Improving gas outburst management at gassy low permeability coal seams at the Karaganda coalfield

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Introduction

General information

With the introduction of the technology for heading of roadways in particularly outburst hazardous seam d6 with a preliminary development of the field gas drainage gangway, for more than 10 years, not one gas-dynamic phenomenon has occurred during development of preparatory roadways at Lenina and Kazakhstanskaya mines.

The development rate of preparatory roadways in the seam increased by 3-4 times and the time for drilling of anti-outburst boreholes decreased (earlier for 1 lm of the development work, the drilling of advanced and gas-drainage boreholes made 23.87 m.

During this time, by stripping of the particularly outburst hazardous seam d6, 2 sudden outbursts of coal and gas occurred. In both cases, discharge boreholes were drilled in accordance with the requirements of the applicable regulatory documents.

When heading roadways in the outburst hazardous seams, in accordance with the normative documents in force in the Republic of Kazakhstan, every 4 meters of development a forecast of current outburst hazard is made, and by heading of preparatory roadways in the seam d6, after field preparation, a monitoring the effectiveness of the implementation of anti-outburst measures is conducted. This type of forecast and devices for its implementation were developed in the fifties of the last century.

At the same time, on occasion, dangerous values were revealed when monitoring the effectiveness in preparatory faces in seam d6 (approximately 1-2% of the number of performed forecasts).

