

THE COMPREHENSIVE DEVELOPMENT, UTILIZATION AND  
MANAGEMENT OF COAL MINE GROUNDWATER IN CHINA

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ABSTRACT

China has plenty of coal resources. Most of the big coal mines are located in North China. Nearly every year, several times of groundwater hazards and intrushes were happened in these coal mines, and these accidents gave serious damages. As in North China, the weather is semi-arid, the rivers, nearby these mine areas, are seasonal and the annual rainfall is only about 600 mm, so we are short of water for domestic, industrial and agricultural uses. Therefore since 1974, we began to study the comprehensive development, utilization and management of groundwater in Hanxian, Jiaozhuo and some other coal mines. This method is a correct, efficacious, reasonable, profitable, safe and economic. It can assure not only the safety of the mines and also we can utilize groundwater for water supply in our mines.

ARTICLE 1

Many coal mines in North China are located in semi-arid region, the rainfalls are about 600 mm per year, rivers are seasonal and the coal seams are Permo-Carboniferous in age. We know, the base rocks of the Carboniferous coal seams are Ordo-Cambrian limestones, very aqueous. So these coal mines have many difficulties to pay the pumping expenses. We are afraid of the sudden groundwater hazards and intrushes. Some times, these mines were flooded. Therefore, many coal mines will not exploit these bottom carboniferous coal seams which are situated at only a short distance above the aqueous limestones, say: 20 to 40 m. Then, the production of the coal mines were limited and some of them decreased rapidly. In these coal mines, we need plenty of water for industrial and domestic uses. Therefore, it is time to adopt the comprehensive development, utilization and management of groundwater policy in our coal mines in North China. Since 1974 till now, we

have worked six years in Hanxing and Jiaozhuo mining areas for geological and hydrogeological survey and pumping tests. Now, we obtain good results.

### 1.1 Hanxing coal mine area

It is located in south of Hebei province, these are Fengfeng, Xingtai, Handan and Lingchen coal mines. We produce more than 10,000,000 tons of coal per year. The exposed surface of the Cambro-Ordovician limestone is 1800 km<sup>2</sup> and this fissured and karstic limestone is very aqueous. We had more than twenty inrushes which were happened in these mines. Since 1974 till now we have drilled /529 mm diameter/ eleven water wells and /273-108 mm diameter/ 353 water wells and observation boring holes. The multi water well pumping tests have proved the dynamic reserve of karstic groundwater is 2 m<sup>3</sup> per second. We have also achieved 100 single wells pumping tests. The first multi-well pumping test of Erlishan, in the Fengfeng mine area, gave a discharge of 1.4 m<sup>3</sup> per second, and the groundwater table gave a drawdown of 2.02 to 2.76 m in the central water wells. This pumping test gave us a very important information, that is the O<sub>6</sub> member of the Ordovician limestone is a relatively impermeable formation. A second pumping test of Wangfeng mine gave a discharge of 1.5 m<sup>3</sup> per second and a drawdown of 2.00 to 2.50 m in the central wells. The third pumping test of Lingchen mine gave a discharge of 1.40 m<sup>3</sup> per second and a drawdown of 11.60 m.

In sum, this mine area is a very interesting place to apply the comprehensive development, utilization and management of groundwater, as here we have both big reserve of good quality of coal and water. We have calculated the dynamic reserve of the karstic groundwater, i.e. 29m<sup>3</sup> per second, which will be utilized for domestic, industrial and agricultural purposes.

### 1.2 Jiaozhuo coal mine

This mine is located on the north of Henan province. We have one big coal seam of 6 m thick and No. 2, No. 3 two small coal seams with 1.3 m and 1.5 m thick respectively. The coal seams, striking NEE, dipping to SSE with an angle 6-10°. Many high angle normal faults, cut this coal field into horsts and grabens. The big faults are nearly perpendicular to the striking of the coal seams and they are very aqueous. Because this limestone is middle Ordovician in age, 800 m thick, exposed area is 2000 km<sup>2</sup>. The flow direction of the karstic groundwater is from NNW to SSE. There are three entrances of the karstic groundwater, flowing from the Taihangshan mountains into the coal mine area. At present, the big coal seam has little reserve and the No. 2, No. 3 coal seams are not worked till now,

because they are afraid of the karstic groundwater inrushes.

In sum, this mine area has 26.6 m<sup>3</sup> per second of dynamic reserve of the karstic groundwater. This mine area is very interesting to apply the comprehensive development, utilization and management of groundwater, then we can exploit all the three coal seams. In the same time, this big discharge of the karstic groundwater that can be used to build a big electric power plant of three million kW and for other purposes.

## ARTICLE 2

The adoption of submersible pumps for draining off the Kailan flooded mines after the earthquake of 1976.

### 2.1 Majiagou coal mine

It is located in the north part of the coal basin. The depth of the vertical shaft is only 180 m, then we can use small submersible electric pumps to pump off all the groundwater from this flooded mine in 30 days.

### 2.2 Tangshan coal mine

It is located in the center of the Tangshan city. We use also this kind of small submersible electric pumps to drain off the groundwater in this flooded mine. We started the drainage on August, 20th, 1976 and on May 30th, 1977 we have drain out twenty million cubic meters of the flooded mine of the karstic groundwater.

### 2.3 Jing ge zhuang coal mine

It is located at 15 km north of Tangshan city. There are many faults and foldings. After the catastrophic earthquake, the discharge of the karstic groundwater is 1 m<sup>3</sup> per second and we started the drainage from August 13th of 1977 to September 8th 1977. 37 submersible electric pumps were put in two vertical shafts. On November 19th, 9 sets of submersible pumps were fitted in the underground pump room. Then the drainage of this flooded mine was fulfilled.

