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Comprehensive Evaluation and Analysis of Water-inrush Source in Wolonghu Coal Mine

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Abstract Fuzzy clustering method was used in the comprehensive evaluation on the water abundance of sandstone aquifer at the bottom of P_2xs (K_3) in the Wolonghu Coal Mine. Then this paper contrastively analyzed the characteristics of water-inrush and hydrogeochemistry of adjacent mines. The results show that the water abundance of northern sandstone is rich, the direct water-inrush source of working face is K_3 sandstone aquifer, and there is a hydraulic relation between this aquifer and the water of sandstone in adjacent mines. They have the same water source and the north of the coal mine gets a supply from external sources.
Keywords sandstone aquifer, water abundance, water inflow, the characteristics of hydrogeochemistry, water source discrimination

Introduction

Wolonghu coal mine belongs to Anhui Hengyuan Coal-Electricity Group Co.LTD. It amounted to gush water more than 10 times since its construction and the source of water dominated by upper Shihzi formation of Permian(P_2ss) sandstone aquifer and the bottom of P_2ss（K_3）is particularly acute. In September 2012, 8101 working face began to water-inrush, the largest water quantity amounted to 400 m^3/h. Although it had carried out a series of measures for controlling flood, water-inrush of the working face still remained steady about 170 m^3/h seriously affecting the safety production of mine. The water quantity was so great and lasted so long time. This was an extremely rare phenomenon in the history of water hazard control in Huaibei Coalfield. So, carrying out the evaluation on the water abundance of sandstone in Wolonghu mine northern mining area and determining the water supply source of 8101 working face were essential.

At present, the research methods for domestic and foreign scholars to distinguish the source of water-inrush are various and achieved certain results(Guo 2013,Ge et al. 2007,Han et al. 2013, Hu et al. 2009). This paper used fuzzy clustering comprehensive method for evaluation of the water abundance of K_3 sandstone aquifer. We can determine the water source in the mining area through comparing the characteristics of water inrush and hydrogeochemistry in Wolonghu coal mine with adjacent mines. It provided some certain scientific evidence for making water prevention technical measures for coal mines and this had practical significance.

Comprehensive evaluation of water abundance of the K_3 sandstone aquifer

Combined with the actual production conditions, lithological structure features, drilling mud loss, rock fracture development degree and the geological structure features (fault, fold) were selected as the evaluation index of water abundance. Aquifer water prediction method is mainly based on a large amount of hydrogeological data using mathematical methods after processing(Liu et al. 2009, Li 2010). Due to water abundance evaluation from a certain aspect has certain limitations, so the multi-factor comprehensive analysis method is adopted to improve the water prediction. This study used the fuzzy clustering multi-factor comprehensive prediction method, dividing Ⅰ, Ⅱ, Ⅲ, Ⅳ four grades, represented poor water-rich, moderate water-rich, strong water-rich and extremely water-rich. According to the degree of its effect on water abundance, we got the water abundance prediction map.

As shown in fig. 1, Wolonghu K_3 sandstone aquifer in coal mine was given priority to with moderate water-rich and strong water-rich, followed by extremely water-rich, weak water-rich rarely development; strong water-rich and extremely water-rich area occupied almost the entire mining area in the north wing mining area, the total area of 49.31%, and it was distributed to strip the North East. Overall evaluation results: the water abundance degree of K_3 sandstone aquifer was from medium to strong water-rich.

