Geological Hazards in Pingdingshan Coal Mine District and Controlling Countermeasures

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Abstract : *Pingdingshan Coal Mine district is one of the six mining areas of Henan Province, which is a large coal base in China. After 60 years of exploitation, it has brought great benefits, at the same time, serious geological disasters have been occurred. It has seriously damaged the normal production of the masses, life, restricting the development of Pingdingshan coal mine economy. In this paper, the geological disasters such as ground collapse, ground fissures and ground subsidence in Pingdingshan coal mine are analyzed, and the degree of geological disasters in the mining area is analyzed in combination with the severely affected mining area. Finally, reasonable and feasible countermeasures have been put forward.*

Key words: *Pingdingshan; coal mine; geological hazard; analysis; control strategy*

I. Introduction

Pingdingshan mining area is located in the west of Henan Province, is an important coal industrial base in China, including Pingdingshan coal field (including Hanliang), Ruzhou coal field and Yuzhou coal mine three mining areas. There are 21 pairs of mines put into production, the annual production of coal can reach 23.141 million tons. Mine within the full range of coal, coal quality is the nationwide varieties of the most complete coal and coking coal production base. With the development of mining, in the acquisition of huge economic benefits, more and more geological disasters have followed, endangering the people's lives and property, while restricting the economic development of Pingdingshan coal mine, contrary to the concept of sustainable development of China's economy. How to deal with these geological disasters has become a problem can not be ignored.

1 **Distribution and Hazards of Geological Hazards**

1.1 *ground collapse*

1.1.1 Distribution characteristics

The ground collapse and the ground fissure caused by the collapse are the most serious geological disasters in the Pingdingshan mining area. The ground collapse in the coal mine area is mainly caused by the collapse of the goaf. In the past, people did not pay enough attention to the destruction of underground mining, such as land resources, villages and other buildings, railways and highways, surface water system, etc., which caused the change of rock mass stress field, which would not only endanger the safety of underground miners and equipment, but also the ground collapse and ground fissures, which will have a serious impact on the safety of surface facilities, such as land resources, villages and other buildings, railway and highway, surface water

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system and so on. It is understood that the area of the mined-out area in the Pingdingshan coal mine is currently 185. 4km^2, the collapse of the subsidence caused by the subsidence of the subsidence affects 15 520 hectares of land[Error! Reference source not found.]. Mined areas within the scope of arable land, the village affected by the perennial seasonal water, severe reduction in food production, housing damage is serious, and with the continued exploitation of the surface collapse of the hazards will also increase.

1.1.2 Hazards of ground collapse

Eight mines of Pingdingshan is China's own design and construction of the first large-scale mine, administrative area under the Weidong District, Pingdingshan City . The geographical coordinates of longitude 113 ° 22'9 "~ 113 ° 30'14", latitude 33 ° 45'13 "~ 33 ° 47'26" east-west along the long 12.5km, north-south tilt width of 3.36km, the total area of the mine up to 41.4195km^2. Since 1966, the mining area has formed a 14.76 km^2 mined area, resulting in more than 14 km^2 of the ground subsidence, accounting for about one-third of the total area of the entire mining area[Error! Reference source not found.](The assessment of geological hazard risk in the mining area is shown in Fig. 1).The mined-out area lead to a large area of ground collapsed, killing large areas of arable land, roads were destroyed, the development of ground subsidence in the mining area is shown in Table 1. The affected area of arable land reached 144 hectares, of which 73.4 hectares of arable land had been accumulated water over the years and could not be cultivated. Threatening houses up to 4805, part of the village suffer more serious effects, resulting in the village for many years of water filling (Figure 2), the house is affected by the collapse, resulting in cracks (Figure 3). The disaster is very serious, in the cause of great economic losses, and also formed a variety of security risks, the production and life of the people and life safety needs to be guaranteed.

