# RESULTS OF IN-SITU MEASUREMENTS, LABORATORY EXPERIMENTS ON LIGNITE SAMPLES AND NUMERICAL MODELING OF COAL PILLAR, PERFORMING UNDER RESEARCH PROJECTS COGASOUT AND GHG2E


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## INTRODUCTION

In the year 2007 Velenje Coal Mine launched a research group on Clean Coal Technologies (CCT). Clean Coal Technologies research group applied for two R&D international projects.

- *Development of Novel Technologies for Predicting and Combating Gas Outbursts and Uncontrolled Emissions in Thick Seam Coal Mining (CoGasOUT); Research Fund for Coal and Steel.*
- *Greenhouse Gas Recovery from Coal mines and Coalbeds for Conversion to Energy (GHG2E); 7$^{th}$ framework programme.*

During both projects, "in-situ" monitoring is provided in the mine, accompanied by laboratory analysis, such as desorption and adsorption laboratory tests and coupled numerical modelling of gas migration under the influence of stress change are performing.

Main objective of projects is prevention against gas and rock outbursts and high gas emissions in the mines.

## EXPERIMENTAL WORK

### *Gas content determination experiments*

Gas content in coal is determined by variations of desorption experiments amongst which US Bureau of Mines direct method and Australian Standard method [1] represent direct gas content determination method that uses physical principles of gas release from coal samples (Figure 1).

### *Sorption experiments*

Sorption experiments are currently in preparatory stage where apparatus (autoclave) composition was re-designed and manufactured in 2011. Modification in apparatus will allow experiments both on solid coal core samples and on crushed coal samples.

Currently, test measurements are performed on different compositions of coal samples in order to test autoclave (Figure 2) and start with regular experiments with basis in existing knowledge [2].

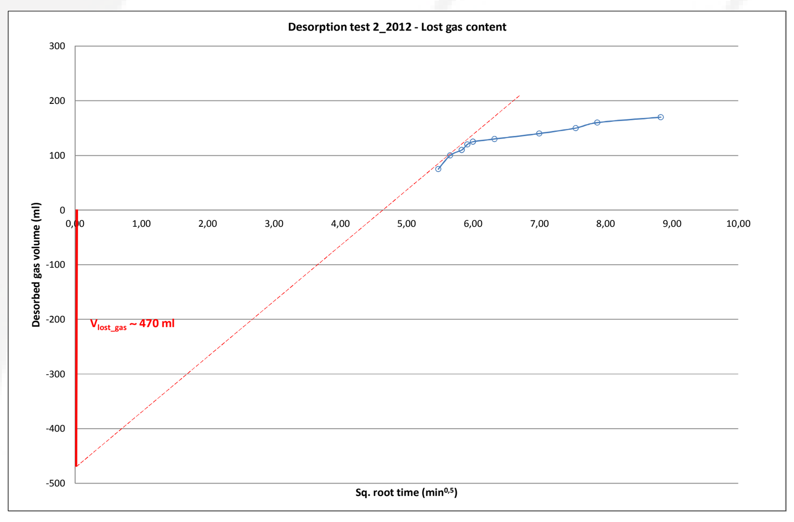

Figure 1: Lost gas determination from core coal sample (Jamnikar, 2012)

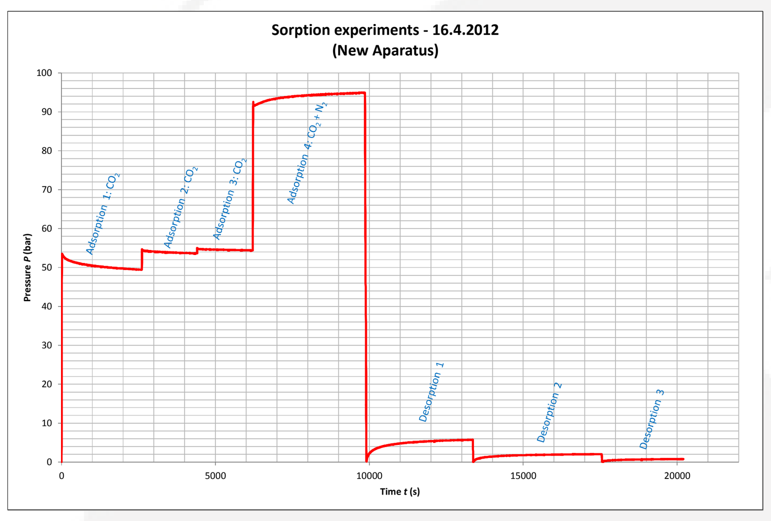

Figure 2: Sorption experiment on crushed coal sample (Razvojni Center Energija, 2012)

## MINE MONITORING

### *Seam gas pressure monitoring*

Seam gas pressure monitoring was established with purpose to correlate gas pressure behaviour in dependence of long-wall face approach with geotechnical monitoring, especially stress measurements.

