbed state and as a free gas in pores, cracks and cavities

Gas sorption depends mainly on the nature and type of coal, and their amounts in both states on temperature and pressure.
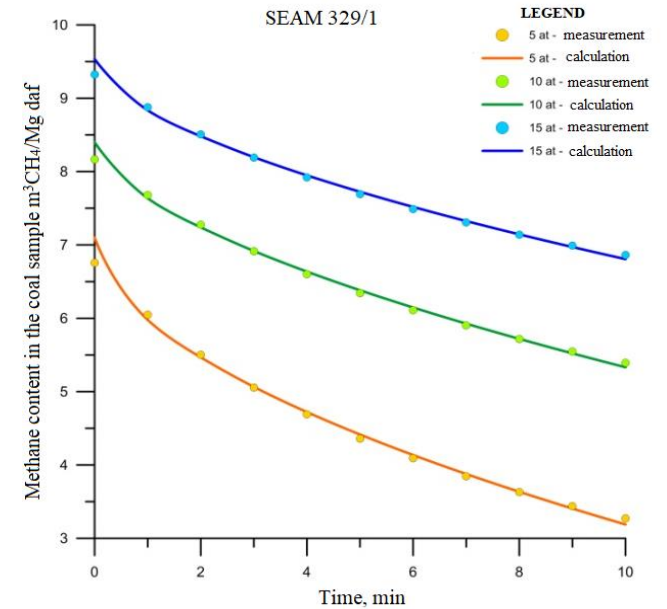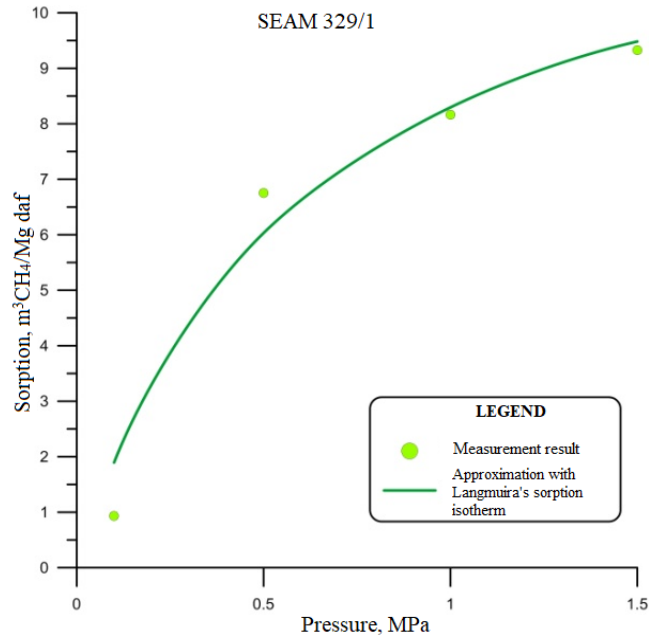
Methane and its relations with coal

The methane migration feasibility in the deposits depends on its saturation with methane and its permeability.

It means that variations in the composition and structure of rock mass influence the level of CH_4 emissions.
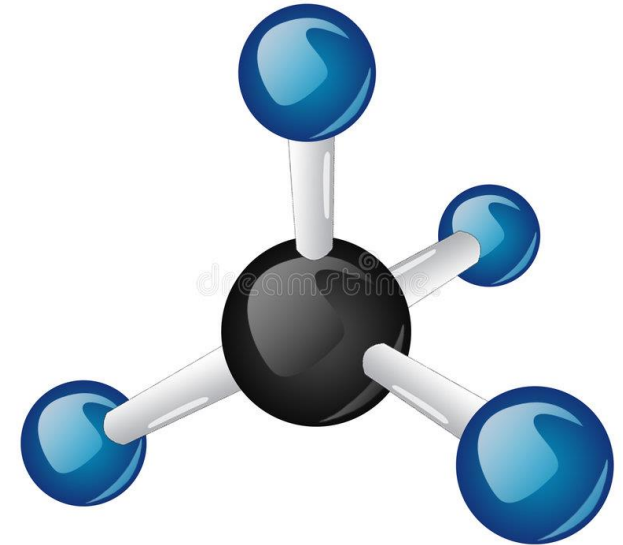
Saturation of coal deposits with methane

The knowledge of the sorption process makes it possible to determine what amount of gas and in what state it is in the deposit

