2009

# Gate Road Development in High Gas Content Coal Seams at Karaganda Basin Coal Mines, Kazakhstan

D. Baimukhametov
*JSC "ArcelorMittal Temirtau" Coal Division, Kazakhstan*

A. Polchin
*JSC "ArcelorMittal Temirtau" Coal Division, Kazakhstan*

T. Dauov
*JSC "ArcelorMittal Temirtau" Coal Division, Kazakhstan*

S. Ogay
*JSC "ArcelorMittal Temirtau" Coal Division, Kazakhstan*

# GATE ROAD DEVELOPMENT IN HIGH GAS CONTENT COAL SEAMS AT KARAGANDA BASIN COAL MINES, KAZAKHSTAN

**Dzhakan Baimukhametov[1], Aleksandr Polchin[2], Tanat Dauov[2] and Sergey Ogay[2]**

*ABSTRACT:* Most coal seams, currently mined in the Karagada Coal Basin, are prone to outburst. The main thick D6 coal seam is considered as most prone to outburst risk. Trials of advance degassing from the surface have not given positive results because of low permeability. 100mm diameter in-seam holes are subsequently drilled in almost all longwall blocks to facilitate preliminary degassing of the coal seams. Gas extraction quantities are however low, even the holes are placed on suction To facilitate the gas release during longwall block development, of the main seam, a method of development below the seam was used. This gave rise to increase in permeability of overlying thick seam with high gas content, achieving a local degasification of the overlying seam by up to 90%.

The initial development roadway was driven under the seam, in rock, at a distance of between 8-12 m from seam floor in the same contour of the future development roadway in the coal seam. A relief area was created as a result of stress redistribution above the roadway. Degassing holes were drilled from the rock development, into the seam area of the future coal seam development heading.

During traditional in seam development, outburst preventive measures were taken, which increased the labour intensiveness of development working, sharply decreasing the development rate. Application of these new techniques allowed increased development rates in seams to be realised, from 25-40 m per month to 120-150 m in the outburst prone areas.

## INTRODUCTION

There are eight underground coal mines in JSC "ArcelorMittal Temirtau" Coal Division. Coal production is 12 Mt per annum. Most of the mines are operated at a depth of more than 500 m, the thickness of each mineable coal seam is more than 3 m and gas content from 18 to 24 $m^3$/tonne. All coal seams are deemed to fall into the dangerous category with regard to coal and gas outburst, and D6 coal seam, which is 4-6.5 m thick, is considered most prone from outburst risk. The D6 seam is mined in two lifts, the top section being mined first and then the gas free bottom section mined 18 months later.

## PRE DRAINAGE METHODS

In order to reduce gas emission from the face as it is being mined; pre drainage was used in almost all blocks by means of 100 mm diameter in-seam holes drilled to the depth 150-170 m, parallel to production face. Hole spacing varied from 4 to 8 m. The decrease in coal seam gas content reached up to 20-25% after a year of degassing. Trials of advance degassing from the surface did not give positive results due to low permeability of coal seams (3-5 x $10^{-2}$ md).

### Lower seam extraction

The method of extracting the underlying seam is used to increase gas permeability of the overlying thick high gas content target seam. This achieved the degassing of the overlying seam by up to 90% . Unfortunately for the D6 seam non sequential extraction was not possible.

### Goaf gas extraction

Goaf degassing to the depth of 500 m from the surface was carried out by drilling of vertical wells from the surface, through at least two goaf areas. However, the difficulties with drilled holes due to depth

[1] *D.E, JSC "ArcelorMittal Temirtau" Coal Division, Karaganda*
[2] *Engineer JSC "ArcelorMittal Temirtau" Coal Division, Karaganda*

increase greater than 500 m, were such, that mine management opted for a system of road headings of special gas-drainage "sewers" driven above the seam at a distance of 20-30 m.

**Ventilation system**

Z-type ventilation system is mostly used for face ventilation. Z system prevents dangerous methane concentration near the production face. Typical scheme of goaf ventilation and degassing is shown in Figure 1.