### *Seam gas composition and isotopic analysis*

Seam gas composition monitoring is performed at wells, drilled during development and preparatory work for long-wall faces. Samples of seam gas are taken and analysed for gas composition (gas concentrations) and isotopic composition of $^{13}C$ in carbon dioxide and methane [3].

### *Rock stress monitoring*

Rock stress monitoring is an established methodology of long-wall face influence observations. Stress cells are built into bore-holes which are drilled with different orientations and inclinations. Rock stress monitoring design normally dictates bore-holes drilling into excavation pillars in order to detect influence of advancing long-wall face.

Amongst operating long-wall faces, K.-50 C (Mine Pesje) was chosen for multiple monitoring campaign (Figure 3).

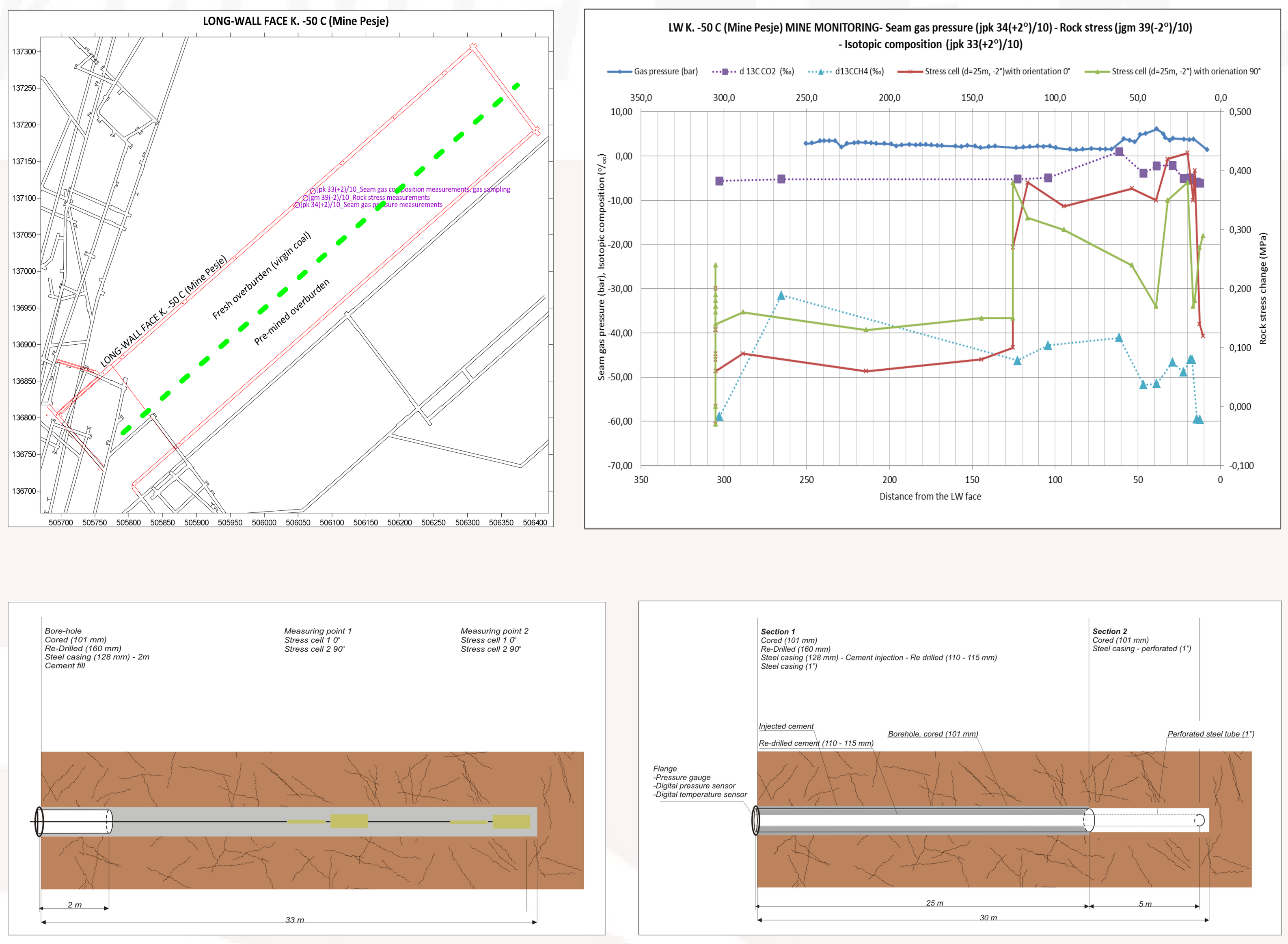

Figure 3: Long-wall face K. -50 C with monitoring locations (top left). Relations between seam gas pressure, gas isotopic composition and rock stress in dependence of distance to long-wall face (top right). (Jamnikar, Lazar, 2012)
Rock stress monitoring well (bottom left), Seam gas pressure monitoring well (bottom right).

