Mine Water Issues in China

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Abstract The mine water issues in China are different from those in Europe and other countries. This article presents the hydrogeologic conditions and the mine water issues in China. In North-China, as increasing the mining depth, the occurrence of hazardous water-inrush accidents reaches a new peak since 2000 and the underground water control would confront more serious challenge from the underlying Ordovician karst aquifers. In South-China, coal mines are menaced by the underlying and overlying Permian karst aquifers. In arid-semiarid Northwest-China, the urgent and most important issues are to protect and preserve the limited water resources and the fragile environment.

Key Words China, mine water issues, water-inrush, water protection

Introduction

China owns many types of coal-bearing basins and has large amounts of coal resources. The coal production will reach 2,600 Mpta in 2010 (National Development and the Reform Committee 2007). The current mine water issues in China are distinctly different from those in the 1990s and also obviously different from those in the Europe and other countries (Christian 2005).

There are mainly five types of coalfields in China, i.e. Permian-carboniferous Coalfields in North China, late Permian Coalfields in South China, early Jurassic Coalfields in Northwest China, Cretaceous Coalfields in Northeast China, Tertiary Coalfields in South China, etc. The distribution of the coal-bearing basins is shown in Figure 1 (China Bureau of Coal Geology 2001). Different types of coal-bearing basins means different typical hydrogeologic conditions and different typical mine water issues. This article mainly focuses on the tough mine water issues in North China, South China and Northwest Coalfields.

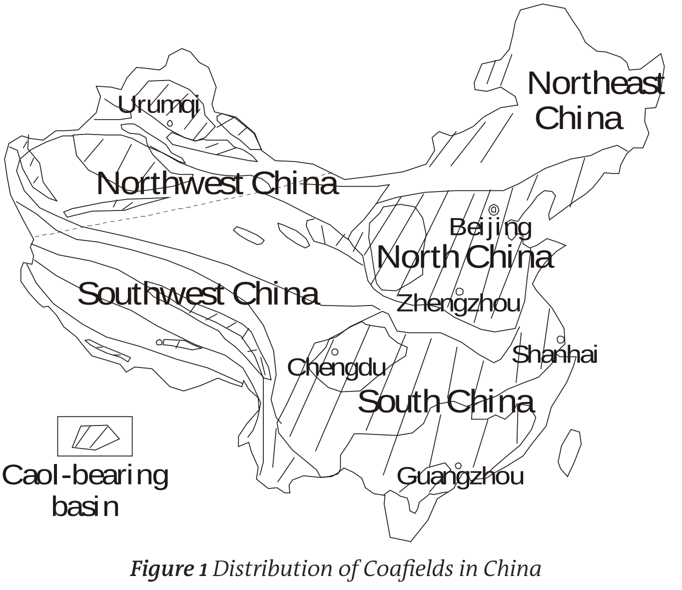

Figure 1 *Distribution of Coafields in China*

Higher Ordovician aquifer water pressure challenge in North China

The coalfields in NorthChina are typical Permian-Carboniferous coalfields. Figure 2 simply shows the stratigraphic column of Feng-Feng Coalfield in North China. North China are nearly absent of the Mesozoic and Tertiary deposits and the Permian-Carboniferous formations directly underlay the unconsolidated Quaternary strata. At the same time, the Silurian and Devonian deposits are also missed in North China and the Permian-Carboniferous formations nearly overlay the middle Ordovician.

Hydrogeologically, the direct flooding layers of the coalmines in these coalfields are the Permian and Coarboniferous fractured sandstone aquifers and the indirect flooding layers are the overlying unconsolidated Quaternary aquifers and the underlying regional karst Ordovician aquifers. The average altitude in North China is 50…200m. The Permian and Carboniferous coal layers are beneath the regional erosion base. The Permian and Coarboniferous fractured sandstone aquifers are water enriched and contribute most water to the mine water inflow. At the same time, the overlying unconsolidated Quaternary aquifers and especially the underlying regional karst Ordovician aquifers also pose greater threat to the coal mines in this region. Therefore, the hydrogeologic conditions of the coal mines in North China are usually complicated and most of the coal mines are called “large water inflow mines”.

Since the 1950s, almost all kinds of roof and floor water bursting had continually puzzled the coalmines of North China. One of the famous accidents is the Ordovician karst water bursting & flooding through a sink-hole, at Fan-ge-zhuang Mine, Hebei, in 1983. So the key mining hydrogeology and mine water issues in North China since 1950s mainly focused on preventing mine water accidents. The occurrence of the hazardous, vast water-inrush accidents was mostly controlled during the 1990s.

Since the 2000s, the upper early Permian coal reserves of North China have left a little. Most of the coal mines have to turn to the lower late Carboniferous coal reserves. As increasing in mining depth, the geologic and hydrogeologic conditions also turn more deteriorated. For example, mining pressure increases, underground water pressure proliferates, underground temperature boosts. In particular, the water pressure of the Ordovician karst aquifer, just beneath the Carboniferous coal layers of Tian-yuan Formation 10—50m, will increase to 3—8 MPa. In 2005, the occurrence of hazardous, vast water-inrush accidents reaches a new peak after the 1990s. The underground water control in this region would confront more serious challenge.

At the same time, the Ordovicians in North China are important karst water supplying aquifers and of significance to domestic, industrial, agricultural, and environmental water need of this region. The Ordovician aquifers are protected and strictly forbidden from being anarchically developed.