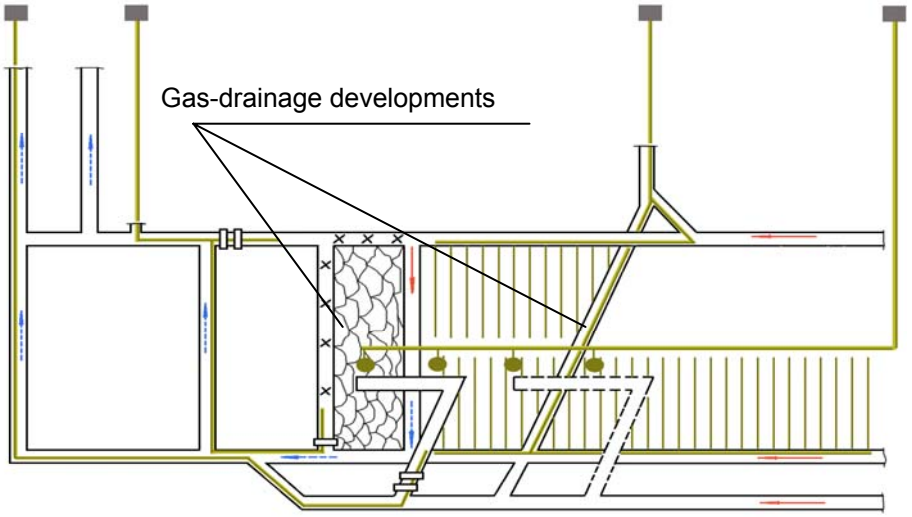



**Figure 1 - Z-type ventilation scheme at Shakhtinskaya mine**

The Z type ventilation proved to be costly in terms off heading support maintenance and longwall face ventilation management. Accordingly the system was changed to U-type ventilation system which enabled better longwall face operation, effective gas drainage management, and improvement of headings support systems, by using rock bolting, in preference to the traditional steel arches (Figure 2).

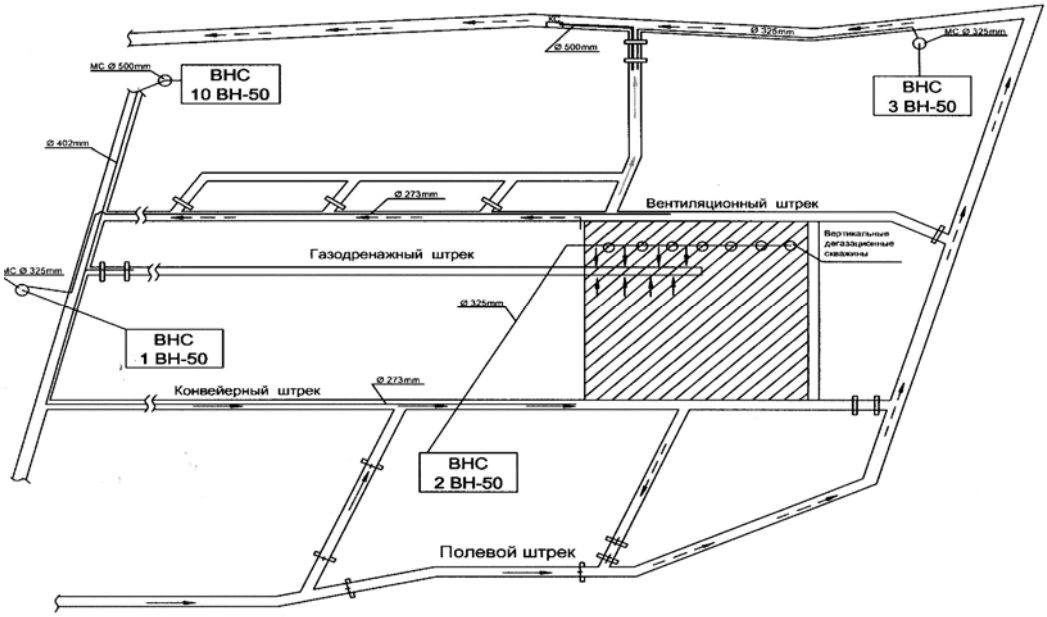



**Figure 2 - U- type ventilation scheme at Abayskaya mine**

## OUTBURST CONDITIONS

One of the restrictive factors of timely development of the longwall production areas was the low drivage rate of mine workings (25-40 m/month) in D6 seam, which is most prone to outburst risk. Low rate of development was due to the numerous outburst preventive measures in place.