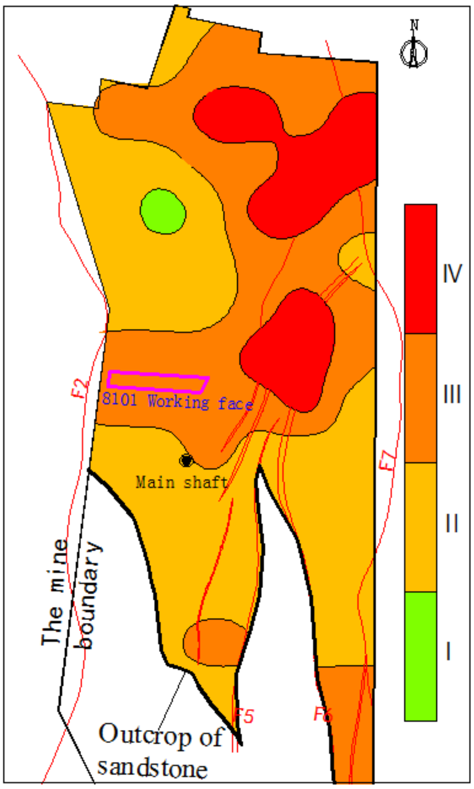

***Fig. 1** Section of water abundance of K_3 sandstone aquifer*

The characteristics of water inflow and hydrogeochemistry of the adjacent mines

In order to analyze the water source and influence scope of 8101 working face in Wolonghu mine, the adjacent mines hydrogeology characteristics were investigated and analyzed including Juji,Xinzhuang,Liuyi and Hengyuan coal mine located in the north of Wolonghu coal mine.

The characteristics of water inflow

Water-inrush phenomenon of 8101 working face appeared on September 16, 2012. The water quantity gradually increased at first and the largest inflow was 429 m^3/h. After December 2012, there was a downward trend and reduced to 170 m^3/h at the beginning of may stabling up to now (fig. 2). Compared to the adjacent mines water inflow, 22061 mining face and 21071 mining face roof water had occurred in Xinzhuang, which was roof sandstone fissure water. By the middle of September 2012, after the Wolonghu mine 8101working face inflow, the two working faces' inflow suddenly decreased tending to dry (fig. 3); Likewise, the same characteristic also occurred in 31 and 32 Mining area of Xinzhuang mine (fig. 4). In addition, As can be seen from the Fig.5, although the distance was far away form Wolonghu to Hengyuan, water inflow in Hengyuan mine which located on the northeast of Wolonghu mine began to gradually reduce, it may have a lag, so it can no rule out a link between the two sandstone mine water. Above all, after water inrush of 8101 working face, the sandstone aquifer water inflow of adjacent mines in the north significantly reduced, and gradually stabilized, it illustrated that the mines must have hydraulic relation between K_3 sandstone aquifer.

The characteristics of hydrogeochemistry

We have monitored the water quality of 8101 face in Wolonghu coal mine and made the Piper diagram (fig.6), from which you can see that the overall quality type is HCO_3SO_4-Na, and it's sandstone fissure water. What's more, the water quality made some changes with the extension of time, and the content of SO_4^{2-}, K^+ and Na^+ increased, as well as total dissolved solid increased gradually. Comparing the water quality of 8101 face with the one of upper loose bed and the seventh aquifer, we can find that the water quality of working face is largely different from the water quality in other aquifers, and its content of K^{+}+Na^{+} is much higher, as well as the content of Ca^{2+}+Mg^{2+} is low. Meanwhile, TDS is low correspondingly.

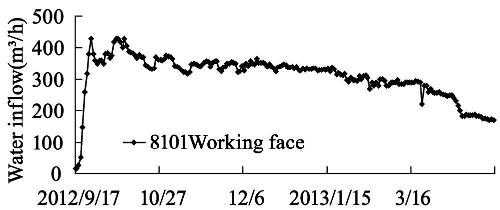

Fig. 2 *The comparison diagram of the change of water inflow in 8101Working face*

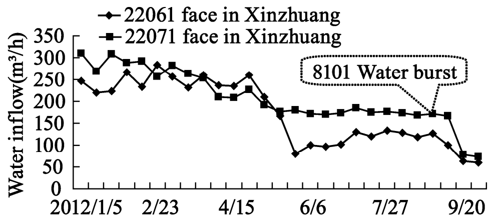

Fig. 3 *The comparison diagram of the change of water inflow in 22061 and 22071 face*

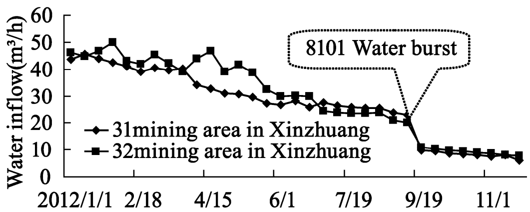

Fig. 4 *The comparison diagram of the change of water inflow in 31 and 32 mining area*