Desorption is a reverse process, which allows to determine what amounts of gas desorb from coal over time.
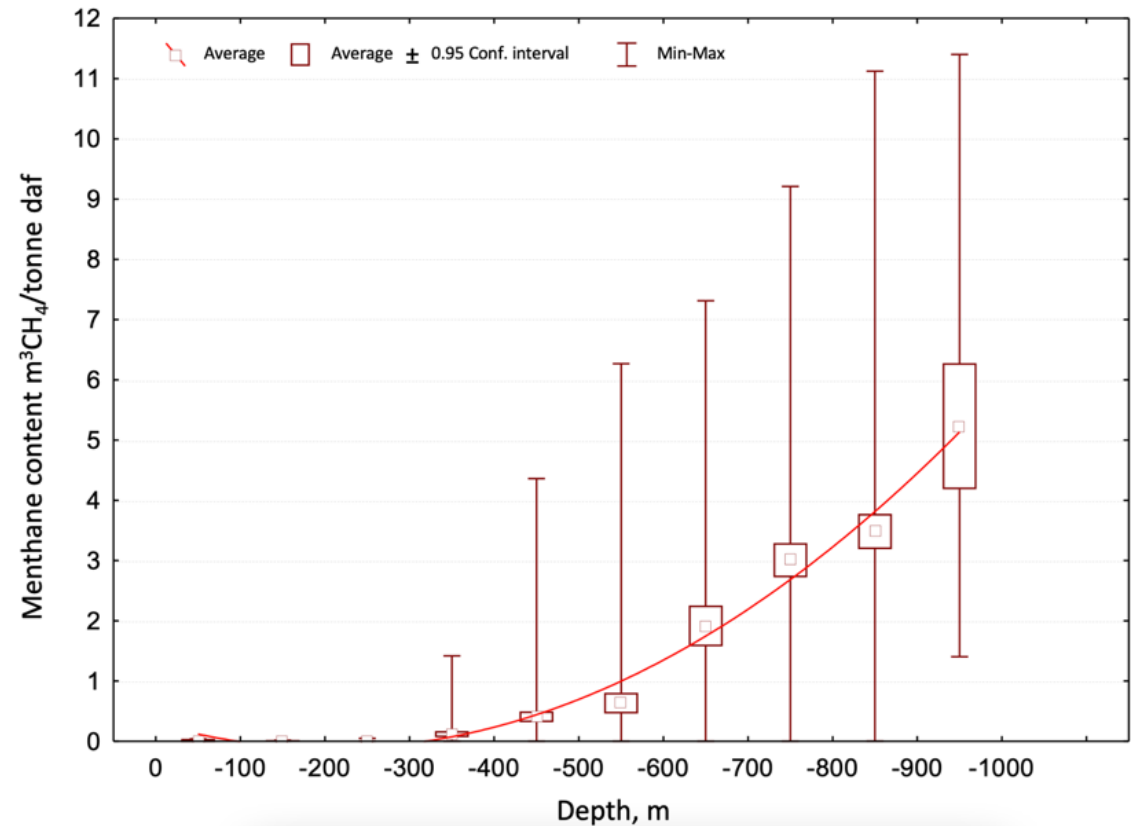
Saturation of coal deposits with methane