Introduction

General information

When drilling relaxation boreholes in hazardous areas identified by the current forecast, the cases of manifestations of outburst hazard, such as increased gas release, clamping of the drilling string, and others were not identified.

All this has forced us to look for new methods for forecasting the outburst hazard and contact DMT company (Germany), to identify the nature of such phenomena and develop appropriate recommendations.

In our opinion, here it is necessary to take into account not only the gas components, but also the geomechanical processes occurring during the development of the gas-drainage roadways, the characteristics of the bedding of the enclosing rocks, the changes in the thicknesses and angles of the sandstones bedding, and the influence of previously mined out seams.

All this requires the development of geomechanical models, to identify areas of increased danger with the use of modern computer facilities.

The specialists of LLP Industrial Mathematics (Kazakhstan, Karaganda), under the direction of Doctor of Technical Sciences, prof. Khalmanov, there are developments in this direction, which require industrial approbation.

Improvement of gas outburst management
Overview

- Establishing gas content testing as standard method

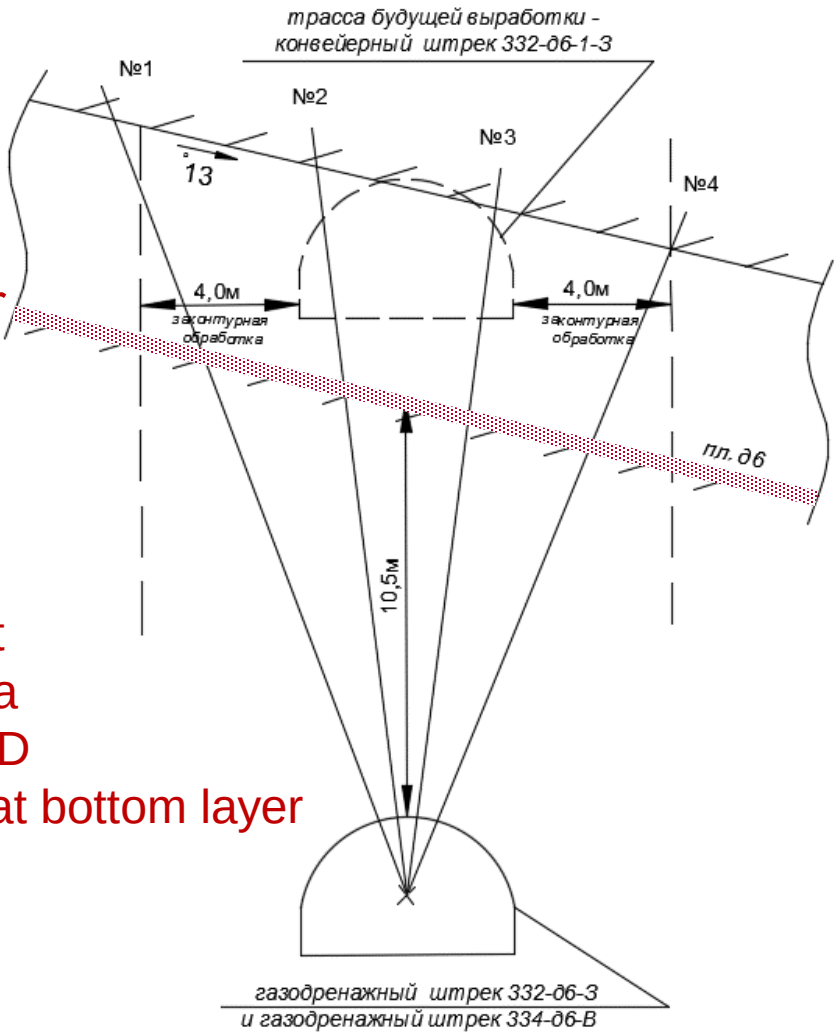
- Development of new/ improved methods of predicting gas outburst hazard
  - Proving effectiveness of pre-drainage in D_6 seam
  - Introducing selective forecast/ exploration drilling in K_{10} seam and method for analysis of gas monitoring data