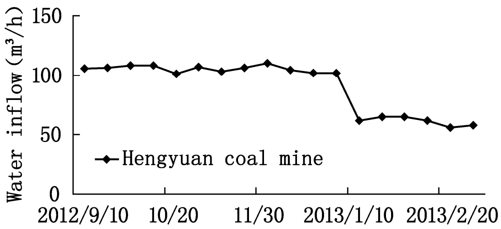

Fig. 5 *The comparison diagram of the change of water inflow in Hengyuan coal mine*

In addition, this paper has compared the water quality of outfall with aquifers in this mine and adjacent coal mines (fig.6 and fig.7). At the beginning of effluent, the water quality of outfall was slightly similar to the water quality of fissure water in magmatic rock, and it belongs to the fissure water of magmatic rock in roof. However, with the extension of time, the recharge source changed, and the water quality followed. The water quality of 8101 working face got to be similar to the element of sandstone water in Xinzhuang and Gedian coal mine gradually and was going to be in accordance with them.

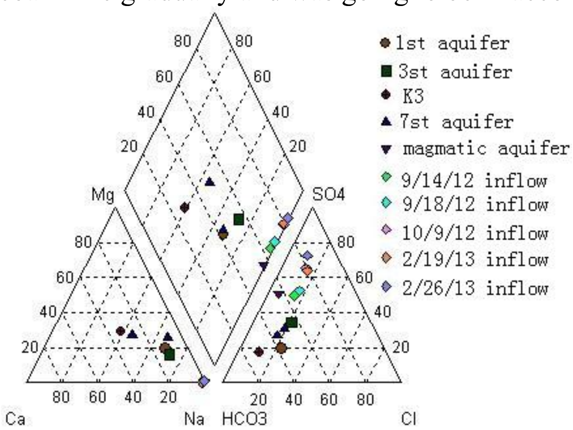

Fig. 6 *Piper figure of water quality of each aquifer and working face 8101 in Wolonghu Coal Mine*

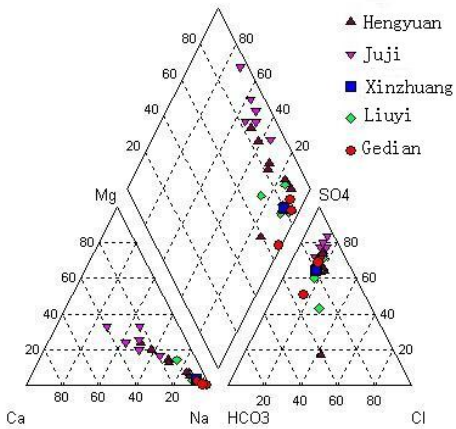

Fig. 7 *Piper figure of water quality of sandstone water in adjacent coal mines*

According to the above characteristics, the direct water source of 8101 face is sandstone aquifer of roof. The aquifer is not closely correlated with the aquifer of Cenozoic loose bed, but it has hydraulic connection with the sandstone water in mines near north, or they have the same source, which belongs to the same hydrologic unit. The region is supplied by external source and the source is located in the north of the mining area.

Conclusions

(1) This paper has made comprehensive assessment of the water abundance of K_3 sandstone aquifer in Wolonghu coal mine by assessment criteria like lithological structure features, drilling mud loss, rock fracture development degree and the geological structure features. The results show that the water abundance degree of K_3 sandstone aquifer was from medium to strong water-rich, strong water-rich and extremely water-rich area occupied almost the entire mining area in the north wing mining area, and it was distributed to strip the North East.

(2) We could get that the direct source of 8101 working face in Wolonghu coal mine is K_3 sandstone aquifer after the contrastive analysis of the water inrush and the hydrogeochemical characteristics of Wolonghu coal mine and adjacent mines. The aquifer has hydraulic connection with the sandstone water in adjacent mines and they have the same source, as well as the north of mine is supplied by external sources.

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