

MOTIVATION AND OBJECTIVES

Methane emissions have become a serious problem in residential areas around abandoned coal mines due to the termination of degassing and dewatering facilities. Methane is toxic, inflammable and explosive, and it is a greenhouse gas. If controlled suction is possible, methane can be used as an energy source. The objectives of the work consist of numerically simulating methane-migration processes through the subsurface as well as quantifying and localizing methane emissions at the surface of the earth. Further methods and techniques are developed to obtain prediction tools for, e.g., changing conditions or optimal gas suction.

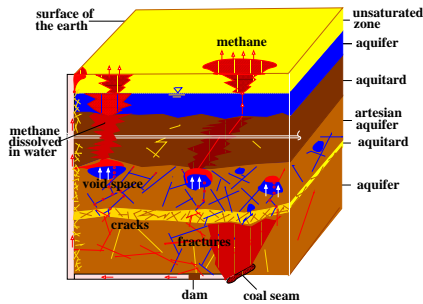


Fig.1. Sketch of a multi-layered system over coal seams

MODEL SET UP

Coupling of hydroinformatic methods and techniques for complex subsurface systems

- CAD (AutoCAD), DBMS (MySQL), mesh generator (ART, coupled 1D, 2D, 3D elements)
- advanced visualization (Data Explorer)

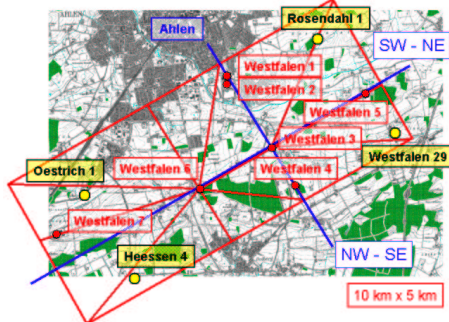


Fig. 2. Bird's-eye view of the model domain of the Westfalen mine

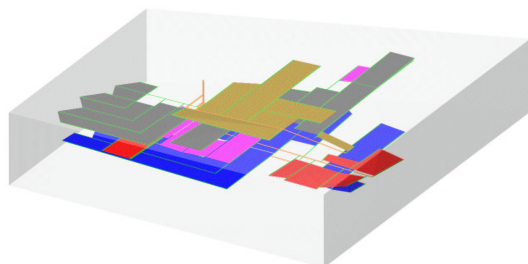


Fig. 3. Base-rock layer with coal seams

NUMERICAL SIMULATION

Methane-migration processes in fractured subsurface systems

- two-phase flow and two-phase/ multicomponent flow and transport model concepts (MUFTE-UG)
- integration of uncertainties: geostatistical parameter distributions (SIMSET), stochastic fracture generation (FRACGEN)

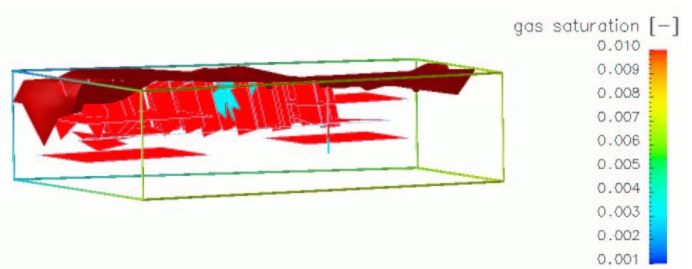


Fig. 4. Numerical simulation of gas saturations

OPTIMIZATION

Development of heuristic optimization methods for methane extraction in the subsurface

- further development of MUFTE-UG
- greedy search, simulated annealing

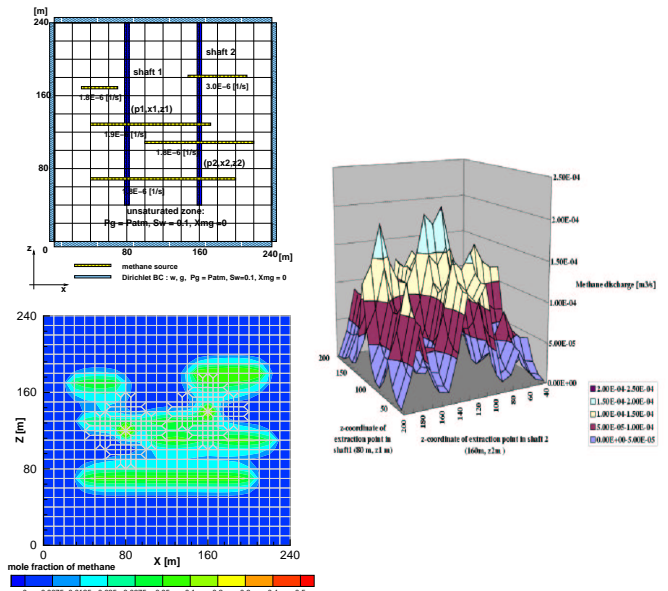


Fig. 5. Domain, numerical results and objective function

REFERENCES

1. Breiting, T., Hinkelmann, R. and Helmig, R., 2000: Modellierung und Analyse von Gas-Wasser-Strömungen zur Simulation von Methanemigrationsvorgängen im Untergrund, Institut für Computeranwendungen im Bauingenieurwesen, Technische Universität Braunschweig, Germany.
2. Breiting, T., Hinkelmann, R. and Helmig, R., 2000: Modeling of Hydrosystems with MUFTE-UG: Multiphase Flow and Transport Processes in the Subsurface. Fourth International Conference on Hydroinformatics, Iowa, USA.