## COUPLED GEOMECHANICAL MODELLING OF LONGWALL FACE

Numerical modelling is widely used in coal mining for understanding the behaviour of coal under dynamic stresses. When the stress results are known then with stress-permeability correlation [4] permeability can be defined which is used for data in the coupled geomechanical program TOUGH2. The objective of the model analysis in Flac3D is to gather stress changes around the pressure borehole for monitoring gas pressure changing in dependence of advancing longwall face. The geometry of the longwall face Pesje K.-50/C was chosen.

The mining method is divided into coal face slicing in height of 4 m and top coal caving in average height of 11 m. The model was simplified and Mohr-Coulomb constitutive model was chosen (Figure 4).

Coupled geomechanical modelling with TOUGH2 will be performed. TOUGH2 is a general-purpose numerical simulator for multi-dimensional fluid and heat flows of multiphase, multicomponent fluid mixtures in porous and fractured media [5] (Figure 5).

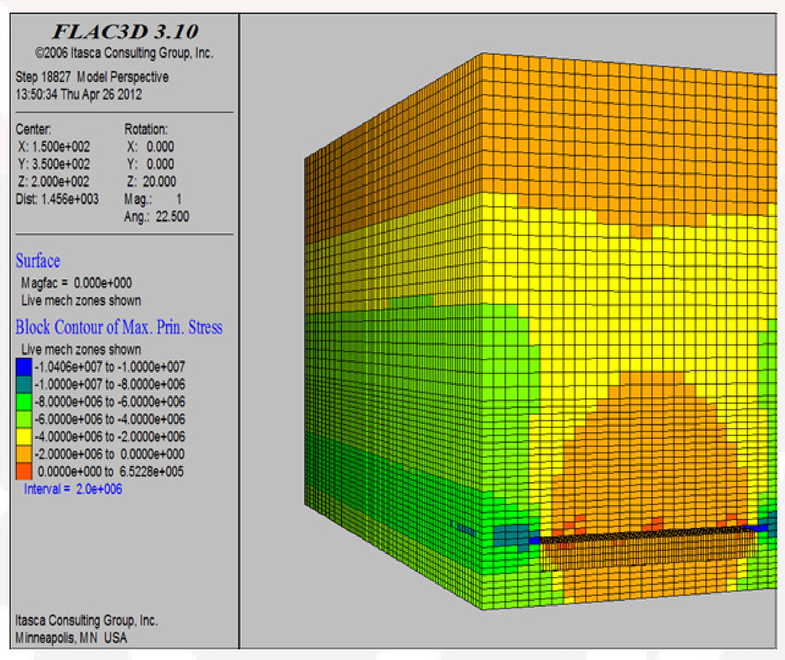

Figure 4: Maximal principal stresses after the excavation (Pa) (Lazar, 2012).

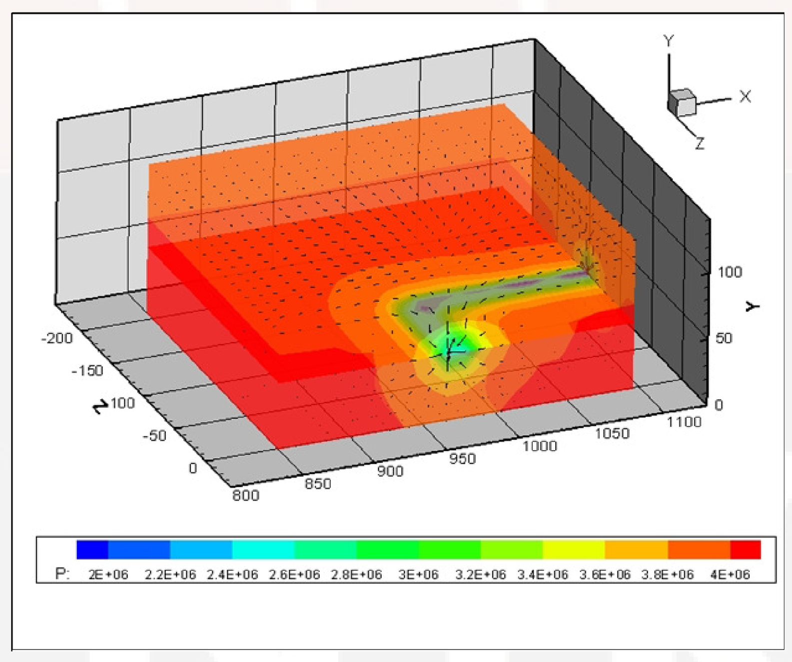
Figure 5: 3D model in TOUGH2 with gas migration around the LW face (Lazar, Si, Bacci, 2012).

## REFERENCES


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