The Main Hydrogeological Characteristics of Mineral Deposits in China

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ABSTRACT

It is very apparent that the hydrogeological characteristics of mineral deposits in China be dominated by meteoric factors, terrain factors and the kind of karstic aquifers as a main source threatening the mining. The hydrogeological characteristics of mineral deposits in dry areas are very different from that in non-dry areas. The rote of precipitation is very important to mine dewatering. The difference of water recharge condition of a mineral deposit located upper (or under) local erosion basis is existing.

There are more than two million square kilometers of carbonate in China. Many water-bearing deposits are distributed in it. According to the karst shapes the surrounding karstic aquifers of mines can be divided into three kinds including solution fissure aquifer, karstic cave aquifer and underground stream (karst stream) aquifer.

Underlier invasion is a main feature of karst water-bearing coal mine and upperlier incoming is a main feature of skarn copper and ferro mine. Swallor pillar and collapse is a special feature of karstic water-impregnated mine.

INTRODUCTION

The chinese mine resources including coal, nonferrous and ferrous metals and other mineral resources are abundant. They are formed in various special geological circumstance and the hydrogeological characteristics will be changed with the site and the kind of mine.

We have carried out mine-hydrogeological and mine engineering geological exploration of different degrees in fifteen thousand and seven hundred fifty ore fields including one hundred thirty-seven kinds of mine since the liberation of china providing data for the mining design of more than six thousand national mines.

—, The Main Hydrogeological Characteristics of Mineral Deposits In China

It is very apparent that the hydrogeological characteristics of mineral deposits in china be dominated by meteoric factors having regional regularity. The role of precipitation is very important in mine dewatering.

In general, the hydrogeological characteristics of mineral deposits in dry areas including Xinjing Uygur Autonomous, Innomenggulia Autonomous Region, Qinghai Province, Gansu Province and north Ningxia Hui Autonomous Region are very different from that in non-dry areas. There is little precipitation(less than 250 mm per year, some place even less than 10 mm) and great evaporating capacity in dry areas. Acridity larger than 4. The hydrogeological condition of mine is simple because the recharge source of ground water is limited and the yield of mine-dewatering is small. Therefore, the main problem of mining in dry areas is not dewatering but water-supply. As for non-dry areas, the precipitation rate per year ranges from 250 to2500 mm. Most rangs from 400 to 1000 mm. Acridity less than 1-2. Because there is a well recharge condition of ground water and a bigger yield of mine-dewatering. The hydrogeological condition is much complicated.

Most mineral deposits in china locate in mountainous districts including mountain(33% total area of china), plateau(26%)and hills(10%). Which is about two-thirds total area of china. It is much obvious that the recharge condition of mine-water be affacted by terrain factors, especially when main mine locates upper or under local erosion basis.

While locating upper erosion basis, the terrain condition of the mineral deposit is not advantageous to the confluence of surface and subsurface water but is advantageous to natural discharge. There is even no influence of surface water to the recharge of mine-water. The hydrogeological condition of mineral deposits is simpler there. In dry districts, there will even be no water in mining when mine locates upper local erosion basis.

Terrain condition is not advantageous to natural discharge if mine locates under local erosion basis. There will be more confluence and more recharge source. The hydraulic connection between surface and subsurface water will offen occured through tectonic fractured belt. In this case, the hydrogeological condition of mineral deposits is more complicated.

==, The Main hydrogeological characteristics of karst water-bearing ore deposits in china

When main surrounding rocks or underlier or overlying rock is carbonate rock in a mineral deposit is called karst water-bearing mineral deposit.

The carbonate rock from Pro-Sinian to Triassic Period has a wide distribution in China. Large mineral reservoir of coal, ferrite , copper etc threatened by karstic aquifer is almost everywhere. Karstic groundwater is not only a main source of mine water-bearing but also a significant source of water supply.

General speaking, the hydrogeological condition of mine threatened by karstic aquifer is rather complicated and the amount of water-yield is huge. Ground water invasion offen occurs while mining. In some places, collapses are created during mine-dewatering. They seriously affect the mining.

Most of the abundant-water mineral deposits (water yield>1M^3/sec) in china are karstic water-bearing mineral deposits. We must take the way of combining drainage with water-supply, unifing management, and synthesizing evaluation . We must make the synthesis benefits of economy and society in changing inundation into water conservancy. In one hand, we need to decrease the threatening of ground water in mining. On the other hand, we also need to take advantage of it as water-supply source. This has an actual significance especially in building the base of energy source and iron-steel industry.

