

Application of comprehensive geophysical exploration technology in mine hydrogeological exploration

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Abstract: In order to provide detailed hydrogeological information and ensure the safety of mining work, this paper summarizes the comprehensive geophysical exploration technology, analyzes the application requirements of the comprehensive geophysical exploration technology, and expounds the application scope of the comprehensive geophysical exploration technology in mine hydrogeological exploration, including mine tunnel exploration, geological disaster exploration, deep mine exploration, etc. Then, it puts forward the application strategy of comprehensive geophysical exploration technology in mine hydrogeological exploration, and obtains real and reliable hydrogeological data through flexible use of transient electromagnetic technology, shock wave advance technology, ground penetrating radar technology, etc., so as to provide reference for mining work.

1. Introduction

Hydrogeological exploration is a prerequisite for mineral exploitation. Due to the complexity of mine hydrogeology, it is necessary to conduct exploration in advance to obtain detailed data and information, so as to provide reference for the development of mining plans, so as to avoid safety accidents such as flooding. At present, China's mine hydrogeological exploration mainly adopts comprehensive geophysical exploration technology, which greatly reduces the difficulty of mine hydrogeological exploration, and is conducive to ensuring the accuracy of survey data, and plays a key role in promoting the development of mine engineering in China. Therefore, it is necessary to flexibly select comprehensive geophysical exploration technology according to the needs of mining work, increase the exploration of hidden areas of mines, and comprehensively investigate potential safety hazards.

2. Overview of comprehensive geophysical exploration technology

The integrated geophysical exploration technology is evolved from the traditional geophysical exploration technology, and integrates the advantages of the traditional geophysical exploration technology to realize the exploration of mine hydrogeology by using the physical law. It can be seen that the exploration technology of integrated geophysical exploration and integration of multiple disciplines can play an important role in the mine hydrogeological exploration. From the perspective of practical application of integrated geophysical exploration technology, with the development of modern science and technology becoming more mature and stable, it supports the combination application of multiple exploration technologies, and has strong flexibility. According to the requirements of mine hydrogeological exploration, different technology combinations are adopted to achieve comprehensive exploration effects[1]. In the exploration process, different detection instruments and equipment, combined with computer information technology, can be used to collect, sort out and analyze the mine hydrogeological data. Compared with other technologies, the data of comprehensive geophysical exploration technology is more reliable, has very high application value, and can complete complex hydrogeological exploration tasks[1].

3. Application requirements of comprehensive geophysical exploration technology in mine hydrogeological exploration

3.1 Determine the mining exploration mode

In the mine hydrogeological exploration work, the mine exploration mode should be determined in advance, the hydrogeological exploration mode should be designed according to the type of mine and the distribution of mine resources, the mining exploration standards should be strictly followed, the safe and reliable hydrogeological exploration operations should be implemented, the exploration results should be effectively guaranteed, and the reference basis for mining should be provided. Hydrogeological exploration work is to assist mine mining, should play a role in optimizing the mineral resources mining program, the use of standardized hydrogeological exploration mode, enhance the standardization and consistency of exploration work, reduce the impact of various factors, effectively ensure the accuracy of exploration results, lay a solid foundation for mine mining.

3.2 Reasonable selection of exploration technology

With the development of science and technology, the types of comprehensive exploration technology are gradually diversified. In the work of mine hydrogeological exploration, targeted selection should be made according to the actual situation to improve the adaptability of comprehensive exploration technology and reduce the difficulty of mine hydrogeological exploration. For example, transient electromagnetic technology, shock wave advance technology, ground penetrating radar technology, etc., are widely used in mine hydrogeological exploration work, should be analyzed in advance, select a single or multiple technology combination, to ensure the accuracy of exploration results. In addition, comprehensive geophysical exploration technology is fully combined with modern information technology, and the hydrogeological conditions of mines are fully displayed through the information system to provide standardized technical support for exploration[2].

3.3 Set up professional exploration team

The application of integrated geophysical exploration technology is to accurately analyze hydrogeological conditions and the distribution of mine resources, which has high requirements on the professional quality of exploration personnel. In order to give full play to the maximum value of integrated geophysical exploration technology and reduce the interference of human factors in the exploration process, a high-level exploration team must be set up [2]. Mining units should increase education and training efforts, improve the professional skills of exploration personnel, flexibly use comprehensive geophysical exploration technology, master the basic requirements of mine hydrogeological exploration, effectively deal with various influencing factors, and arrange special personnel to supervise and manage to ensure the smooth development of mine hydrogeological exploration.