- Development of new/ improved methods of preventing gas outbursts
  - Improving pre-drainage parameter at D_6 seam
  - Selective relaxation drilling in K_{10} seam

- Working on short term improvements in parallel (development of Trigger Action Response Plan)

D_6 seam
Existing pre-drainage layout

soft bottom layer



Gas content > 20 m³/t
Gas pressure > 3 Mpa
Permeability < 10^{-3} mD
High desorption rate at bottom layer

D_6 seam
Planned improvements and test program

Conceptual method

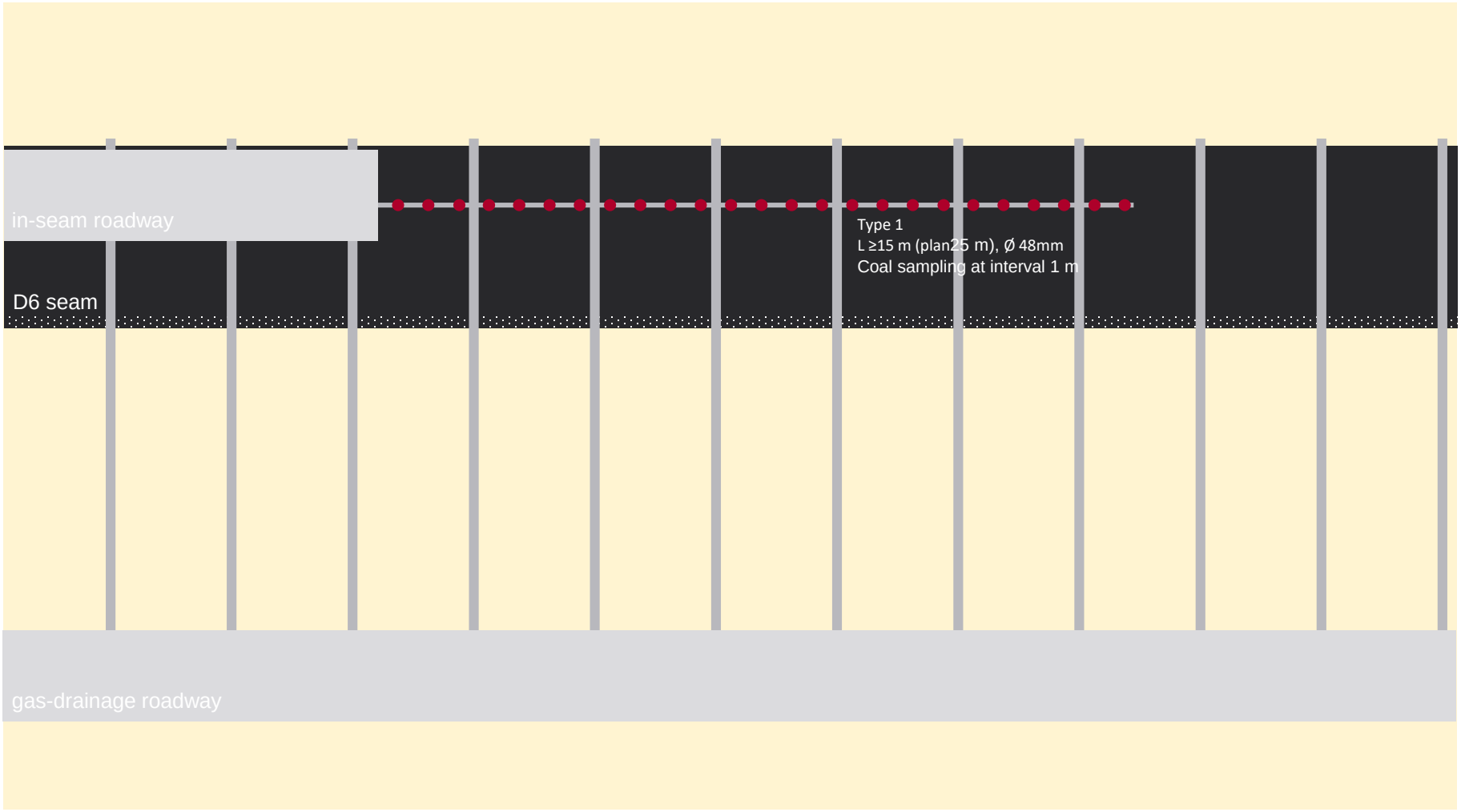
- Reducing gas content below a certain level (Threshold Limit Value)
- Verification of effectiveness of pre-drainage based on sampling and gas content tests prior to development
- Modelling of reduction of gas content in order to improve borehole spacing and lead time