The result is well in preventing inundation by utilizing the synthetic methods of curtain grouting, stoping water loss and drainage in the abundant-water mineral deposits in china.

Mineral deposits threatened by karstic water in our country can be divided into three kinds according to the difference of karstic shape of aquifer. The first kind is mineral deposits threatened mainly by karstic solution fissure aquifer , the second kind by karstic cave aquifer and the third by underground stream (karst stream) .

(--) Mineral deposits threatened mainly by karstic solution fissure water

This kind of mineral deposits are mainly distributed in the north of Qin Mountains-Dabie Mountain-Huaihe River of China. That is, the most part of the tectonic unite of North China Platform. The Majiehou limestone of Middle Ordovician widely distributed in north China is the principal aquifer that threatens the mining. The main hydrogeological characteristics are:

1. The space of the aquifer that threatens mining is mainly karstic solution fissures and then karstic caves subsidiary. It forms solution fissure net system.

2. The ground water flow in karstic fissures is basically permeable flow having relative homogeneous and well connective property.

3. Most of this kind of mines store in rich-water, high-pressure and large scale storage tectonic unit. The amount of water-yield in strong runoff belt is rather big.

4. The condition of recharge, runoff and discharge of karstic water is offen been controlled by fracture and igneous . Which also has an significant influence to the yield of mine.

(==) Mineral deposits threatened mainly by karstic cave water.

They are mainly distributed in the south of Qin Mountains-Dabie Mountain-Huaihe River of China including Taiwan province. That is, the South Chinese Geosynclinal Folded System and the north-east part of Yangtzi Platform.

The aquifer of threatening mining is limestone of Devonian, Carboniferous, Permian and Triassic etc. Among which the storage property of Marokou limestone of low Permian is the best. The principal hydrogeological characteristics of this kind of mines are as follows:

1. Karst commonly exists in aquifer. Most of them are karstic caves. Karstic fissure and karstic pore are subsidiary. The vertical zoning is apparent. The caves are commonly exist and its filling degree is high in shallow part of aquifer.

2. The distribution of karstic groundwater is heteogeneous. The groundwater is permeable flow in macroscopic and has unite water table in general.

3. Karstic collapse is very common.

4. Most of the aquifer threatening mining formed some storage tectonic unit of small scale.

(二) Mineral deposits threatened mainly by underground stream (karst stream)

They are mainly distributed in the south west China. That is, the south-west part of Yangtzi Platform. The aquifer threatening mining is limestone of Devonian, Carboniferous, Permian and middle and low Triassic. Among which the Yangxian limestone of richwater of low Permian is the principal aquifer. The hydrogeological main characteristics of this kind of mines are,

1. The bare degree of aquifer is high and the karstification is strong. In this area, it is common that karst depression, karst funnel, water sink, cave, hidden cavern and hidden river etc. A large amount of precipitation turn into groundwater and only a few turn to form surface flow throughout the year. There are several underground stream (karst stream) systems in some mineral deposits. Each of them formed independent system of recharge, runoff and discharge having no reciprocal hydraulic connection.

2. Karst is rather heterogeneous here and there is no water or little water along the two sides of underground stream (karst stream). Ground water hasn't any unite water level. Its flow has the hydraulic characteristics of watercourse flow.

3. The flux of underground stream is dependent on its catchment area.

4. It is very apparent that the water regime of underground stream be controlled by precipitation. The flux in rain period is several tenthes to several hundreds times bigger than in dry period.

The principal feature of coal mine threatened by karstic water in China is underlier water invasion. The conductive fracture is offen the main path. The coal field in Carboniferous and Permian of north China is threatened by water invasion coming from the aquifer of middle Ordovician limestone under the coal floor(Fig. 1). And the karst water intake from upperlier is the principal feature of skarn ore mine of north China(Fig. 2). Karst water is also the important water-supply source of cities and towns, agriculture and industry in north China.