4. Application range of comprehensive geophysical exploration technology in mine hydrogeological exploration

4.1 Mine tunnel exploration

At present, integrated geophysical exploration technology is mainly applied in mine tunnel exploration work. Since the mineral resources development in the central and western regions often adopts tunnel excavation and other forms, it is necessary to use integrated geophysical exploration technology for analysis. According to the mining demand and hydrogeological conditions, targeted integrated geophysical exploration means are adopted to carry out exploration and analysis of the target area to avoid affecting the mining efficiency. Traditional exploration methods require manual measurement and marking, which will consume a lot of time and energy. In contrast, comprehensive supplementary negotiation technology can obtain hydrogeological information in a short time and clarify the underground structure in mine tunnels, including the structure of

underground rock mass and the distribution of cracks, which has an important impact on the mining plan and is conducive to improving the construction quality of mine tunnels.

4.2 Geological disaster exploration

Comprehensive geophysical exploration technology is an efficient and accurate exploration means, which has been comprehensively promoted in the geological disaster exploration work of mines. It can quickly and accurately grasp the geological conditions inside mines, and predict the probability of geological disasters according to the survey results, so as to ensure the safety of mine production personnel. Geological disasters in mine engineering are often sudden and will cause serious consequences once they occur. Although the geological structure changes, the apparent level changes are not obvious, so it is necessary to use comprehensive geophysical exploration technology to conduct survey, timely detect the precursor of geological disasters, provide a basis for emergency response departments to prevent serious losses caused by geological disasters.

4.3 Deep mine exploration

The integrated geophysical exploration technology can be used in the complex mine environment, especially when the traditional exploration technology can not meet the needs of deep hydrogeological exploration. Using comprehensive geophysical exploration technology to measure the underground electromagnetic field or resistivity, accurately obtain the information of groundwater flow speed, direction, depth, etc., and infer the distribution of groundwater bodies according to the exploration results. Due to the strong adaptability of integrated exploration technology, it can meet the exploration work in a larger scope and depth, and is less affected by factors such as mine topography[3].

5. Application strategy of comprehensive geophysical exploration technology in mine hydrogeological exploration

5.1 Transient electromagnetic exploration technology

Transient electromagnetic method, also known as pulse transient electrical survey technique, is one of the comprehensive geophysical exploration technologies widely used in mine hydrogeological exploration. It is essentially a survey technology based on time domain. In the application process, the magnetic field change between the ore and the mine geology is used to complete the hydrogeological investigation. The advantages of transient electromagnetic method are accurate exploration data and high efficiency, which can help workers quickly grasp the target information of mine hydrogeological exploration. At present, it is mainly used in geological exploration of mine hydrogeological areas, scientifically setting survey lines according to the distribution of mine hydrogeological areas, and optimizing and adjusting transient electromagnetic technology, so as to obtain the parameter information of mine hydrogeological exploration. To create favorable conditions for carrying out mining work. In order to increase the accuracy of mine hydrogeological exploration data, it is necessary to analyze the difference between actual parameters and conventional parameters, improve the application value of transient electronic exploration technology and exploration technology, grasp the mine smoke ring effect simultaneously during the exploration process, and predict possible geological disasters so as to take preventive measures in advance and reduce the loss caused by geological disasters. In addition, according to the actual situation of Kawano pulse and the division of exploration targets, the parameters of relevant devices are adjusted. After the transient electromagnetic equipment emits a pulse square wave, a magnetic field can be quickly formed, and the direction of the magnetic field is in the direction of the normal line. When the mine hydrogeology is abnormal, an abnormal eddy current magnetic field will be formed around the magnetic field, showing the size and conductivity of the abnormal magnetic field. Analyzing the disappearing process of the magnetic eddy current can help the staff grasp the mine hydrogeology and the changing situation of the regional market. In the process of exploration, professional equipment will be used to collect data, and the data

information will be used to draw curves, clarify the hydrogeological characteristics and specific distribution of mines, and meet the mining needs of mine resources[3].