Test program

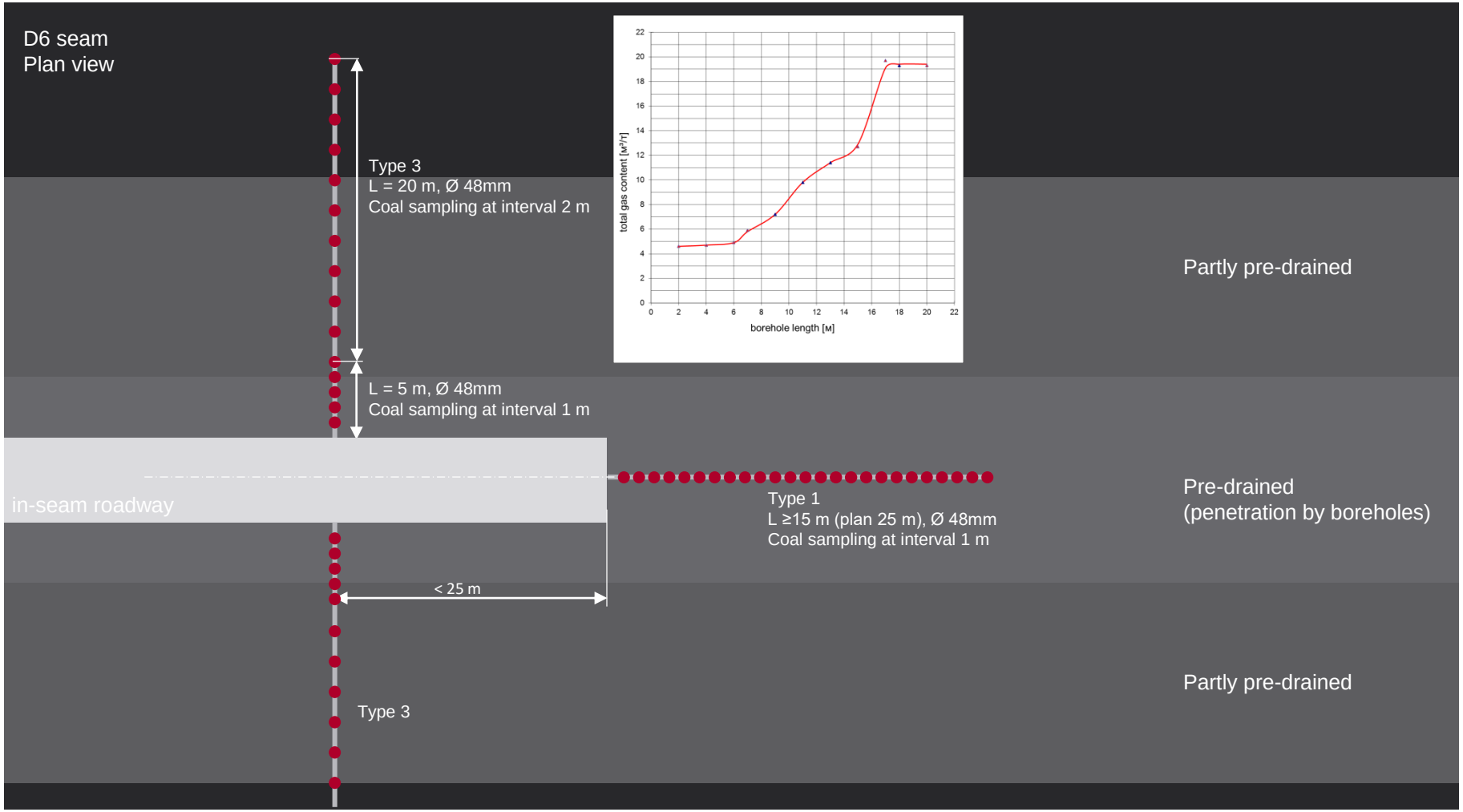
- Systematic acquisition and analysis of data at Lenina Mine under process
- Evaluation of distribution of gas contents between pre-drainage boreholes and within side walls under progress
- Reservoir modelling
- Definition of Threshold Limit Value (= maximum acceptable gas content)

D_6 seam

Sampling scheme of actual test phase (cross cut)