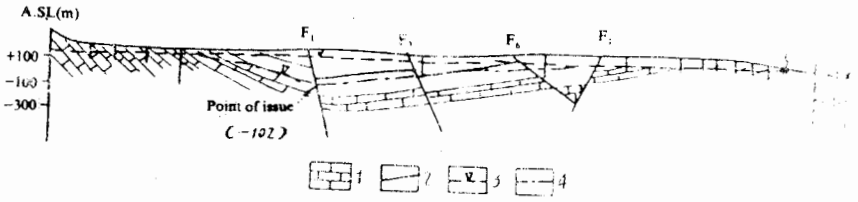

Fig.1 The sketch map of geological section of Hebei Fengfeng coal mine

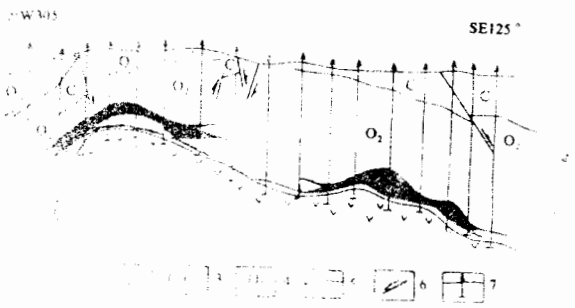

Fig.2 The sketch map of geological section of Hubei prov.Wang Yao ore mine

1.Mid.Ord.limestone aquifer
2.Coal layer
3.Water level before water-intrusion
4.Water level after water-intrusion
1.Iron orebody 2.Diorite 3.Carboniferous
4.Mid.Ord. 5.Geological boundary
6.Fault 7.Borehole

One hundred and thirty times of water invasion have happened in abundant-water coal mine of north china since 1949.Among them there are twenty-two times which the amount of water invasion ranges from 50 to 100 m^3/min and eleven times the amount of water invasion bigger than 100 m^3/min.The biggest is 2053 m^3/min.The abundant-water coal mine of north China is Kailuan,Tiaozhu,Fengfeng,Zhibo,Xinwen,Feicheng etc.

The coal field in upper Permian of south china is threatened directly by the karst water of Maokou limestone of lower Permian under the main coal layer.The main coal layer of Longtan is only several centimeters to several meters to the under Maokou limestone aquifer in middle Hunan province.Thirty-nine times of water invasion have happened in abundant-water coal mines of Enkou,Meitanba,Doulisan,Qiaotouhou etc.The amount of water invasion is 58 m^3/min in Enkou coal mine(Fig.3).The limestone aquifer of Triassic,Carboniferous and Devonian is the uppertier surrounding rock aquifer of polymetallic mines in west Hunan province and north Guangdong province and of skarn copper and

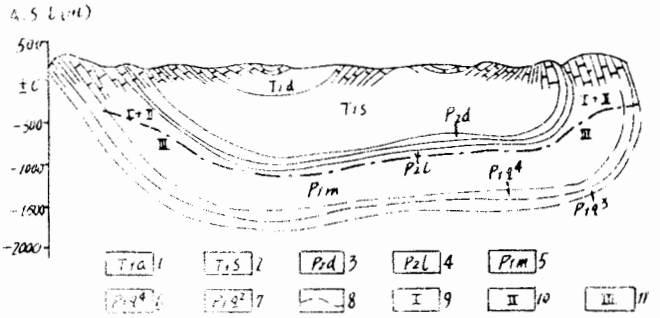

Fig.3 The sketch map of hydro-geological section of Enkou coal mine in Hunan province

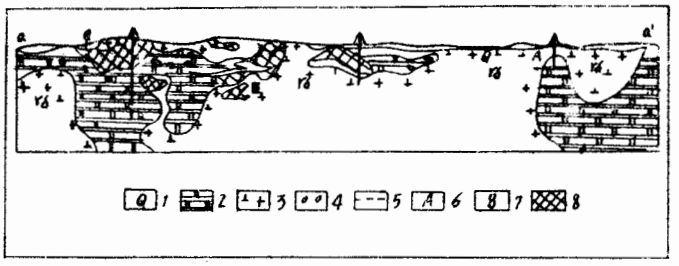

Fig.4 The sketch map of hydrogeological section of Tonglu mountain copper mine in Hubei province

iron ore mines in the district of middle and lower reaches of Yangtze river. The aquifer including karst and having strong storage theratens the mining(Fig.4).