Thick coal seam D6 is considered as most prone to outburst risk, particularly in Lenina and Kazakhstanskaya mines. Sudden coal and gas outbursts which took place at Lenina mine in 1995 and 1998 were considered to be the most powerful in coal mining throughout the world. The amount of pulverised coal and the volume of methane gas ejected in 1995 were estimated at about 640 t and 550,000 m3 respectively. However, in 1998 outburst, 3250 t of coal and 1.3 $Mm^3$ of methane were ejected. Since then, a set of outburst preventing measures have been introduced during the development and subsequent operation at D6 coal seam. These measures are based on (dry drilling) drilling relief holes ahead of the face.
The introduction of preventive measures caused labour practices which affected the rate of heading development in the upper level of D6 coal seam.

The thick D6 seam has a Lower layer of very friable coal. The relief holes were quickly filled with drill cuttings and often the volume of coal fines released from the holes, can reach up to several cubic meters. However, on a number of occasions these typical pockets of soft coal and accumulated gas resulted in sudden coal and gas outbursts.

Despite of the high gas content, the soft coal zone has very low gas permeability. This low permeability was proven in the process of hole drilling, when the intensity of gas emission was similarly low in the adjacent holes drilled 1.0-1.5m away.

## DEVELOPMENT OF OUTBURSTS PROCEDURES

The development of the D6 seam is made more difficult, due to the lack of overlying and underlying protective seams and a high gas content of coal. The D6 seam consists of an upper vitrinite rich section and a lower section which contained a soft coal layer, which is best described as a continuous shear zone varying in thickness of between 10's cm to around 100cm.

Different pre-drainage methods of gas-drainage holes were tested and procedures of outburst preventive measures were designed, for the management of gas-dynamic phenomena, particularly during roadways drivage in the upper layer of D6 seam. This resulted in 40-50 m of exploratory wells to be drilled for every one meter of development face advance.

Current outburst risk prediction is performed by evidence of gas and crushed coal yield from boreholes. Additional boreholes are drilled on the occasion of gas-dynamic phenomena signs, such as drilling assembly jamming, increased gas emission, gas and coal fines outburst.

Outburst risk prediction and outburst preventive measures are required to be implemented in every 4m of development face advance.

Availability of weak coal zone in the lower layer influences relief drilling length and speed. The holes are dry drilled and the 80 mm diameter holes are 30-40 m long. For larger 200-250 mm diameter holes, the borehole length can be as much as 20 m (average 12-15 m). Trials of longer hole drilling leads to drilling assembly jamming.

Normal development rates using the above procedures, in the upper layer of D6 coal seam were in the order of 25-30m per month.

## UNDERLYING STONE DEVELOPMENT DRIVAGE

To overcome the low development efficiencies, JSC "ArcelorMittal Temirtau" Coal Division specialists designed a new method of development for the outburst risk prone D6 seam. The main points are summarised as follows:

The gate development roadways are driven under the coal seam at a distance 8-12 m from seam floor and beneath the headings, which will serve the future working of the upper layer. The development of the lower roadway driven in rock below the seam (rock gate) causes the redistribution of the stresses in the strata above. Degassing holes are drilled into the area of future roadway in coal seam from this roadway 60-80 meters behind the face. 3-5 holes are drilled to the seam roof in the form of a fan covering the future in seam development heading area.

The distance between fan holes cluster is 4 m. The degassing hole angle is defined by covering 4 m of rib area of the in seam gate road. The degassing holes are connected to a vacuum gas pipe range. The favourable conditions for safe roadway development in the upper layer of seam are created as a result of stress relief and the degassing operation from the underlying stone development. This also improves the upper roadway development rates. Figure 3 shows the current development method for the D6 seam as used in the Kazakhstanskaya and Lenina mines.