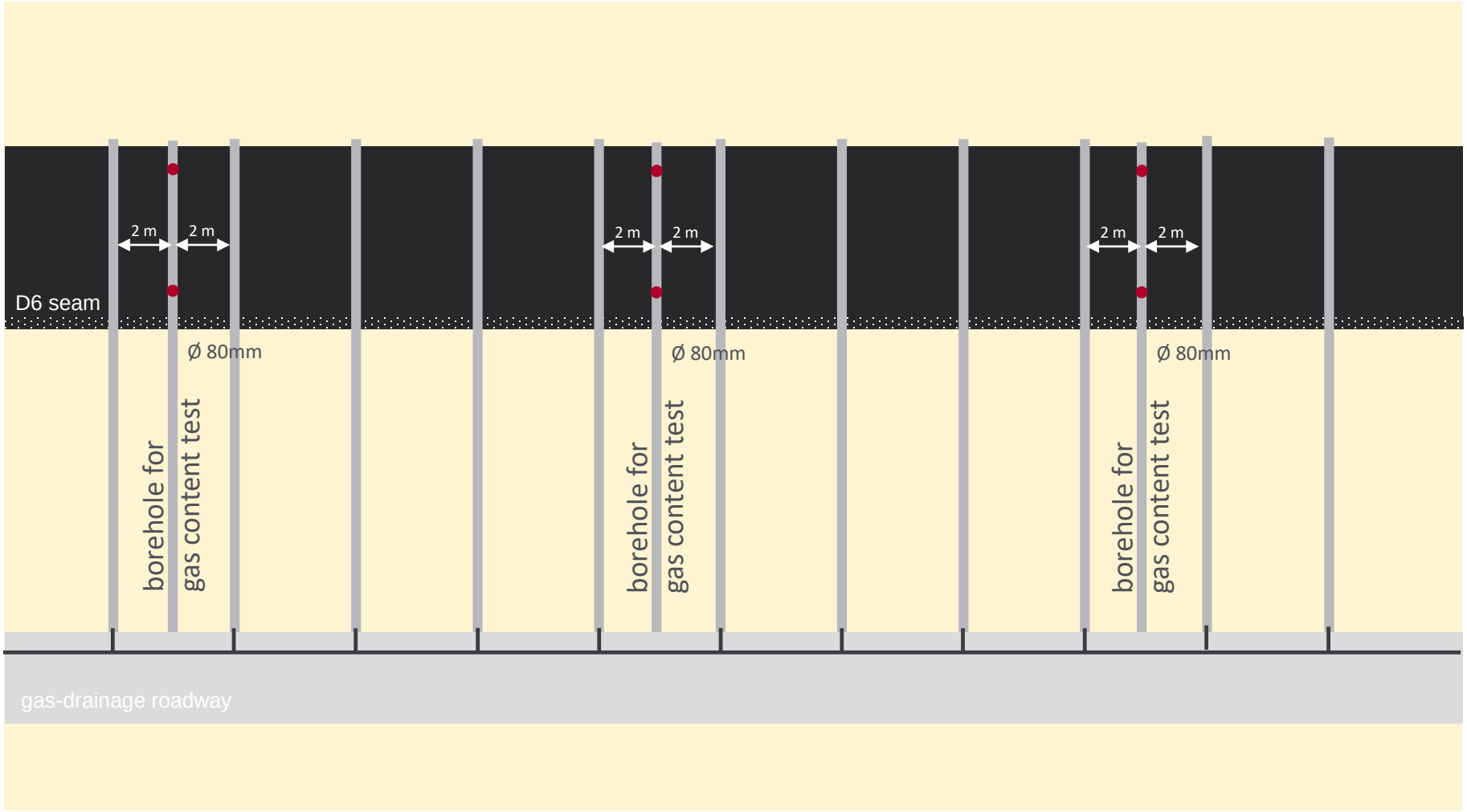


D_6 seam
Sampling scheme of actual test phase (plan view)

