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Optimization of the ventilation network in an underground mine

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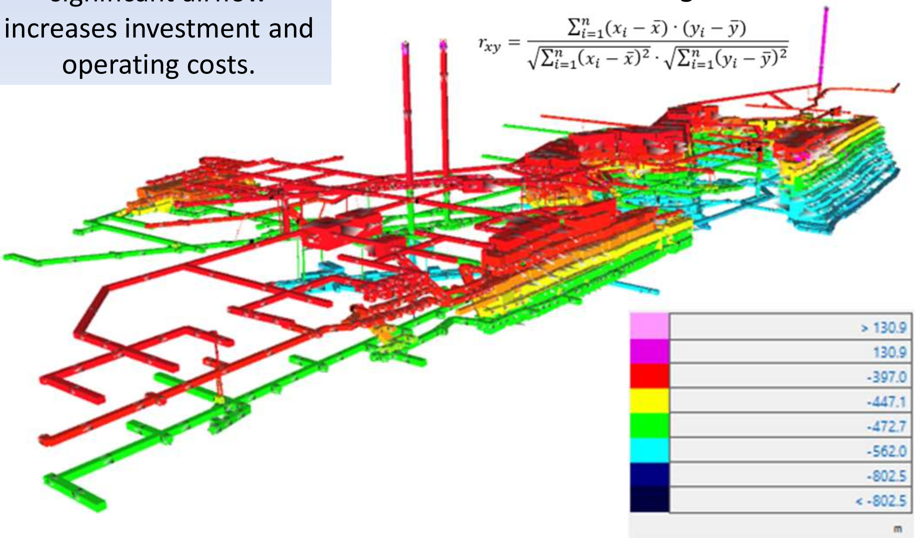
Creating a reliable forecast of ventilation of underground mine workings and simulation of air flow and forecasting of events such as underground fire or gas and rock outbursts requires formulation of a mathematical model and preparation of relevant data by measurement. There are physical and mathematical descriptions of the phenomena, but adapting them to computer simulation requires the creation of a uniform model of the ventilation network with appropriate properties, which requires the formulation of a mathematical model and, in turn, conducting measurements in the workings of an underground mine. In the final stage, there is a need to apply the search for appropriate numerical methods and evaluate the convergence of these methods with the exact solution.

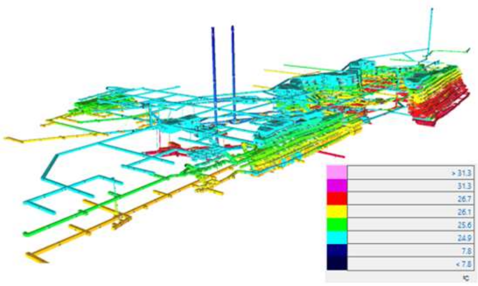
The structure of the ventilation network of a deep mine should be determined with a view to shaping the appropriate properties and purity of the air. An effective way to achieve this goal is, on the one hand, to flow a large amount of air through the workings, and on the other hand, to limit the emission of harmful components or heat. Providing a significant airflow increases investment and operating costs.

The construction of the model was based on the direct translation of the surveyor-geological data contained in the horizontal projections of each level into a three-dimensional model of two-dimensional analysis using the Hardy Cross method. The model was verified using the results of self-measurements and the ventilation department. Correctness was checked for consistency between the results of measurements and simulation of air volume and dry temperature measurements in a computer program. For the test, Pearson's correlation coefficient was determined according to the formula:

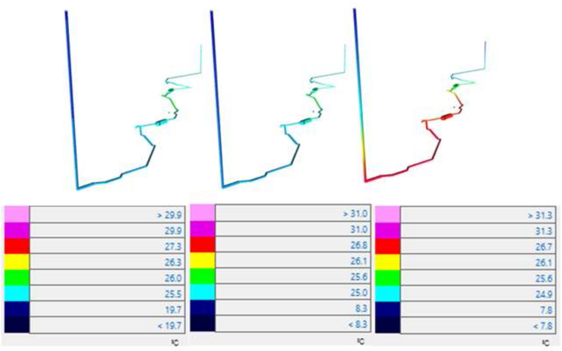
$$r_{xy} = \frac{\sum_{i=1}^{n}(x_i - \bar{x}) \cdot (y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2} \cdot \sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}}$$



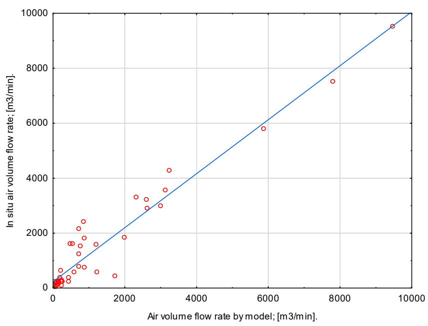
Model of the Klodawa Salt Mine in the engineering ventilation program (color scale represents depth in [m])



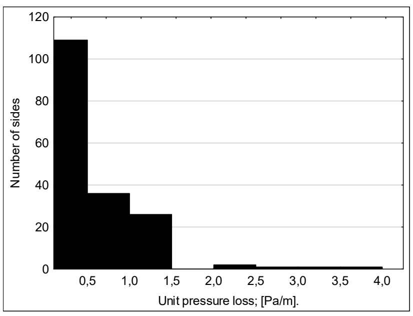
Model of Klodawa Salt Mine in engineering ventilation program (color scale represents dry air temperature in [°C])



Model of Klodawa Salt Mine in engineering ventilation program (color scale shows: from left: rock mass wall temperature; [°C], dry air temperature; [°C], primary rock mass temperature; [°C].



Comparison of airflows obtained from in situ measurements and from the model



Distribution of the number of sidings according to their unit pressure losses

The structure of the Salt Mine "Klodawa" S.A. consists of more than 14 thousand sidings with a total length of more than 401 km.
It is divided into 28 first-order layers and 4 second-order layers. More than the above includes 6 defined explosives for the analysis of the spread of blasting gases.