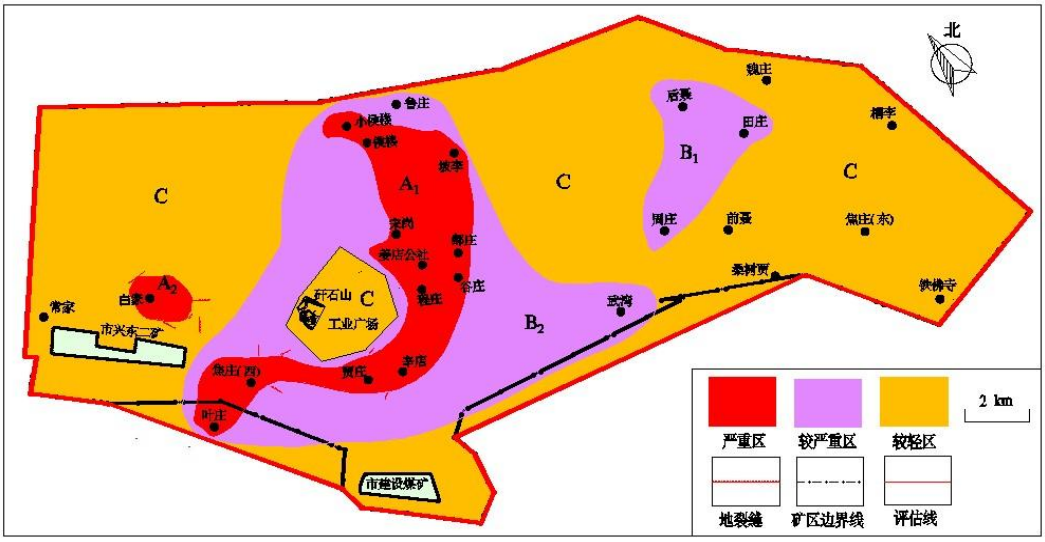

Figure 1 Assessment of the risk of geological hazards caused by mining in the mining area

Table 1 Pingdingshan shares eight mine mine ground subsidence development situation

Town	Village name and coordinates	popul ation	House (room)	Cultivated land area (ha) and damage
Hongzhuang , Yang town	Jiazhuang	960	2600	23.4 hectares of water
Zhanbei town	Poli	920	2100	4 hectares, seasonal water

Donggaohuang town	Houlou	1100	2700	1 hectare, seasonal water
	Wuwan	1300	2800	73.4 hectares, long water
	Chengzhuang	2800	6500	10 hectares, seasonal water
	Jiaozhuang			25.4 hectares, seasonal water
	Yezhuang	980	2700	1.7 hectares of seasonal water
	Xinnan	2100	5400	5.4 hectares, seasonal water

Figure 2 Village water plot

Figure 3 mine dangerous room

1.2 *Ground fissures*

1.2.1 Distribution characteristics

Ground fissures are also one of the important types of geological hazards in the area. The ground fissures in the mining area are mainly due to the underground mining activities caused a certain range of mined-out areas, so that the overlying rock and soil loss of support, resulting in the fall of these rock and soil, causing ground cracking. Pingdingshan coal mine due to the large area of goaf, forming a large number of ground fissures[3]. Its length is from a few meters to several kilometers range, it is learned that the current Pingdingshan coal mine development of the longest ground fissure up to 4500m; Most of the width is less than one meter and a few are several meters wide; visible depth of not more than 4m. Individual deep bottomless, no obvious direction. Development sites are mostly in mountainous wasteland[5.].

1.2.2 Hazard of ground fissures

Pingdingshan number six coal mine as an example, in the mining area is clearly visible and has a certain size of the ground cracks up to 38, are formed by the mining activities, mostly cracks in the ground, a few were arc, polyline. Most of the ground fissures are developed on the top of the hill, and are sloping parallel to the slope or in a small angle. The length is from 100m to 150m. The width is generally 0.3m and the maximum width is 1.1m. The visible depth is 0.4 ~ 3.5m. Bottomed out. Most of the cracks were in the form of clusters, mostly in parallel, with the same direction as the slope. Ground fissures mainly cause housing cracks and land damage. There are different degrees of damage to the village houses in the six mining areas, some of which have become dangerous (Figure 4 and Figure 5). In addition, the ground subsidence caused some damage to the roads and greatly affected the residents. As the ground fissures are mainly developed in the mountain wasteland, according to incomplete statistics, the ground subsidence and the ground caused by cracks, a total of 3.7 hectares of arable land damage. In addition, ground fissures also caused 131 hectares of wasteland to be

destroyed, 1.5 hectares of forest land was destroyed. The gob and its induced ground fissures endanger the safety of more than 1,500 households , 7800 houses and 3900 people.

Figure 4 housing cracks

Figure 5 housing cracks

1.3 *Ground subsidence and its hazards*

The causes of ground subsidence in Pingdingshan coal mine are different due to geographical location and mining situation. For example, the population density in the square of mining area of No.8 coal mine of Pingdingshan coal group, water concentration and concentration of buildings, cause the underground soft rock stratum to be compacted and consolidated; densely populated, large amount of water consumption, a large amount of groundwater resources mining, groundwater is pumped out of large amount, belongs to the type of pumping settlement. However, in the No.4 mining area, many affected areas are located in the secondary tectonic zone of the fault of the Goudi mountain, and the fault is staggered, which exposes up to four faults with a fall of more than 15 meters, and is in the outcrop area of the coal seam; Affected by the fault cutting, the overlying strata of the whole poor, easy to be affected by a variety of induced factors, so that the relatively stable fault " activation ", resulting in the surface movement, causing cracks in the ground construction. For example, there are four oblique wells that have been abandoned for many years in the mining area, and the natural collapse will induce the "activation" of the fault, which in turn causes settlement deformation. In addition, there are many local small coal mines around the area, and over the years the super-layer crossing exploitation may also be one of the main factors that cause the fault to cause the fault. Only the No.4 mine area due to surface subsidence damage as many as 807 households, damaged area of 47926.22km^2, the number of damaged 3218 people, resulting in a very serious economic losses, and security risks.