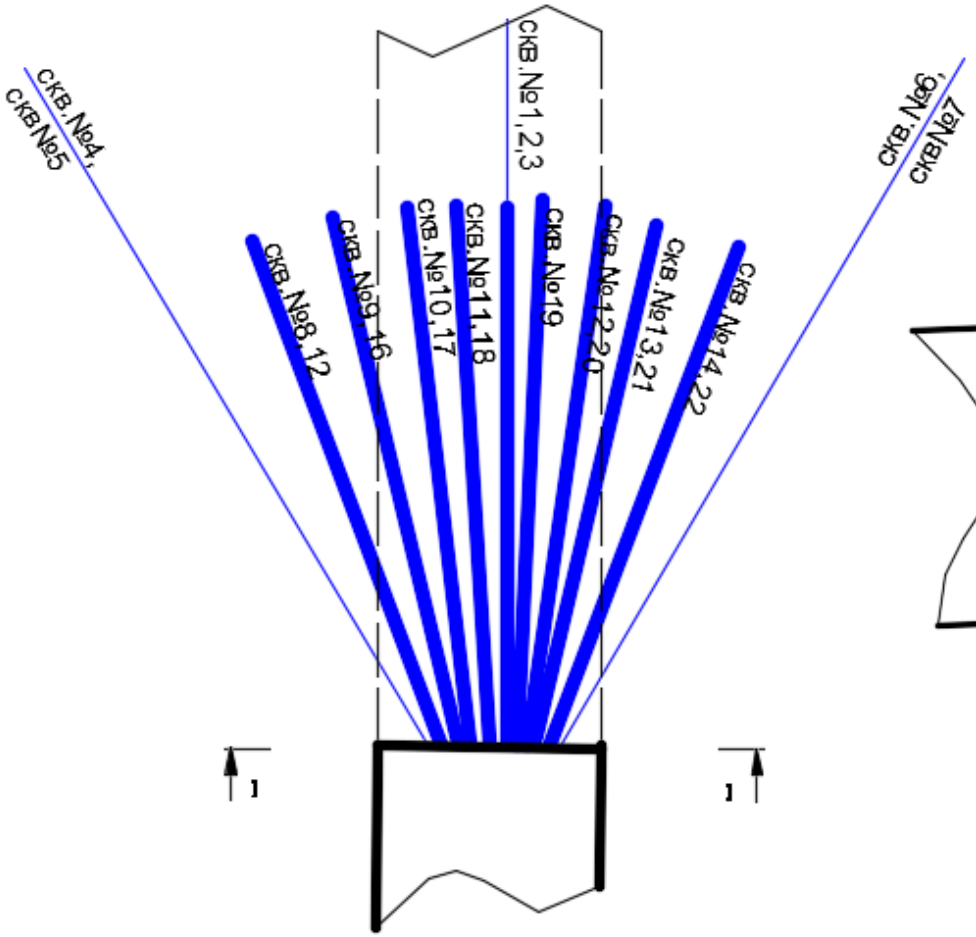


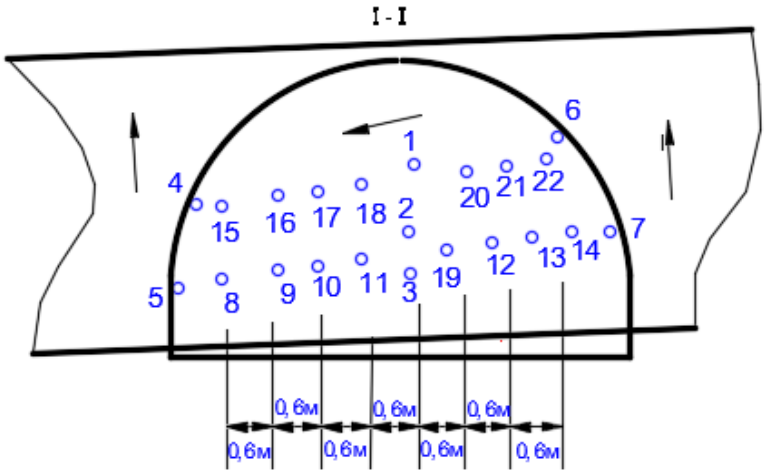
D_6 seam

Possible future method of coal sampling



K_{10} seam
Actual layout of relaxation boreholes





K_{10} seam
Planned improvements and test program

Conceptual method

- Preliminary risk assessment (gas content, tectonic structures, abutment pressure zones)
- Staged amount of exploration/ forecast boreholes according to level of risk
- Identification of actual gas outburst hazard based on information from forecast/ exploration boreholes
- In case of actual hazard relaxation by staged drilling
- Target: selective drilling with less drilling in low risk areas and focus on high risk areas