1. Karst aquifer of lower Triassic
2. Weak aquifer
3. Aquifuge of upper Permian 4. Coal
5. Maokou karst aquifer of lower Permian 6. Qixia karst aquifer
7. Aquifuge 8. Karst boundary
9. Strong developed karst belt
10. Middle-degree karst belt
11. No karst belt

1. Quaternary 2. Marble of middle and lower Triassic 3. Magmatic rock 4. Cave
5. Karst boundary 6. strong karst belt
7. Weak karst belt 8. Orebody

There are also some abundant-water mines threatened by underground stream (karst stream) aquifer in west Hunan province and south west China. One of them is jianbei coal mine in Sichuan province. The amount of water invasion is 1500m^3/min and the damage is enormous.

三, The swallow pillor and collapse in the district of mine threatened by karst water

(一)Swallow Pillow, The karstic swallow pillow of circular or elliptic post is offen been met in the coal mining of Carboniferous and Permian of north China. Which is a special natural karstic collapse feature of coal mine threatened by karstic water in north China. It is formed when the upper layer collapses into the karstic space in carbonate rock.

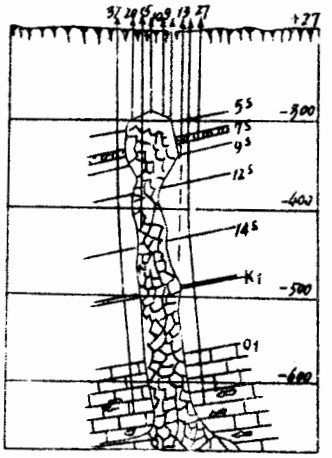

Fig. 5 Water intrusion swallow pillar of Fanggezhuang coal mine in Kailuan coal field of Hebei province

The swallow pillor are mainly distributed in the coal mine district of Carboniferous and Permian of north China. Most in Shangxi and Hebei province.

The drop of swallow pillow ranges from several tenthes to several hundreds of meters. Which directly affects the construction of well tunnel of coal mine. Conductive swallow pillow plays a role of water invasion path. There are forteen swallow pillows in Kailuan coal field of Hebei province. Among them there is a enormous conductive swallow pillow that the diameter bigger than 60 meters and the height bigger than 280 meters in 2171 face of -313 meters level of Fangezhuang coal mine. It conducted the aquifer of Ordovician to form water invasion. The amount of water invasion reaches 2052 m^3/min and the mining-well was submerged(Fig. 5).

(二) Surface Collapse, Surface collapse caused by drainage, water invasion and dewatering of mine is a special phenomenon in the limestone covered by the Quaternary shallow sediments. It is a very sharp hydrogeological and geoengineering problem of mineral deposits threatened by karst water and also an important geo-environment problem.

There are ninty-four mine fields having collapses that have been discovered. They are mainly distributed in south China. There are also a few mine fields having collapses in north China but the scale and quantity of collapses far inferior to in south China.

Six thousand and one hundred collapses had been discovered in Enkou coal mine of Hunan province before 1986. House of 18.3 km^2 and more than 9500 mu farm fields had been damadged and eight small resevoirs had been destroyed. Surface water flood into pit along the collapse caves in riverbed. The pit yield speeded from 21.7 m^3/min in normal up to 70.8m^3/min .

More than six thousand collapses had been discovered in the drainaging funnel that inferior to 1 km^2 in Siding pb-zn mine of Guangxi Zhuang Autonomous Region before 1981. One -third river water flow into pit along the collapse caves in riverbed in the summer rainstorm period in 1976. The instant maxium drainaging yield reached 24 m^3/sec and the pit was submerged.

The total drainaging yield is 223934 m^3/day in the coal mine of Meitanba in Hunan province. More than twenty times of water-invasion and mud-invasion had happened. More than two thousand collapses had been discovered before 1983. A mud-rock invasion of 500 m^3 happened in the east main lane of -90 meters level of Zhushantang well in september 25, 1980. Which made sixty meters of tunnel be stoped up.

The surface collapse is controlled by karstic regularity. Which offen occurs in the place where the thickness of the Quaternary sediment above the karst is less than 30 meters(seldom reaches 50 meters), the shallow karst is common, the flow of ground water is strong, the fractured belt is nearby and the place of riverbed , low-lying land and swamp etc.

REFERENCES

1. The review group of mineral hydrogeology and engineering geology of geology department, Selections of review report for the karst water-bearing mines. The Geology Press, 1986

2. Yu Pei , The mineral hydrogeological and engineering geological work want to give better service to the exploration of mine resource, China Geology, November 1986

3. Xin Kuide Yu Pei, Study of the conjunction of water-supply and drainage for karst water abundant mines in the north of China, Hydrogeology and Engineering Geology, May 1986