1.4 *Debris flow, collapse, landslide*

Pingdingshan coal mines are mostly located in the plains (Figure 6), only a small part of the hills, landslides rare development. Development department also has a small impact on the people. For example, in the Pingdingshan six mining area within the no man's land to see the development of landslides, landforms are denuded low-middle mountain, far from the village building, in addition to causing surface deformation and damage, but also did not cause roads, bridges destroyed. The formation of debris flow requires three basic conditions: the steep and easy to collect the appropriate water collection; upstream accumulation of abundant loose solid material; short-term there is a large number of sudden flow of water[4.], the mine can not provide the above conditions. Is located in the plains, the collapse of rare, no longer discussed too much.

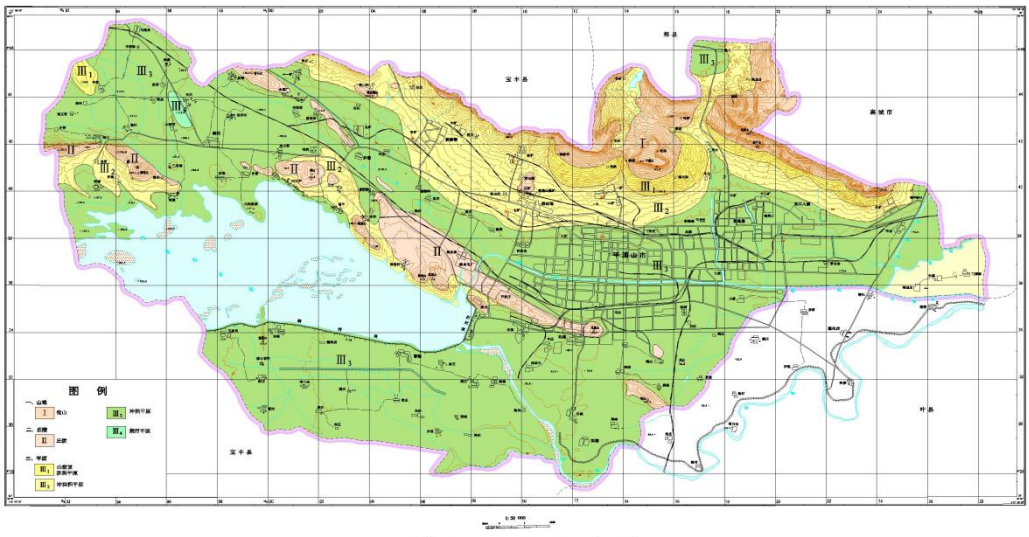

Figure 6 Pingdingshan topography map

II. Control measures

2.1 *Principles of Prevention and Control*

2.1.1 Prevention and treatment

Nowadays, there are a number of geological disasters, the degree of danger can be identified, and can implement a series of governance measures such as engineering management to actively carry out land restoration, to minimize its risk. Due to the sudden, mass, and derivative of geological disasters, it may occur in the short time, the larger areas of the disaster, causing huge losses or even lead to a series of follow-up geological disasters, sustained damage to the mining area. So the potential geological hazards of hidden dangers is far greater than the proven geological disasters, in the disaster prevention and control of the relevant units should focus on dealing with potential geological disasters, develop good preventive measures to minimize its harm.

2.1.2 Local conditions, development, and both prevention and control

In the mining process should actively respond to the call of the state, do not go past old way "first pollution and then control" . In the mining work should be closely combined with the geological conditions of the mine, for different mine geological hazards to give the corresponding response measures. In the mining at the same time, the mine custom science reasonable prevention, recovery, governance measures.

2.1.3 technical priority, the first design after the construction

Mine disaster management must be in strict accordance with the national development of technical specifications, to design a practical program. And to ensure the feasibility of governance programs, security, the pursuit of governance of the largest economic benefits. Rough set can be used before construction[Error! Reference source not found.] and other methods to do a risk assessment of the disaster, to minimize or avoid the mineral development caused by mining geological hazards.

2.2 *Countermeasures*

2.2.1 Close monitoring, strategizing

According to the distribution of geological disasters in the mining area, disaster intensity, the status quo

and other factors to purchase appropriate monitoring equipment, establish a sound and perfect mine geological disaster dynamic monitoring system; closely linked to the people of mining, the introduction of the corresponding laws and regulations, from a sound and efficient and sensitive geological disaster group policy prevention network: the establishment of a set of geological disaster early warning system, timely access to disaster early warning information, the degree of disaster threat to a minimum**Error! Reference source not found.**. On the already have a hidden danger of geological disasters, tree warning signs, isolation and other measures to avoid casualties. The use of balanced scorecard performance evaluation system and other scientific and rational methods to develop efficient and reasonable rescue plan, optimize the rescue, to minimize the loss caused by geological disasters **Error! Reference source not found.**.