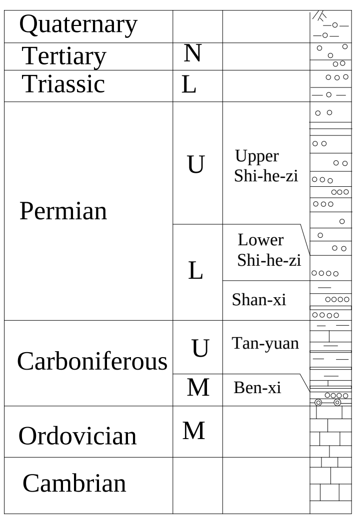

Figure 2 *Stratigraphic column of Feng-feng Coafield in Noth-China*

To prevent hazardous floor-water-inrush accidents from high-water-pressured underlying Ordovician aquifer in North China, the series of theories and techniques developed in recent years include: (1) recognizing that underlying faults and pit-holes are the most possible path to occur floor water-busting, the actual water-bearing and water-bursting aquifers vertically lies in the middle of the Ordovicians, and the top of Ordovician strata partially-fully filled by calcite, pyrite and clay can serve as relative aquifuge; (2) having developed work-to-art underground geophysical exploration techniques, which have been a necessary part of work to check the underlying faults, pit-holes, karst zones and the like in advance; (3) on the basis of above theory and exploration results, re-assessing the dangerousness of coal excavation from high-pressured Ordovician; (4) having developed reliable floor-grouting techniques to consolidate weak floor, faults, pit-holes, which have been widely adopted many North China coal mines.

Now, more and more Taiyuan coal reserves threatened by the high-water-pressured underlying Ordovician have been vastly liberated and successfully excavated in North China.

Late Permian karst water-inrush prevention in South China

The coalfields in South China locally occurred in late Permian. Fig. 3 shows the stratigraphic column of the region. The main minable coal layer lies in the late Permian Longtan Formation. The overall coal products of this region account for small part of national total coal production.

Hydrogeologically, South China is in humid region and dominated by modern karst terrains. Coal excavation from late Permian Longtan Formation is seriously threatened by lower Maokou karst aquifer and upper Changsxing karst aquifer. All the times, the key issue in South China is to prevent late Permian karst water bursting.

Groundwater and environment protection in North-west China

The primary minable coal layers of these coalfields lie in the lower Jurassic Formation. The reserves of this region account for over half of the national total coal reserves. The state is transferring the center of coal industry in 21st century to North-west China.

The geologic and hydrgeologic conditions of North-west region are relatively simple. The mine water inflow is primarily derived from weak Jurassic sandstone aquifer. The total mine water inflow of a mine is usually no more than 100—300 m³/h. Mine water bursting hazards only happened under certain special circumstances. For example, Quaternary water from Sala'usu sand burst into Da-liu-ta Mine, Shendong Coalfield in 1996.

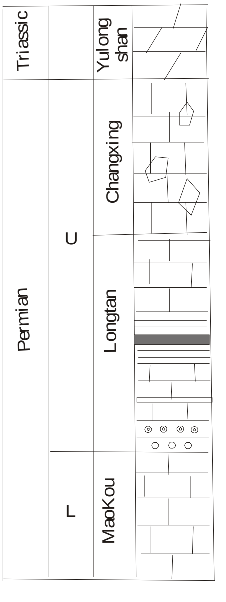

Figure 3 *typical column of the South-China*

The environment of the North China is vulnerable. The urgent and most important issue is to protect and preserve the limited water resources in the region. Since late 1990s, the state has invested much funds and performed series of research on the environment and water protection technologies.

The main solutions and techniques include: (1) dividing the North-west aquifers into different water protection type; (2) coal mining being strictly banned within or near the important surface water bodies and underground water aquifers; (3) some weak water-bearing aquifers within the roof fracture zone being dewatered as possible in advance, to enhance the water utility of weak aquifer; (4) developing gaof-water pooling technique, to enhance the goaf mine water utility; (5) applying goaf-filling technique in North-west to control roof caving and fracture zone and protect overlying aquifer(Miao 2009).

The solutions and techniques have been successfully adopted in Shendong mining area.

Conclusions

The mine water issues in China are different from those in the 1990s. The coalmines in North-China will have to confront challenge of higher Ordovician water pressure; the main solution is not to dewater the Ordovician but to use the top Ordovician as relative aquifuge to liberate the Taiyuan coal seans. Those coalmines in South China are always cautious against the danger from overlying and underlying Permina karst aquifers. The key issues in Northwest China are to protect the water value resources and the vulnable environment; water protection zone delineating, weak aquifer water pooling, goaf water pooling, goaf filling, etc have been used to protect Northwest water resources and environment.

References

National Development and the Reform Committee, People's Republic of China. (2007) The "Eleventh Five Year" development programming in coal Industry. National Development and the Reform Committee, People's Republic of China.

Christian Wolkersdorfer, Rob Bowell. (2005) Contemporary reviews of mine water studies in Europe. Mine water and the Environment, 24: (supplementary materiall) 1—76.

China Bureau of Coal Geology. (2001) Systematic analysis of coal field occurrence in China. Xuzhou: Press of China University of Mining and Technology.

Miao Xie-xing, Wang An, Sun Ya-jun, et al. Research on theory of mining with water resources protection and its application to arid and semi-arid mining region[J]. Chinese Journal of Rock Mechanics and Engineering, 2009, 28(2): 217—227