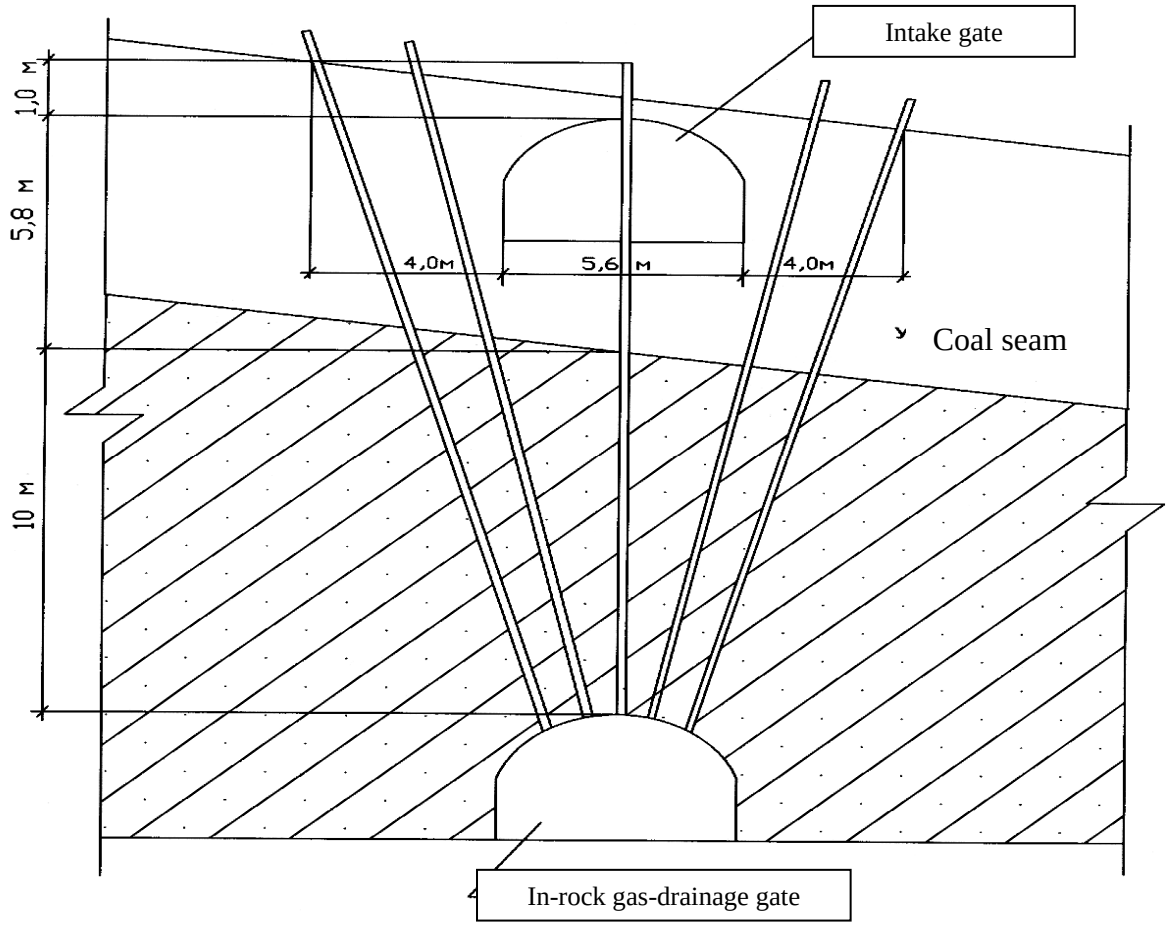



**Figure 3 - Development method of most prone from outburst risk seam**

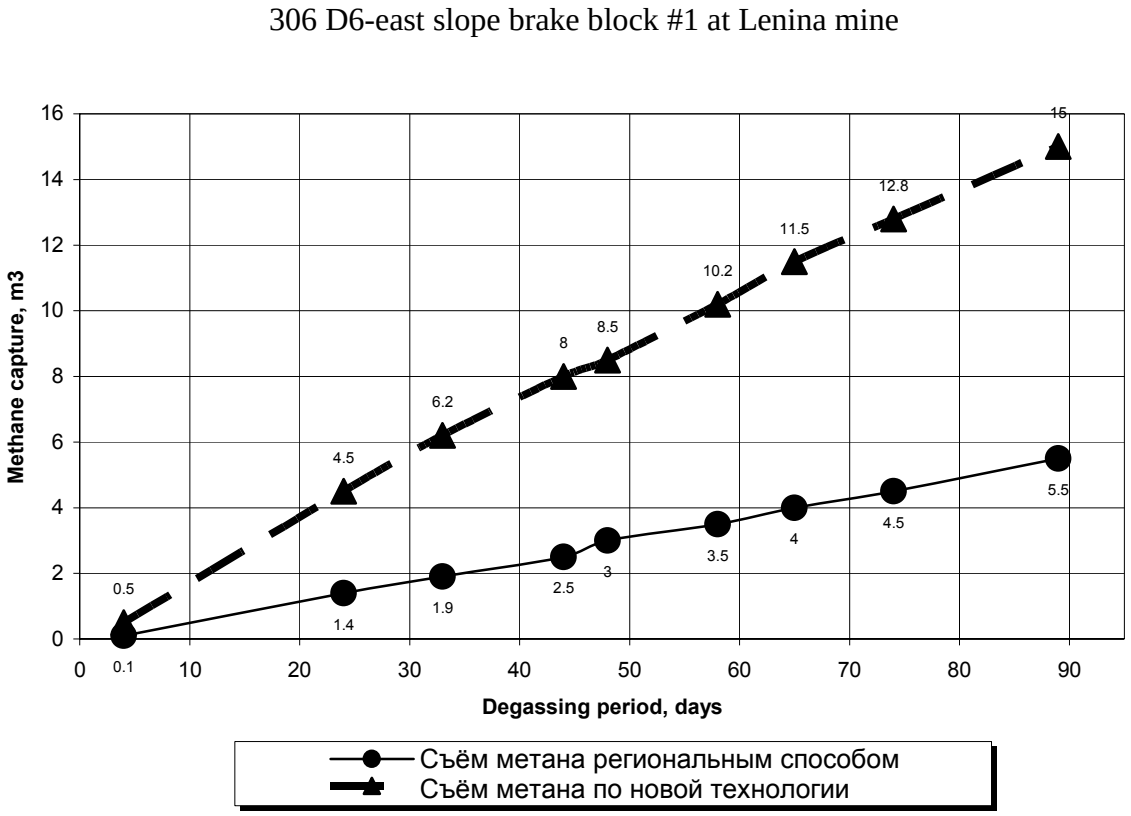
## OPERATIONAL EXPERIENCES

Methane extraction per tonne of coal in the vicinity of adjacent roadways at Kazakhstanskaya mine was 14-17 $m^3$ .This creates the conditions for safe in-seam roadways development in the upper layer. The average efficiency of holes was approximately 2 $m^3$/min, and maximum up to 3.4 $m^3$/min.The gas drainage allowed driving of in-seam roadways in the upper layer of D6 seam without outburst preventive measures and at a high rated of roadway development. The average development rates of 232 $D_6$-13 intake gate was 117m. The maximum development rate is now 150 m per month.

For comparison, the average development rates of 232 $D_6$-13 intake gateroad, 799m long, was 266 m per month. This was achieved with the implementation of all outburst preventive measures. Degassing implementation of the headings and surrounding areas is cost-effective. This accounts to 6.25 mln. tenge (US$ 52,000) per m of development or 7800 tenge (US$64) per tonne of working in the upper layer of D6 seam, even with longer in-rock gate and intake gate.

Degasification reduces the gas accumulation zones, thus contributing to minimising the possible coal and gas outburst occurrences. Such measures provided safe working conditions in the upper layer of D6 seam. A significant advantage of the new method is that the total production unit development period was reduced by six months even with the development increased development requirement.

The success of the operation at Kazakhstanskaya mine, allowed the introduction of the method to Lenina mine. As can be seen from Figure 4, the decrease in coal seam gas content adjacent to the newly developed of a drift was 15 $m^3$ per tonne.




1 – methane capture by regional method
2 – methane capture by new technology

**Figure 4 - Methane capture by degassing means**

## CONCLUSION

The experiences of the new development gas drainage method as applied of the longwall development of the outburst prone D6 seam, has the following advantages:

1. By carrying out the initial development in a gas free (stone) environment, underneath the seam outburst risks are minimal.

2. The stone drivages allows stress relief of the overlying coal seam and increasing of seam gas recovery in this area

3. Holes drilled form the stone drives enabled better effective gas drainage to a safe levels before developing the in seam longwall gate roads, particularly in the upper layer of D6 seam..
4. Development rates in relieved and degassed area in the upper layer of D6 seam has increased by three to four times. This contributed to improvement in mining and development rates.

A new development method at D6 seam is now being recommended for the further use at mines of JSC "ArcelorMittal Temirtau" Coal Division.