The main form of methane occurrence in the coal deposits of the Upper Silesian Coal Basin is methane absorbed in coal seams.
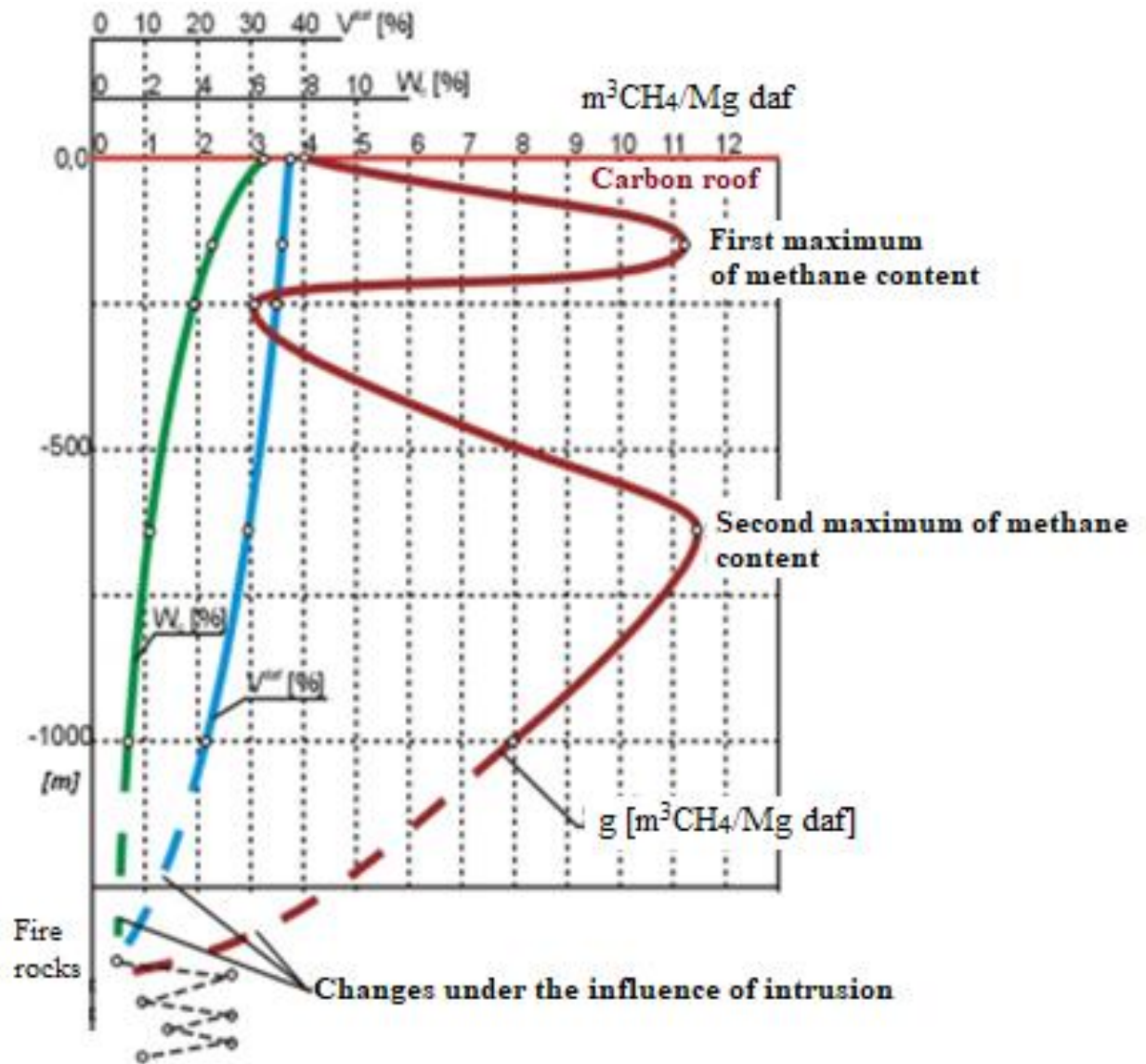
Coal seam gas (mine gas) contains almost 100% pure methane