Test program

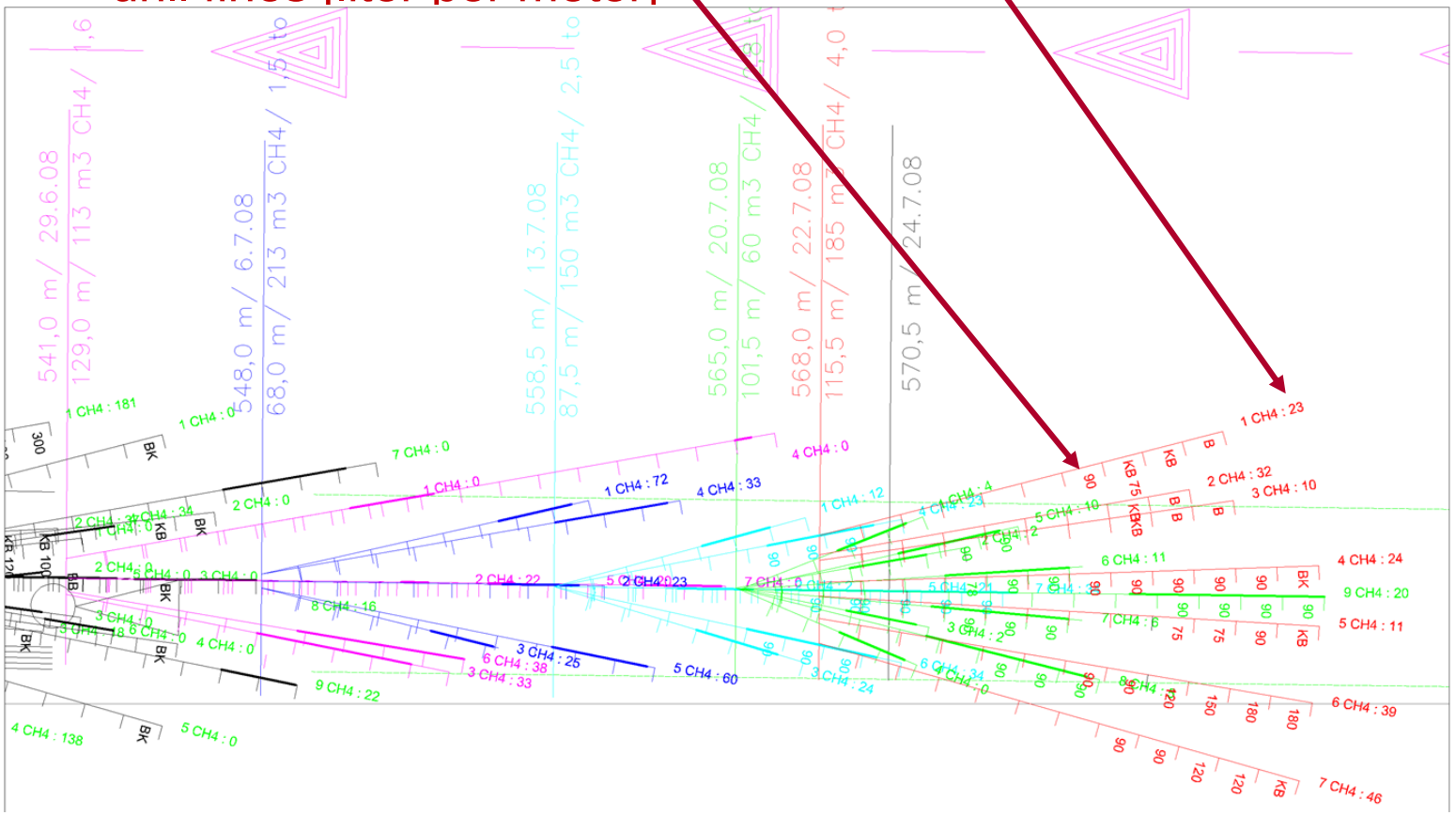
- Systematic acquisition and analysis of data at Kusembaeva Mine planned
- Statistical analysis of gas emissions, drill fines and lab test results
- Definition of Threshold Limit Values for indicative parameter

K_{10} seam

Measurement of coal cuttings from exploration and relaxation boreholes (Germany)