## ARTICLE 3

The drainage of the open-cut coal mines

### 3.1 Lingquan open-cut coal mine

It is located in the Dalannor city, Interior Mongol province. The upper Jurassic coal seam is 20 m thick. Here we use 3 deep water centrifugal pumps to drawdown the

groundwater table under the bottom of the open-cut mine.

### 3.2 Haizhuo open-cut mine

It is located on the west part of the Liaoning province. This Jurassic coal seam is 40 to 100 m thick. The alluvial sand and gravels are aqueous, 20 m thick. We dugged a drainage tunnel outside of the open-cut mine area and we have prevent the alluvial groundwater to flow into the open-cut coal mine.

## ARTICLE 4

How to prevent and control the hazards and inrushes of the groundwater

### 4.1 Meng tougou coal mine

It is located in the West of Peking city. The Mengtougou river flows west to east into the Yongtin river, and the maximum flow is 156.5 m<sup>3</sup> per second. There are more than 30 small seasonal creeks flowing into the Mentougou river. The annual rainfall is about 700 mm. Before 1960, the mine stopped every year during the raining season. We have spent four million yuan for the canals. Since 1960 till now the water inrushes were never happened in this mine. These facts proved that the surface water is the origin source of the groundwater. Therefore this method of management and control of surface water is efficacious, vigorous, scientific and economic. We can apply in many similar conditions with this method.

### 4.2 Guanxi mine

It is located in the north of Guangdong province. The upper Triassic coal seam is 4.67 m thick. As the base rock, Hutian limestones are very aqueous, so we digged a tunnel on the level -237 m. The total length is 3.720 m. Thus from 1972 to 1980, the dangerous water hazards and the terrible inrushes have never happened in this mine, because we have drained out more than 30,000.000 m<sup>3</sup> of groundwater and the maximum discharge of the tunnel groundwater is 3036 m<sup>3</sup> per hour.

### 4.3 Ma an coal mine

It is located on the north west border of the Pearl river delta, in the Guangdong province and at 13 km south to Zahoging city. The 12 upper Triassic 12 coal seams have 16.70 m. We have studied throughly the composition of the alluvial sand and clay in their horizontal and vertical distribution. We noticed this quick sand moves when it is saturated and it can flow with water together. So we fitted a wooden door on the underground adit to prevent the

inrushes of quick sand. Thus before we close this door, we prepared many bunches of straw and laid down on the ground inside the door and then we piled up to a height of 50 cm and we close the door. With the direction of the flow of the groundwater all the bunches of straw will be compressed together and moved close to the door, so only the water can come out of the door. We must fit 2 more doors with 15 m distance between 2 consecutive doors and so we can resist the high pressure of sand and water behind the doors. When the alluvial groundwater was dewatered completely, the dry sand can not move any more, then we can extract the coal seam safely.

#### 4.4 Meitanba coal mine

It is located in the central part of the Hunan province. The Wei river flows through the southern part of the mine area. One of the tributary river flows near the outcrop of the coal seam. Generally, the discharge of the Wei river is about  $100 \text{ m}^3$  per second. The irrigation canal of Weishui river flows through the coal field about 1,7 km long, the discharge is  $10 \text{ m}^3$  per second. We have digged an irrigation network containing 20 ponds and reservoirs per  $\text{km}^2$  and we utilize the groundwater to irrigate 100.000 chinese acres of fertile ricefield. The faults are the main cause of the water inrushes and hazards. We have studied all the boring data and the exploitation facts. We concluded that Meitanba is a very good representative coal mine /example of very aqueous and dangerous coal mine/. Since 1960 we have changed our old method of management and control of groundwater, that was extracting coal seam under high groundwater pressure and the result was very miserable such as: we can only produce 30.000 tons of coal per year and many inrushes of water, sand and mud were happened every year in this mines. So we had no profit to cover the mine expenses and sometimes we have no money to pay the salaries to the miners. Then we adopted the "Deeply drawdown water table and strongly pumping groundwater to the surface for industrial and agricultural uses". We worked with this comprehensive management of groundwater for more than 20 years, this mine becomes a big production of one million tons of coal per year and gets more profits. Certainly we have many similar conditions of very aqueous groundwater coal mines like Meitanba, it is time to adopt this new method to manage the groundwater to extract more coal without water hazards and inrushes.

### ARTICLE 5

#### Water supply

##### 5.1 Xishan mine

It is located in the central part of Shanxi province. Now,

the Xishan coal mine develops very quickly. We have plenty of coking coal reserves and also we need big quantity of groundwater for drink, bath and for washing plants. We have drilled some prospecting water researching holes and we observed the Ordovician limestones are very aqueous and its quality is good. The water table of these karstic limestone are variable from 250 to more than 300 m, so we must use submersible electric pumps to drain out the deep Ordovician groundwater.

## 5.2 Luan coal mine

It is located in the south east part of Shanxi province. We need plenty of good quality of drinking water and also for bath, coal washing plant and other industrial uses. Recently, we drilled some deep water wells and we got some good results.

## 5.3 Hanchen, Pouchen, Chenhe and Tongchuan coal mines

These mines are located in the central part of Shenxi province and the geological and hydrogeological conditions are nearly the same as we mentioned above /5.1 and 5.2/. Now we find also plenty of good water in Ordovician limestone in the coal mine areas of Shenxi province.