Shift of mine water inflow from fissured coal layer aquifer to thick overlying aquifers: a western Jurassic coal mine, China

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Abstract

The mining hydrogeological conditions of the Ordos coalfields disclosed by the active coal mines are actually various and more complicated. The Xiaojihan coal mine is located in the east of the Ordos and is turning into a more complicated hydrogeological status. The article presents evidences to prove the changes and explores the reasons for this phenomena. Increased inflow rates, dropped aquifer water levels, decreased mine water TDS, etc. indicated that the sources of mine inflow have really been shifting from the fissured coal-layer aquifer to the overburden J_2a-J_2z sandstone aquifers. The total mine water inflow still insistently goes up. This posed more serious challenges to mining safety . We should timely take measures to prevent it evolving into another mine water hazard.

Keywords: mine water inflow, Jurassic coal fields, shift, western China

Introduction

The Ordos Jurassic coalfields basin in the western arid China now is becoming the key base of China coal industry (National Development and Reform commission 2016). However, the more serious challenge are that the mining hydrogeological conditions disclosed by the active coal mines are actually various and more complicated.

The Xialjiao coal mine is located in the east of the Ordos basin. It is a fully mechanical modern coal mine, has the production capacity of 10 million tonnes and commenced coal mining in 2014. The main minerable coal beds of the coal mine lie in the upper part of the middle Jurassic Yan'an Formations (J_2y), which are overlain by the middle Jurassic Zhiluo Formations (J_2z) and An'ding Formations (J_2a), the lower Cretaceous Luohe Formations (K_1l) and the Quaternary sand deposits. As reported by the detailed coal exploration: (1) all the middle Jurassic and the Lower Cretaceous were half-consolidated; (2) while mining, the water interconnected zone would at most reach the J_2z sanstone aquifers, which would resultantly be the water source aquifer and might drain a limited quantity of mine water owing to its weak water abundance; (3) the J_2a and K_1l aquifers are higher above the water connected zone; and (4) the type of mining hydrogeologic coditions at the Xiaojihan cola mine was calssified as simple.

However, as the ealier mine coustruction engineerings, including ventilation shaft, main roadways and first trial longwall face etc., were drawing near or passing through the J_2y cola layer, there unexpectedly happened a seires of serious waterburst with high water pressure and big inrush rate. It was verified afterwards that the minerable coal beds were actually hard, fissured and fully water carring, i.e. rare fissured-coal-layer aquifers. It was observed that the rare fissured-coal-layer aquifers were being strongly dewatered and its water pressure were apparently lowering. The maximum total inflow at that time was up to 800 m^3/h. The Xiaojihan coal mine was then re-classified as hydrogeologically medium complexity with a potential risk of rare fissured-coal-layer aquifer water inrush.

But 2-3 years later, more long wall faces were excavated and the mining continuously went western and deeper. Though the inflow

from the coal-layer aquifer shrinked further, the total mine inflow at the Xijihan coal mine went up from about 700 m^3/h in 2013-2015 to 1200 m^3/h in 2018. Certainly there were inflow water sources other than the fissured coal-layer aquifer. The overlying roof aquifers of Zhiluo (J_2z) and An'ding (J_2a) of the Middel Jurassic, which had previously explored to be bearing less ground water, began to contribute the most of total mine water inflow. We were forced to re-consider the mining hydrogeologic features of Xiaojihan coal mine.

Methods

Mainly from the perspective of a hydrogeologic practioner and on the data basis of regular in situ observation, water level monitoring, mine water inflow measurement and water quality analysis, use the hydrogelologic methods to assess the situation happened at Xiaojihan coal mine. .

Analysis

The evidence to prove the water sources of inflow shifting includes: (1) The total mine inflow at the Xijihan coal mine has gone up from about 700 m^3/h in 2013-2015 to 1200 m^3/h in 2018; There are certain inflow water sources other than the fissured coal-layer aquifer; (2) Driving the coal gateways of a langwall face had dewatered the coal-layer aquifer to almost depletion, then roof dripping water in the goaf side predominated current inflow drainage; The roof dripping water from the J_2a-J_2z sandstone took account 77% of the total mine inflow; (3) the groundwater level of the J2a sandstone aquifer and the J_2z sandstone aquifer has decreased up to 20m-40m since 2014; and (4) The TDS of mine water showed an obvious downwards trend. On this basis, we assessed that the hydrogeology condition at the Xiaojihan coal mine got shifted and more complicated.

The Reasons for the changes of ming hydrogeological condtions at Xiaojihan caol mine: (1) As the initial mining activities dewatering the fissured J_2y coal-layer aquifer, the active underground mining areas were beginning to evolve into a groundwater "sink"; The "sink" was getting larger and larger with the subsequent mining engineering; (2) There were no ideally expansive and uniform aquifuge formaitions between the J_2a-J_2z sandstone aquifers, which occurred lense-like in the Jurassic intraplate lake sedimentary basin; and (3) Though the J_2a-J_2z sandstone aquifers were more than 120m above the J_2y coal bed, coal excavation have actually caused much higher water interconnected zone than we had expected; The water interconnected zone had gone further upwards to the J_2a-J_2z aquifers; Semi-consolidated feature of the Jurassic should account for the higher water interconnected zone(figure 1).

Features of current mining inflow at Xiaojihan coal mine: (1) The inflow rate was still accumulatively increaseing with the further expansion of mining area; and (2) It is diffilcut to find a geologic channel or target area to block the water recharge or to prevent the increase trend of mine water

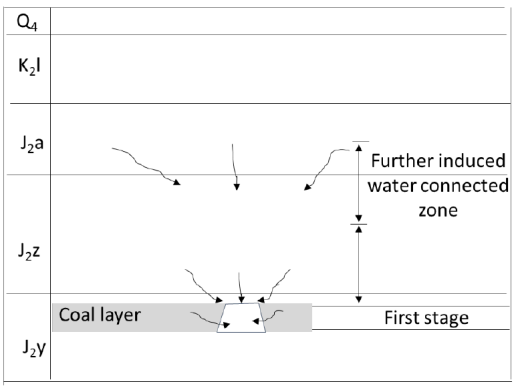

Figure 1 *schematic map of hydrogeologic condition shifting at the Xiaojihan col mine*

inflow. For the coal mines in this region, it is an unprecedented challenge.

Conclusions

Under certain condition, the mining hydrogeologic status of a coal mine might also be changerble. On the evidence of increased inflow rates, dropped aquifer water levels, already tiny decreased mine water TDS, etc., the sources of inflow at the Xiaojihan coal mine have really been shifting from the fissured coal-layer aquifer to the overburden J_2a-J_2z sandstone aquifers. It was the activities of initial mining and dewatering that gradually made the mining area a strong "sink", strenthened the originally weak hydrolic relationship between the J_2a-J_2z aquifers, and eventually induced the upper aquifers to discharge into the working face. It could be predicted that the water inflow would still be increasing. The situation was going worse. Could we timely prevent it evolving into a new kind of mine water accident? It is urgent.

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