In the mines of Upper Silesia, the most significant saturation of the deposit with methane occurs in the depth range of 950 - 1050 m.
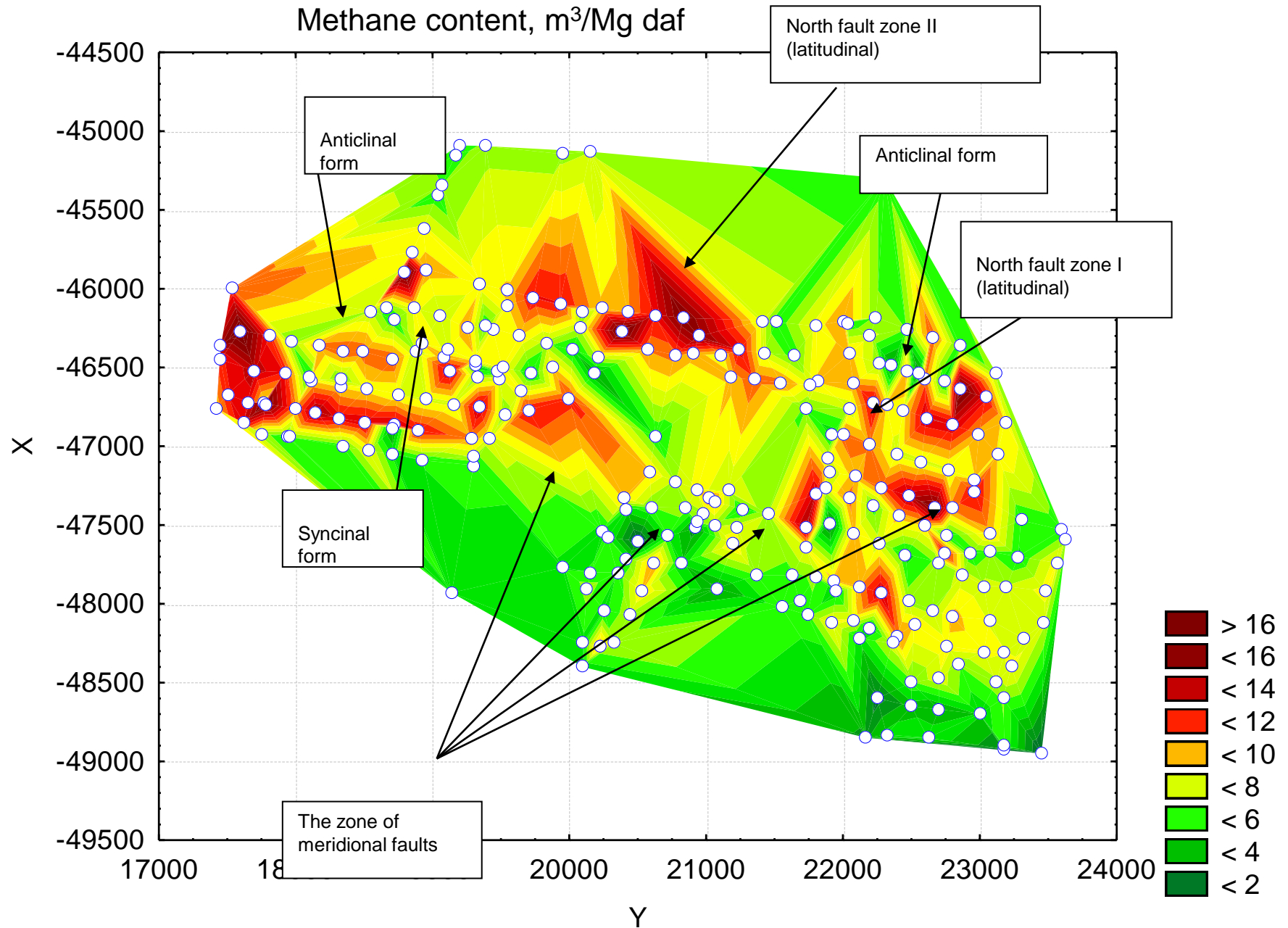
Saturation of coal deposits with methane

Averaged changes in methane content as well as moisture and volatile matter content in ROW coal seams (following Tarnowski, 1971)
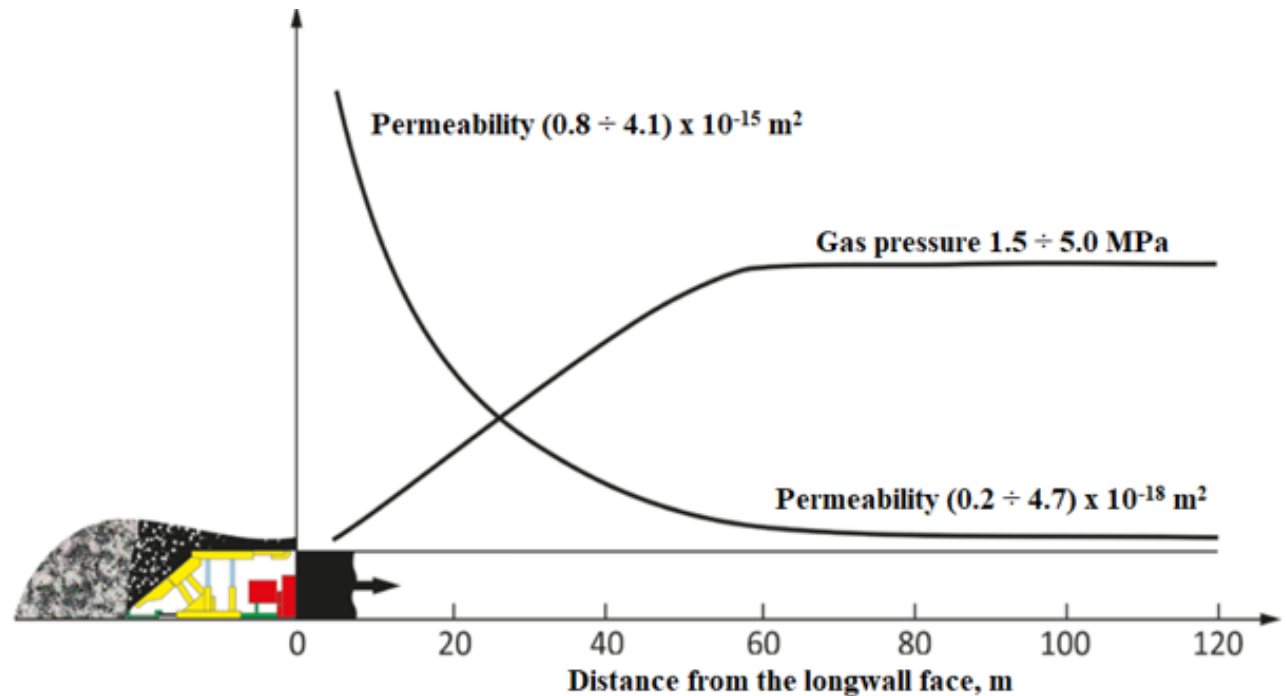
Wafer chart of methane content in coal deposit

