An Interdisciplinary Response to Mine Water Challenges - Sui, Sun & Wang (eds)
 ISBN 978-7-5646-2437-8

Mine Water Inflow Prediction Based on Double Groundwater Level Flow in Continuous Medium

Haifeng Li[1], Yuezan Tao[2], Peigui Liu[3]
1 Hefei University of Technology, Hefei 230009, hgdlihf@163.com
2 Hefei University of Technology, Hefei 230009, taoyuezan@163.com
3 Hefei University of Technology, Hefei 230009, peiguiliu@yahoo.com.cn

Abstract Owing to the exploration degree, generalized hydrogeological model and understanding level, water yield of mine is predicted to be constant over time. However, according to large of surveying and long-term monitoring activities, the mine drainage changed with the depth and time of mine operations. Because of permeable variability between different media in mine area, mine drainage occurs primarily as non-continuous flow. Using the module MODFLOW and incorporating the non-continuous flow theory into calculation, the predicted water yield was approximately 50% lower than that using the continuous flow theory.
Keywords mine water yield, non-continuous flow, double water level, mine area

Introduction

In most studies, the rate of mine water drainage is predicted to be constant over time. However, the monitoring data of many mines demonstrate that the mine yield tend to vary over the course of mine drainage (fig. 1).

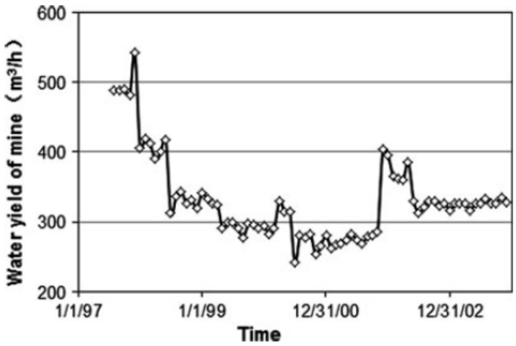

Fig.1 *Temporal variation in the rate of water yield of a mine in Anhui, China*

When there is no available for recharge and the inflow medium permeability is lower than that of the outflow medium. Based on the law of conservation of mass, the inflow water equals the outflow. Thus, the hydraulic gradient of inflow water must be greater than the outflow. The hydraulic gradient limit is the key to accurately predict the water yield of a mine.

Case study

The ore body observed for this study is situated in Anhui, China. The ore body of this deposit consists of four main water-bearing systems: loose pore water-bearing; clastic fissure water-bearing [Jurassic aquifer of Zhuanqiao group (J_3zh)]; volcaniclastic fissure water-bearing [Jurassic aquifer of Longmenyuan group (J_3I), Luoling group (J_2I) and Moshan group (J_1m)] and magmatic fissure water-bearing. Although the third water-bearing system consists of three parts, they have the same lithology and structure. There is no continuous aquiclude among the three groups with good hydraulic connection in this system. Usually it was regard as an entire level in the groundwater flow conceptual model. With artificial mining operations, fissures reopened and further development owing to the unloading effect. This phenomenon will lead to the upper aquifer's permeability less than the lower's. That is the main reason to result in double water level in continuous medium during mine drainage.

Methodology

In this study area, by comparing the model-simulated head with field-observed head, mathematical model was calibrated under transient conditions by varying the hydraulic conductivity, specific yield, storage coefficient and recharge within the simulated area.

The general three dimensional partial finite differential equation is expressed as:

$$\frac{\partial}{\partial x}\left(K_{xx}\frac{\partial h}{\partial x}\right)+\frac{\partial}{\partial y}\left(K_{yy}\frac{\partial h}{\partial y}\right)+\frac{\partial}{\partial z}\left(K_{zz}\frac{\partial h}{\partial z}\right)+N(x,y,z,t)=S_s\frac{\partial h}{\partial t} \quad (1)$$

K_{xx}, K_{yy}, K_{zz} are the hydraulic conductivities along the x, y and z coordinate axes parallel to the major axes of hydraulic conductivities (L^2T); h is the hydraulic head (L), Ss is the specific storage, N is the volumetric flux per unit volume representing sources and/or sinks of water, and t is time.

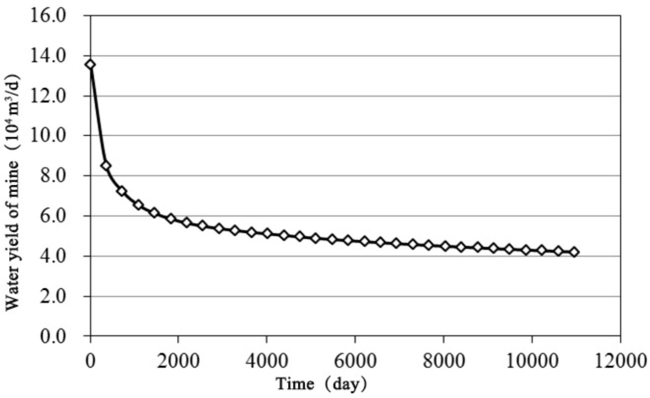

Fig. 2 *Temporal variation in the rate of water yield*

Results and discussion

The hydraulic gradient limit varies greatly with lithologic structure and further study is required to determine the precise hydraulic gradient limit. For the purpose of this study, the limit gradient is assumed to be 1/10 and intensive drainage is set at a depth of 500 m below the quasi mining surface. Its variation with time over a period of 30 years is shown in fig.2. The initial water yield is nearly 14.0×10^4 m^3 /d. After 15 years of continuous mining, the water yield decreases to about 41200 m^3/d (fig. 2). While the predicted water yield obtained from the continuous flow theory is 8.23×10^4 m^3/d.

Conclusion

The following conclusions were drawn from the above study results:
The predicted water of mine yield varied over time and the rate of mine water drainage approaches a constant rate.
Using the non-continuous theory, the predicted water drainage of a mine was about 50% lower than that result obtained from the continuous flow theory.

References

Liu PG (2008) Risk estimation model and its application on groundwater pumping. Dissertation, College of Water Resources and Environment. Hohai University , Nanjing (in Chinese)

Shu LC, Liu PG, Li W (2008) Environmental impact assessment using FORM and groundwater system reliability concept: case study Jining, China. Environ Geol 55(3): 661-667

Tian KM (1994) Research on the non-continuous flow in continuous medium. China Min Mag 32(2): 22-25