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Water disaster investigation and control in coal mine of Southern China

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ABSTRACT: The number of coal mines in Southern China was the possession of more than 60% of the total coal. This area was a large undulating terrain, and the terrain was so complex that the exploration was very difficult. The water damage had a great effect on southern mines. They were mainly threatened by the karst water and the goaf water. This thesis was studied through mining geophysics and its methods, which were able to fit the characteristics of karst regions. Using those methods, we could detect and determine the location, size, distribution, and water-filled situation of geological anomalies that was closely related to mineral water disasters. Based on the characteristics of the mine on geology, water damage, mine drainage, this thesis studied the prevention and control measures for coal mine features in southern China to carry out scientific governing for mine water damage.

The number of coal mines in Southern China takes up more than 60% of the total coal. This area is large undulating terrain, and landform was complex, so it was very difficult to explore [1]. There were greater affected by water damage. They were mainly threatened by limestone karst water and the goaf water. Due to faults or karst pipeline conducts water body，this made a great deal of mine water inflow and high drainage costs, and also often caused water inrush accidents[2]. It was a great threat to mine safety production. Meanwhile, long time of the small coal mining caused a large number of the formation of shallow goafs[3]. The area of water accumulation was not clear, which brought great secure risk to the later period of mine[4,5]. Therefore, the study of exploratory methods to water disasters and governing ways had an important reference significance in China Southern mine.

1. THE SOUTHERN CHINA MINE WATER DISASTER CHARACTERISTICS

There was a large topography of Southern region and a complex landform in China. Southern mine karst water disaster and goaf water disaster had certain regularity[6].

1) Karst water inrush was the main pipe flow, and it was fast and violent. So the disaster was very strong. In the process of roadway development, it would encounter a variety of karst water, which mainly for cave, collapse column, underground rivers and other pipeline flow.

2) Relationship between the distribution and structure of the cave was close. Caves were often interlinked with underground rivers, the surface of rivers, and even other aquifers. Distribution between caves was also closely related to the structure of stratigraphy.

3) Goaf water scope was unclear, and the goaf water inrush was generally rapid. Due to more mountains in the south of China, mine production capacity was small. Because of a shortage of funds, most of mines were not equipped with the necessary geophysical and geochemical exploration means, the power of prevention and control water was relatively weak.

2. THE MINING EXPLORATION METHODS AND EQUIPMENT IN SOUTHERN CHINA

For example, in the mining area of Zunyi, mine water disaster exploration, based on caves, underground rivers and goafs, was the main target of probe. According to various geophysical methods and applicable results of hydro geological exploration in the Southern mine, we chose three karst hydro-geology geophysical methods that were ground transient electromagnetic method (TEM), underground geological radar (GPR) and mining transient electromagnetic method (TEM). Our exploration approaches were mainly hydro-geological investigation, ground geophysical, underground geophysical prospecting and drilling.

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Figure 1: Southern Coal geophysical and complex terrain construction site

1) Mine hydro-geological investigation: Through the mine hydro-geological investigation in many regions, we mainly found the relationship of the mine among water source, channel, fill, diameter and discharge. Southern mining, which mainly water-filled channel had faults, karst pipeline, goafs, closed poor drilling.

2) Ground geophysical exploration: To enhance the signal of noise ratio and resolution of data collection as the core guiding ideology, taking into account the ground conditions of the Southern mine complex, we mainly chose the V8 multifunctional electrical meter, high-current transient electromagnetic instrument and super high density electric method.

3) Combined with large fixed source of TEM and Large current of TEM, we observed that under the condition of geological and topographical , the large fixed source of TEM had the advantages of high efficiency, high exploration depth, and could penetrate the high resistivity shielding layer. With this method, we could obtain good geological results in guiding water structure and water bearing zone detection.

In the case of poor conditions of terrain, large current of TEM could reduce the power supply coil and the receiving coil in this area. It made the efficiency multiplied in this field. We had achieved good detective results with these two detection methods.

For two examples of Changqing Mine and Lushuidong Mine in Southern China (Figure 2 and Figure 3), the figure fully reflected the region's stratigraphic changes, but also reflected the goaf water situation.