Methane content, m³/Mg daf

Methane versus rock-mass permeability

» The rate of methane emission from the rock mass will depend on its permeability, and to a large extent, may vary depending on the analyzed mining region.

» The process of methane filtration from the coalbed to the excavation takes place as a result of rock depressurizing during the mining operation. This lowers the pressure of free gas, which contributes to its desorption.

Permeability $(0.8 \div 4.1) \times 10^{-15}$ m^2

Gas pressure $1.5 \div 5.0$ MPa

Permeability $(0.2 \div 4.7) \times 10^{-18}$ m^2

Distance from the longwall face, m

Fundamental forms of methane inflow to mining excavations

Desorption and gradual filtration outflow of CH_4 under the pressure gradient caused by mining.

Methane outflow from fractures and cracks in the seam as a result of mining operations.

Low methane emission $\Rightarrow$ Ventilation system

Methods of reducing high methane emission in to the excavation

High methane emission → Ventilation system

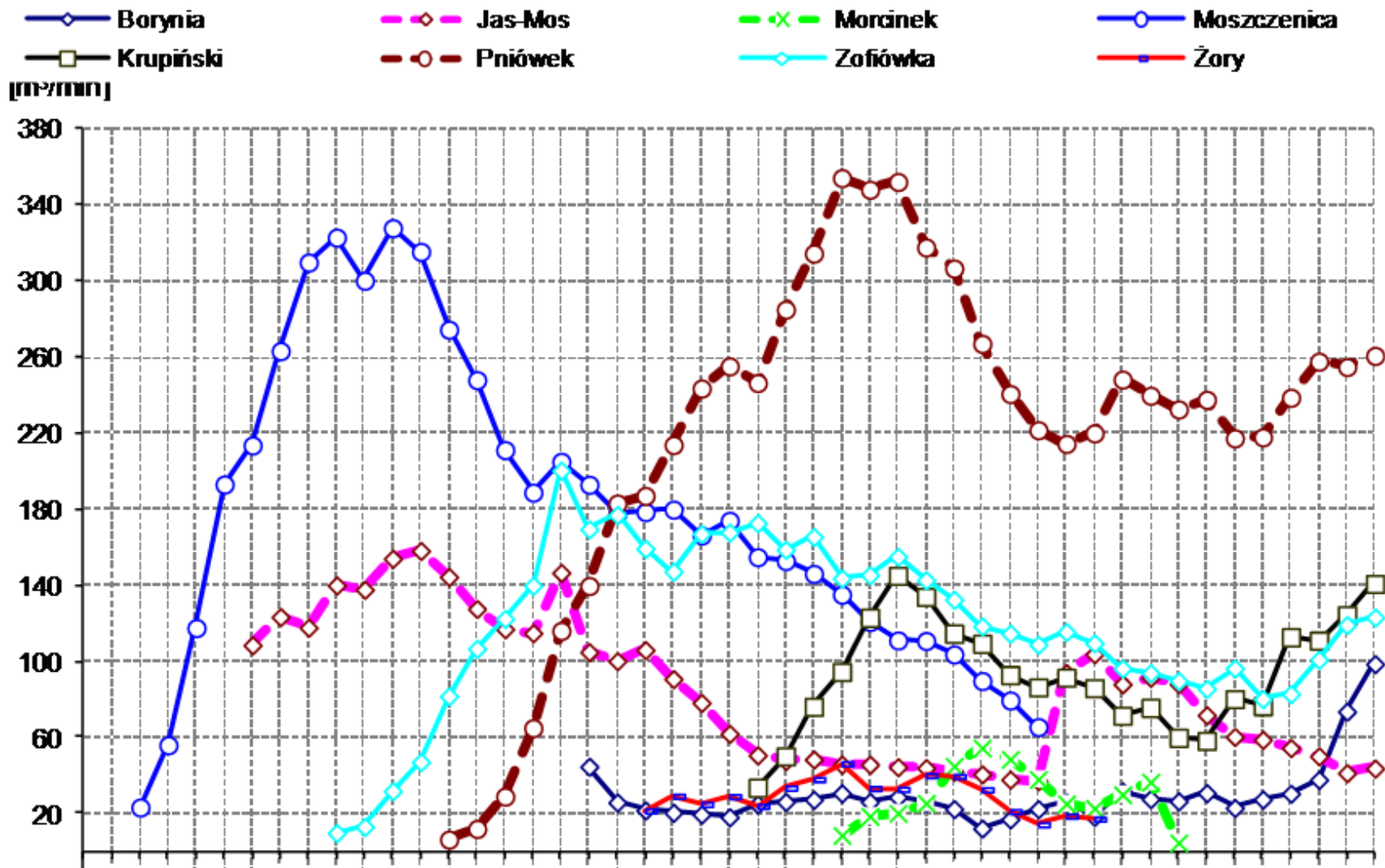High methane emission → Drainage system