2.2.2 Restore the ecological environment with people-oriented

Carry out the relocation and repair of villages that are severely affected by the disaster and repairs the village of the village where the damage is less serious; filling and repairing the damaged road; according to the different needs of residents, reasonable deployment of excavation, arable land, roads, engineering. To take reclamation measures to restore the mining area of land resources; mine closed pit, the timely construction of industrial sites to clean up the land leveling project; To carry out mining area topography and ecological environment restoration project[9.]. So that the people get placement.

2.2.3 Vigorously promote and improve the responsibility system

The government should play its functions and increase the work on popular science, disaster, propaganda and education. Improve the quality of the project responsible staff, to participate in the work of disaster prevention and control personnel disaster warning training; to improve the people of the mine disaster awareness and response to geological disasters. Establish a sound responsibility system, the responsibility system layer by layer, specifically to each involved in the prevention and control works of the staff, who is responsible for the problem**Error! Reference source not found.**.

III. Conclusion

Pingdingshan coal mine for more than 60 years of mining, resulting in mined area of 185.4km^2. A series of geological disasters caused by the collapse of the mined-out area affected the land by as much as 15 520 hectares, which caused serious damage to buildings, railways and highways such as land resources and villages. Not only become one of the obstacles to the development of mining economy, but also on the residents of the mining area of property and life safety has a huge threat. Pingmei Group should rely on the progress of science and technology to carry out comprehensive prevention and control of geological disasters, geological disasters to closely monitor the prevention and control personnel to carry out publicity and education. Trying to play a governance efficiency and control at the same time, restore and improve the mining geological environment and ecological environment.

References:

[1.] Yang Jie-ying.Study on Main Environmental Geological Problems and Countermeasures in Pingdingshan Coal Mining Area [J]. Mineral Resources Protection and Utilization, 2011, (1): 46-50.

[2.] Luo Qing-wei, Feng You-li.Design and Risk Assessment of Ground Subsidence and Ground Fissure Development in Pingmei Coal Mine [J]. Coal Science and Technology, 2017,36 (02): 107-109.

[3.] Yu Zha. Geological Disaster Prevention Q & A [M]. Chongqing: Chongqing University Press .2016.

[4.] Wei Zhang. Cause Analysis of Zhaohe Debris Flow in Erlong Town in Zhenping County in Henan Province[J]. Applied Mechanics and Materials,2014,3489(638):.

[5.] Malinowska Agnieszka ,Hejmanowski Ryszard. The impact of deep underground coal mining on Earth fissure occurrence [J]. Acta Geodynamica et Geomaterialia ,2016,(4):321-330.

[6.] Feng You-li, Luo Qing-wei.An risk assessment of ground collapse in goaf based on Rough set [J]. Journal of Henan Polytechnic University (Natural Science Edition), 2016,35 (6): 759-764.

[7.] Zou You-feng, Chen Jun-jie, Zhang Zi-yue.Study on the status of fund subsidy and the development of disciplines in mine mining subsurface project - based on the perspective of the National Natural Science Foundation of China [J / OL]. Journal of Henan Polytechnic University (Natural Science Edition), 2017, : 1-7.

[8.] Fu Yuanzhai, Wang Jingbo. Application of Geological Disaster Risk Management Performance Evaluation System Based on the BSC [J]. International Business and Management, 2015, 10 (1):.

[9.] Yunzhang Rao,Ruizhi Gu,Ruikai Guo,Xueyan Zhang. Measures to restore metallurgical mine wasteland using ecological restoration technologies: A case study at Longnan Rare Earth Mine[J]. IOP Conference Series: Earth and Environmental Science,2017,52(1):.

[10.] Wang Xian-Guo, Ge Yan, Wu Dong-Min et al. Geological Hazards in Xiaoqinling Mining Area, Henan Province [M]. Wuhan: China University of Geosciences Press .2010.

[11.] Meng Zhen, Li Zhigang.Analysis of the Geological Environment Protection and Management and Recovery Technology in Coal Mine [J] .Environmental Energy Conservation, 2013,27 (6): 36-38.

[12.] AL Alam, S Hespiantoro, D Dyar, D Balzer, D Kuhn, J Torizin, M Fuchs, S Kastl, J Anhorn. Science-practice nexus for landslide surveying: technical training for local government units in Indonesia [J]. IOP Conference Series : Earth and Environmental Science, 2017, 56 (1):.