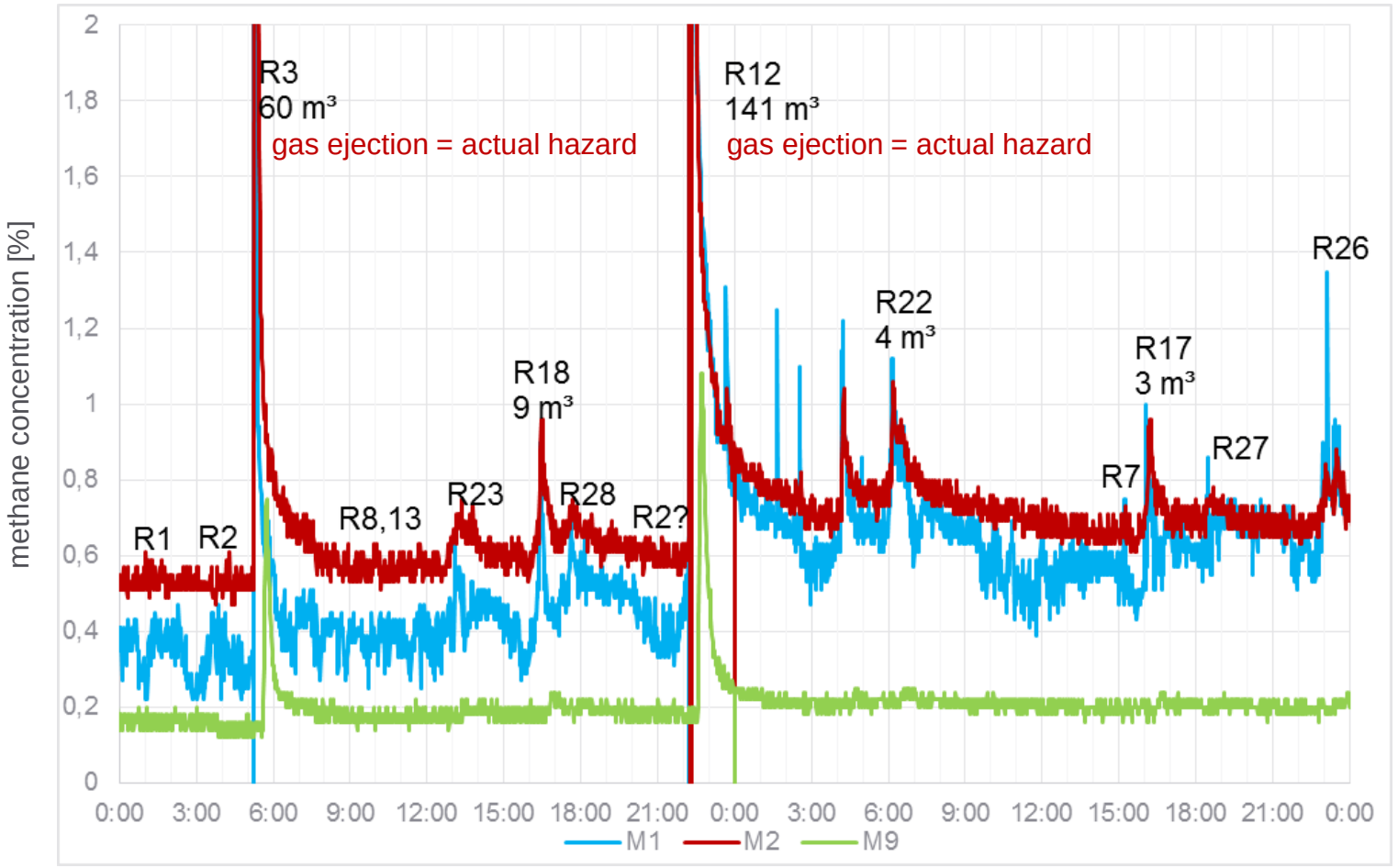
gas volume [cubicmeter per borehole]

drill fines [liter per meter]



K_{10} seam

Methane levels and volume during relaxation drilling (Kazakhstan)



K_{10} seam
Concept of selective forecast/ relaxation drilling

K10 seam
Plan view

1) Drilling of forecast boreholes in advance of development
2) Change from forecast to relaxation in case of indication of actual hazard
3) Drilling of infill boreholes until no more indications are observed
4) Checking effectiveness based on gas emission (Mine Scada) data by QV_{30} method