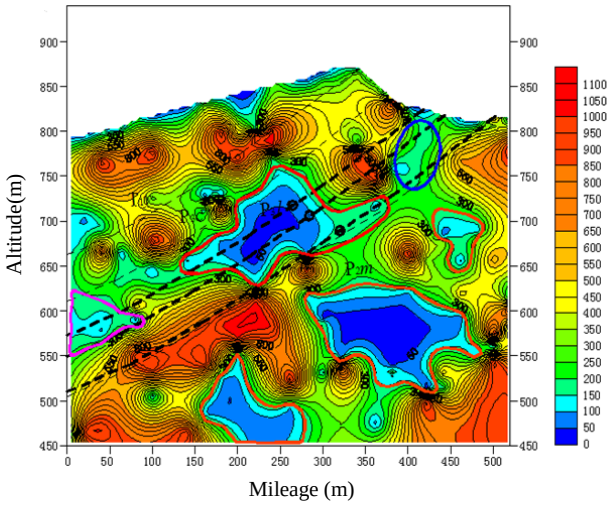

Figure 2: Changqing Mine apparent resistivity contour sectional view

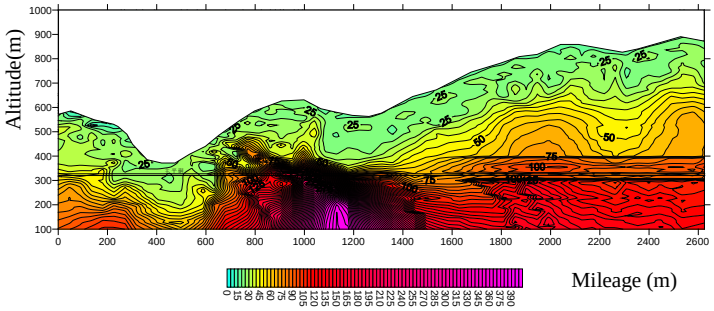

Figure 3: Lushuidong Mine apparent resistivity contour sectional view

4) A good exploration, combined with underground geophysical exploration and geochemical exploration: A variety of geophysical and geochemical exploration was a useful means to complement. Mine of GPR could carry out closely effective detection (30-50m) in front of the tunnel face, mine of TEM could be effectively detected on the water body for remote detection (80-100m), and mine in geochemical exploration was mainly water contented recognition for the goaf.

Considering that there exist 20m blind areas in mine TEM, We need to avoid blind areas in mine detection. After a lot of practice, we adopt the mine TEM tracking detection used as shown in Figure 4. The detection distance is 100m, and the driving distance is 80m; the next cycle reaches 80m to detect. In accordance with such 80m cycle detection, we can avoid blind area. By analyzing TEM response

characteristics of typical water flowing abnormal body, apparent resistivity contour is low resistance in a large scope when goaf or large collapse column is in the water filling conditions, and the continuity of low resistivity anomaly is better.

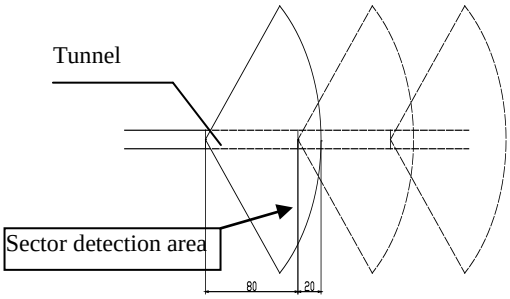

Figure 4: The track layout of sector detection the driving face

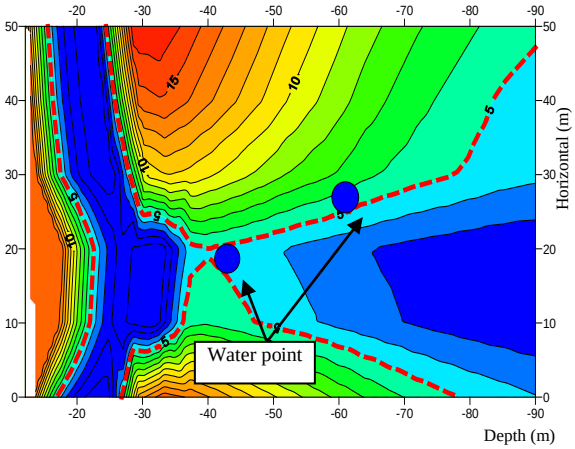

Figure 5: The contour map of apparent resistivity for tunnel detection

On the contrary, there is no blind area of the radar, which can detect continuously. Radar echo reflection method is mainly used for analysis.

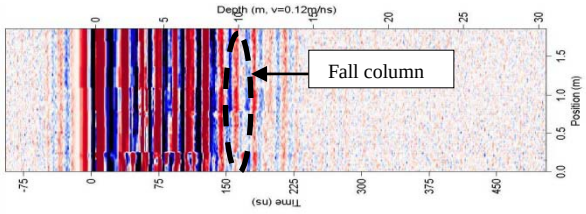

Figure 6: The radar detection results map of 3# coal concentrated track tunnel in coal mine mining area (10.9m fall column boundary)

3. THE COAL MINE WATER DISASTER'S CONTROL METHODS IN SOUTHERN CHINA

The principle of control mine water disaster was "Prevention, plugging, discharge, drainage and cut " in China. According to Southern mining characteristics of geology, water disaster, mine drainage, combined grouting sealing and interception, we should carry out scientific control of mine water disaster.

1) Karst water drainage

Drainage was the best way to karst water governing According to the hydro-geological conditions of mine, main methods were used in hydrophobic drilling, hydrophobic tunnel and other projects to carry out drainage.

2) Plugging on water gushing point

When tunnel crossed over the water inrush that threaten collapsed column in karst fracture zone, we should take advance pre-grouting method and ensure mine safety.

3) Drainage for thin coal seam of goaf water

Goaf water range and pressure in hydrocephalus should be clear before drainage. If we weren't sure, we could take geophysical method to identify the scope and the amounts of goaf water. At the same time, we still need to perform the mining policy while probing, to prevent local or other low-lying water.

4) Tests for water disaster treatment effect

For safe's sake, we had examined the effect of treatment on mine water disaster. The main test methods were geophysical exploration and drilling. Geophysical methods of water-rich region, drainage or grouting treatments were used to solve it.

4. EXPERIENCES AND CONCLUSIONS

1) The main method of exploration of the South mine area was transient electromagnetic method (TEM). In the case of flat terrain, TEM with large fixed loop was generally used to detect, and in the case of steep terrain, TEM with large current was generally used to detect. Coal mine detection by TEM and Ground Penetrating Radar (GPR), was combined with drilling, which could solve the water detection.

2) The commonly used method of water disaster governance was adit water gravity in South China coal mine. In the aspect of karst water prevention, drainage was the best way to control. Slip-casting was also a better way for controlling karst water. The control effect of mine water disaster must be inspected. After inspection and safety, the production of work could be carried out.

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