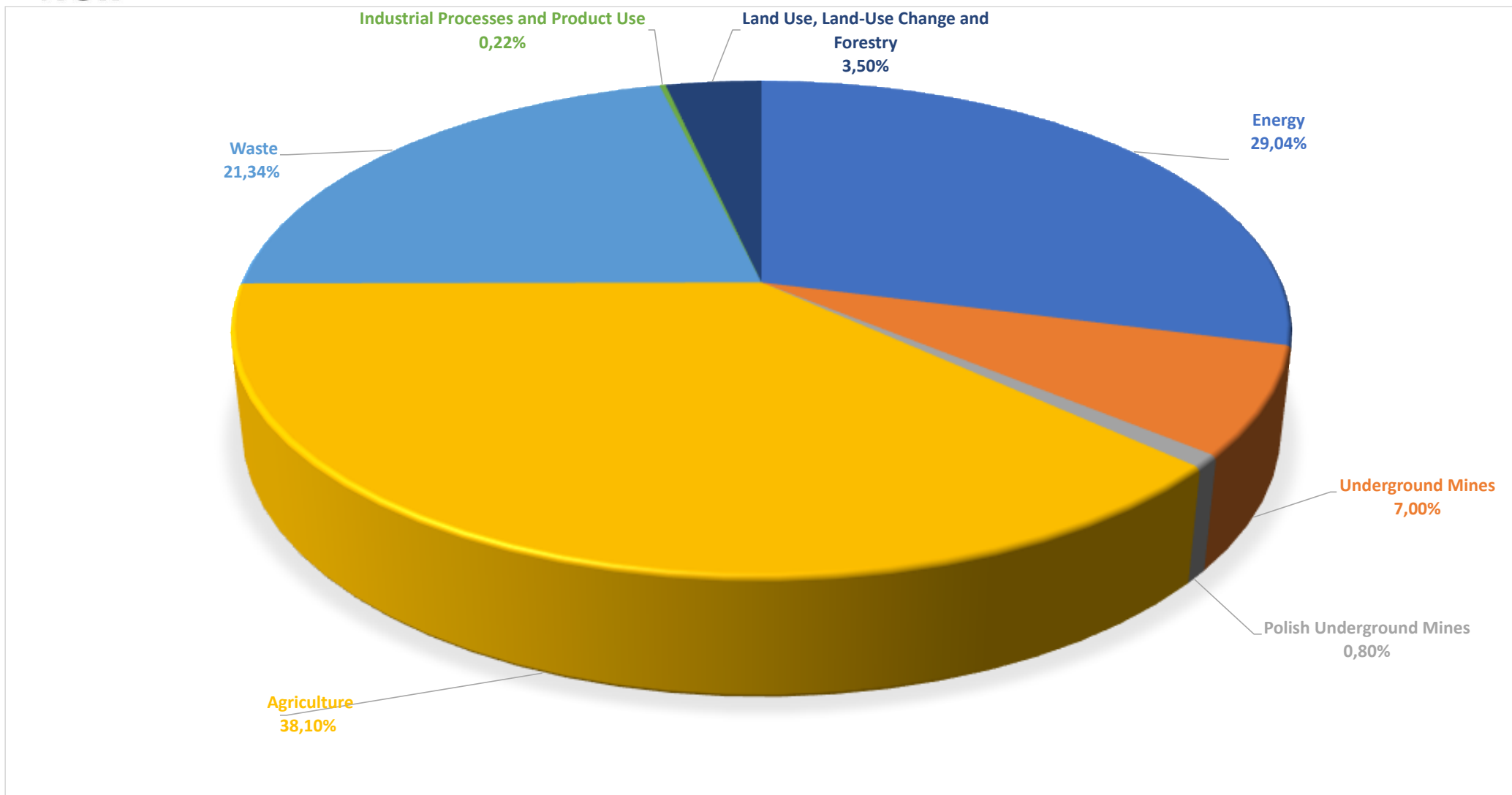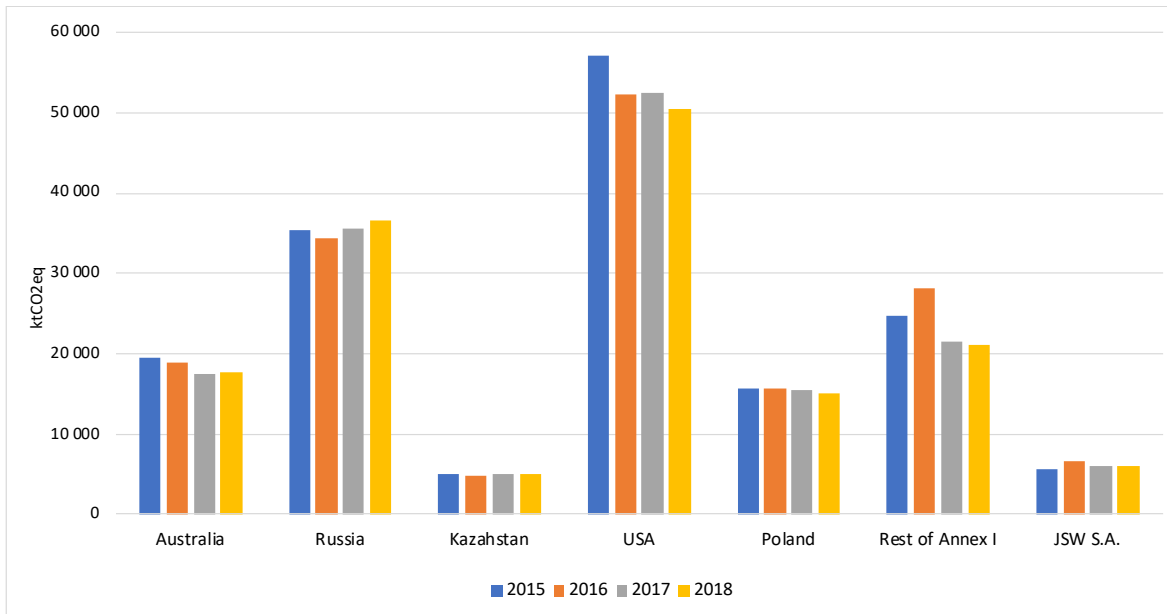The percentage of methane released to the atmosphere - 63%
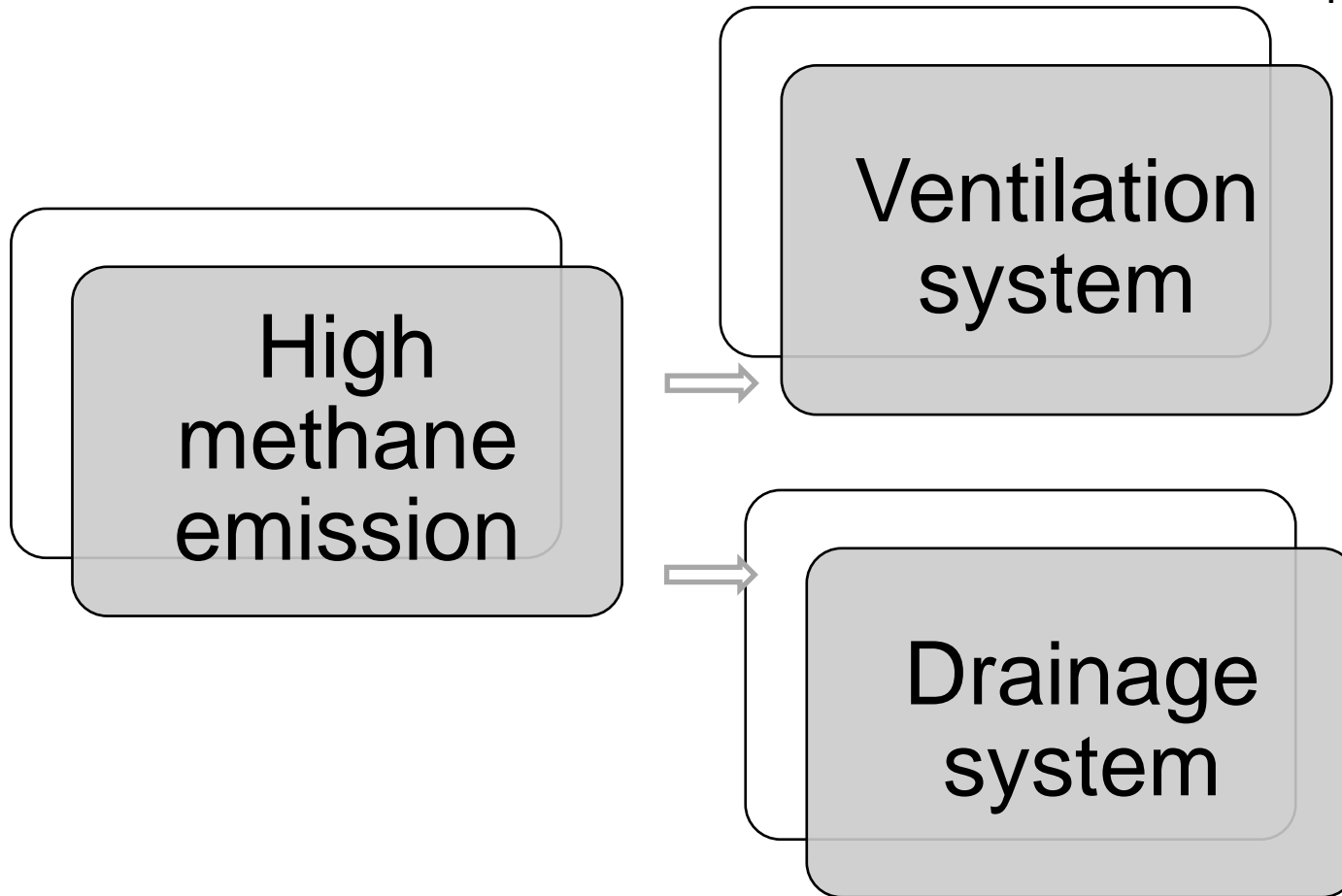
Drainage efficiency - 37%

Changes of total methane emission in coal mines during the time of their existence

Emission of methane by sector in Annex I countries

- Industrial Processes and Product Use 0,22%
- Land Use, Land-Use Change and Forestry 3,50%
- Energy 29,04%
- Waste 21,34%
- Underground Mines 7,00%
- Polish Underground Mines 0,80%
- Agriculture 38,10%

JSW S.A. mines are responsible for around **0.31 %** of total methane emissions

The global underground mining sector emits an average of **6.0 Mt** of methane, of which Polish mines release **0.62 Mt**.

Underground mining in Poland emits 15,55 $MtCO_2eq$ - **10,28%** of emission from this sector.

JSW S.A. mines are responsible for around **4%** of total methane emissions

Note that these figures do not include emissions from China and India.

Underground mining and exploration

↓

Emission of methane as an inseparable part of mining activities

Thank you