5.2 Seismic wave advance exploration technology

The principle of seismic wave advance technology is to realize accurate exploration of the mine area and obtain detailed hydrogeological information by means of seismic wave propagation. This technology requires the use of professional equipment to launch seismic waves towards the target area, and the seismic waves will continue to propagate in the mine rock layer. If the hydrogeological anomalies block the seismic wave transmission, it will also be hindered and affected. Finally get accurate exploration information. At present, seismic wave advance technology has high application value and good effect in mine hydrogeological exploration, which can accurately judge hydrogeological conditions and mineral resource distribution. Before the exploration, the operating parameters of the three-component sensor of seismic wave source need to be adjusted to avoid being affected by layout points during the exploration process, and the accuracy of exploration results cannot be guaranteed. The equipment should be strengthened and arranged according to the parallel waist line under the mine to ensure that the three-component sensor of the seismic wave source is arranged in a straight line state, so as to send seismic waves safely and stably and lay a good foundation for obtaining mine hydrogeological exploration information. However, it should be noted that the application of this technology will be affected by various factors, so the factors that may affect the exploration effect should be analyzed in advance, and optimized and adjusted. At the same time, the control of weak geological cross sections and water distribution should be emphasized, and information collection should be strengthened to obtain mine hydrogeological information. After obtaining data information, a seismic wave simulation section is formed, the geological structure of mine roadway is mastered through observation, in addition, hydrogeological exploration information and observation images are extracted, seismic wave advance technology is coordinated, and advance migration imaging processing is implemented, so that the staff can fully grasp the hydrogeological anomaly information and provide reference for determining the mining plan[4].

5.3 Ground penetrating radar exploration technology

In recent years, GPR technology has been widely used in mine hydrogeological exploration. This technology mainly obtains data information through electromagnetic wave characteristics, reflection and scattering, and defines the hydrogeological and electromagnetic characteristics under the instructions of quantitative judgment, so as to provide standardized reference for comprehensive mining. The advantage of ground penetrating radar technology is flexibility, convenience, easy to operate, suitable for mine hydrogeological exploration work, and can help to avoid safety risks in the mining process. With the development of science and technology, GPR exploration technology is gradually upgraded in the direction of automation. By inputting mine geological environment information in advance, the operating parameters of GPR equipment can be adjusted synchronously to obtain more accurate exploration data. Ground penetrating radar equipment is mainly composed of four parts: power supply, cable, transceiver antenna and receiver. Before application, it is necessary to set the central frequency of the antenna to help staff determine the groundwater distribution area and mineral resource storage layer information. Compared with other comprehensive geophysical exploration technologies, GPR technology is more suitable for uneven surface or small-scale geological density exploration. In the exploration process, attention should be paid to factors such as on-site weather and water resources distribution, so as to maximize the value and ensure the accuracy of exploration results[4].

5.4 Radio wave exploration technology

Radio wave method is a comprehensive geophysical exploration technology commonly used in mine engineering, which has a good effect on the exploration of hydrogeological anomalies, and has low cost advantages compared with other technologies. The principle of the radio wave method is to emit high-frequency electromagnetic waves into the ground, and through the analysis of the actual

attenuation of electromagnetic waves, the detection of hydrogeological information can be realized. In the case of high-frequency electromagnetic waves passing through the rock layer, part of them will be absorbed by the magnetic field of the rock, so there will be obvious electromagnetic wave attenuation, and when the fault electromagnetic wave is encountered, it will be greatly instantaneous. In the mine hydrogeological exploration work, the attenuation of electromagnetic wave is combined with the analysis of whether there is fault. If the actual location of the fault needs to be mastered, the staff needs to use the computer to process the attenuation curve of electromagnetic wave and obtain detailed data through rigorous calculation. However, the radio wave exploration technology can only determine the approximate range of the fault, and cannot determine the fault location more accurately.

5.5 Downhole 3D electrical technology

Developed from the theory of power field, 3D underground electrical method is a relatively accurate hydrogeological exploration technology, which can accurately detect low-resistivity water-rich areas around coal seams. In the actual exploration process, the staff will use the high-density electrical instrument as the detection equipment to measure the circle size of the working face, and calculate the measurement results to obtain the apparent resistance value of the working face bottom plate, and at the same time scientifically interpret the three-dimensional imaging. Underground 3D high-density electrical advanced detection mainly applies the principle of high-density resistivity method to the underground and implements advanced detection work. Due to the obvious difference between the processing method and interpretation method and the surface, and the different interference factors, it is necessary to compile the processing software suitable for mine work. The exploration process is mainly divided into three parts: data acquisition, data processing and data analysis. According to the actual situation in the area, the flexible use of underground three-dimensional electrical method can ensure the accuracy of data and maintain the safety of mine production.

5.6 Current perspective exploration technology

The current perspective method can fully explore the hydrogeological structure of mines, including the geological structure and water content inside some rocks, which makes up for the shortcomings of other exploration techniques and obtains more comprehensive hydrogeological information. In the application process of current perspective method, it is necessary to focus on observing the change of current, quantitatively analyze the geological structure combined with the change of electric field, and pay attention to the change of external magnetic field to prevent the negative impact on the measurement of electric field and reduce the accuracy of exploration results. Generally speaking, when the external magnetic field interferes, the natural magnetic field will fluctuate and generate inductive current, resulting in poor clarity of the electric field distribution image[5].

5.7 Mining direct current exploration technology

Mine direct current method is mainly used in mining work, which can find mineral resources, and judge the distribution and nature of ore bodies. It is more suitable for mine areas with complex geological structure, and is conducive to improving the accuracy of exploration results. Because the mining scale cannot be expanded, the geological conditions in the mining process are still complex, and the traditional geophysical exploration technology cannot guarantee the timeliness of exploration work, and the accuracy of exploration data is poor. In contrast, the mine direct current exploration technology belongs to the full-space electrical exploration method, which mainly uses the electrical and physical characteristics of mineral rocks to analyze the electrical differences of different rocks. Thus the mine hydrogeological conditions are defined. In the actual exploration process, the corresponding number and spacing of electrodes need to be set on the surface, and then through the DC power supply in the underground, due to the difference between the underground medium and the dielectric, the current will be subject to different impedance, and the formation of an electric field in the underground, by measuring the potential difference between the electrodes,

you can obtain the electric field response data, after processing and interpretation of hydrogeological information. Mine DC technology can detect a large area of underground space, combined with the qualitative characteristics of ore body and rock mass, the underground hydrogeology of mines is analyzed, and at present it is mainly used in the detection of tunnel floor structure, rich water layer and other work.

6. Application effect of comprehensive geophysical exploration technology in mine hydrogeological exploration

From the practical application of integrated geophysical exploration technology in mine hydrogeological exploration, it can obtain the information of groundwater distribution, flow and storage more accurately, provide important data for mining, and guide the utilization of water resources in mines and the prevention and control of geological disasters. Comprehensive geophysical exploration technology has many advantages, not only can comprehensively understand groundwater information, but also various types of comprehensive geophysical exploration technology, can be selected and applied according to their own needs, and can ensure the accuracy and efficiency of data, and quickly obtain survey data in a short time[5]. With the continuous development and optimization of neutralization geophysical exploration technology, it has been applied more and more widely in mining. In addition to hydrogeological exploration, it is also applied in underground rock exploration and measurement, which has strong practicability and can accurately obtain address structure anomaly data to help mining units predict geological disasters in advance. In groundwater survey, according to the conductivity principle of water source, fully grasp the magnetic field around the mine, and effectively avoid the safety accident caused by leakage. Underground mineral exploration will also be applied to comprehensive geophysical exploration technology to accurately locate mineral resources, reduce the impact of water resources, comprehensively improve mining efficiency, and prevent blind mining from causing harm to the surrounding geological environment.

7. Conclusion

In recent years, the mining depth of our country has been increasing, which means that we need to face more complicated hydrogeological conditions. The traditional exploration technology has obvious drawbacks, mainly using various instruments to transmit and receive signals to realize the exploration of ore deposits, but it can only be applied in a small range, and the reliability of the data provided is insufficient. Therefore, the mine hydrogeological exploration has increased the application of comprehensive geophysical exploration technology. As the most flexible and practical exploration technology, it has great potential in mine work. The corresponding comprehensive carbon-free technology can be adopted according to the actual demand to provide guarantee for the safety of mine production. There are many types of comprehensive geophysical exploration technology, which is suitable for different hydrogeological conditions, and the obtained data is true and accurate, which promotes the sustainable development of mine engineering in China.

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