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Mesophase pitch, Porous carbon, hydrogen peroxide, N-methylmorpholine oxide.

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Abstract

Coal-based energy structure, complex geological conditions and mining technology determine the development of geophysical prospecting technology in China has its own characteristics, and its technical development is of great significance to coal mine safety production. At present, geophysical prospecting technology has been widely used in the field of coal mine geological mining by virtue of its simple operation, convenient construction and high detection accuracy.

Keywords

Geophysical prospecting, safety mining, accuracy.

1. Introduction

At present, many coal mines are still facing severe forms of coal mine geological exploration. In coal mine geological work, the application of geophysical prospecting technology with high quality and high efficiency is more obvious to improve the geological effect of coal mines [1]. From the specific application of geophysical prospecting technology, various types of interference factors also exist in large quantities. Therefore, technical personnel should closely combine the actual geological conditions and hydrological characteristics, and scientifically apply geophysical prospecting technology to better detect the occurrence of underground water in coal mines. Under the background of resource shortage, in order to effectively improve mining efficiency, coal mining enterprises should pay full attention to the application of geophysical prospecting technology, so as to carry out in-depth investigation of coal mine geological structure, provide valuable geological reference materials for mining units, and greatly improve the efficiency of coal mining. At the same time, the application of geophysical prospecting technology in coal mine geological mining can also effectively monitor the occurrence of various geological disasters and water disasters, so that mining units can formulate targeted preparatory solutions in advance, so as to effectively ensure the safety of mining and construction personnel, and promote the healthy and sustainable development of coal mine geological mining industry in China [2].

This paper also summarizes the principles and methods of various geophysical techniques, briefly describes the advantages and disadvantages of various geophysical techniques, and looks forward to the development of geophysical techniques in the future.

2. Seismic Method

Seismic method is a very early method used in mining, this paper mainly introduces two methods of trough wave and three-dimensional seismic.

2.1. Three-dimensional Seismic

Three-dimensional seismic wave is a kind of medium transmitted to another, when the wave through different media cementation will occur reflection or transmission [3]. In the elastic interface, if the reflection angle is equal to the incident angle, and the incident angle, reflection

angle and transmission wave have the same ray parameters, in the detection process, the detection results show the resolution of the real geological structure, mainly divided into longitudinal and transverse resolution.

Three-dimensional earthquakes are divided into one-dimensional, two-dimensional and three-dimensional. Among them, three-dimensional seismic waves have very good detection effect. Therefore, three-dimensional analysis is often used in actual detection.

2.2. Slot Wave

The technology thinks that coal seam wave is dispersive wave [4]. In 1963, T. C. Kerry proved the trough wave dispersion relationship through deduction and experiment. This technology was carried out in the underground coal seam, and directly detected the geological structure in the coal seam. It is the detection technology with the highest resolution at present. The detection principle is that the coal seam density is small and the seismic velocity is low, and a interlayer is formed in the coal seam. When the earthquake is excited, the seismic wave is generated, and these two waves include S and P. Among them, S also includes SH wave and S wave. When the wave propagates to the upper and lower boundaries, it is reflected or refracted into the coal seam, forming a trough wave.

In coal-bearing series, the density of coal seam is usually smaller than that of upper and lower roof and floor. The propagation velocity of seismic wave in coal seam is small, and it is an obvious low-speed wave. When this seismic wave passes through multiple reflections and superpositions, it is guided through the coal seam, and the trough wave will be formed. This wave only propagates in the coal seam. When the geological structure exists in the working face, the wave transmission will be interrupted. Through the other side of the detection wave will be recorded. Geological structure is judged by image.

3. Electromagnetic Method

The mine electromagnetic method mainly includes the direct current method, the transient electromagnetic method, the radio wave perspective technology, the direct current method first rises in our country, the earliest time also only carries on the application in the hydrogeological exploration, later along with the science and technology unceasing progress and the development, this technology has obtained the better improvement, has applied it to the mining enterprise.

3.1. Transient Electromagnetic

Transient electromagnetic method is also called time domain electromagnetic method, which belongs to half space transient electromagnetic method [5]. It is through the ungrounded loop or access to the ground wire source to emit pulsed magnetic field to the underground. During the first launch, the magnetic probe is used to observe the secondary induced eddy current field caused by the underground medium. The resistivity of the whole formation is obtained by the data of transient electromagnetic observation. The equipment mainly detects the underground structure and geological characteristics. The detection principle is shown in the diagram. The least square constraint inversion algorithm is designed based on the transient electromagnetic differential equation. The center coordinates, inclination angle, size and other parameters of the anomalous body can be obtained by inversion fitting the anomalous field, so as to realize the spatial positioning of the anomalous body.

The mine transient electromagnetic method uses an ungrounded loop to send a pulse magnetic field to the surrounding rock or working face of the roadway. Under the action of a pulse excitation, the induced current generated by the good conductive geological body around the roadway or inside the working face will excite the induced electromagnetic field that changes with time, that is, the secondary field ; after the primary field stops changing, the secondary

field is received, processed and explained to realize the exploration of geological bodies around the roadway or inside the working face.

Transient electromagnetic method is a kind of detection method introduced from the Soviet Union to China. One of the advantages of this method is that it has good directionality, and it has a relatively sensitive detection force for liquids when detecting. After introducing this technology, China has applied it to the waterproof work of mining. However, this method has a great disadvantage that it has a great influence on the medium, so it has not been widely used now. The radio perspective method is mainly operated by high-frequency waves. This method has relatively high requirements for environmental geology. In the process of use, it is also necessary to disconnect the cable line, which will have a greater impact on the propagation process. The working face involved in China's mining work is relatively large, so it will inevitably affect the frequency of electromagnetic waves.

3.2. Radio Wave Penetration Technique

When the electromagnetic wave propagates in the underground rock stratum, because of the different electrical properties of various rocks and ores, they have different energy absorption of electromagnetic wave. The low resistivity rock stratum has a strong absorption effect on electromagnetic wave. When the wave forward meets the interface of fracture structure, the electromagnetic wave will produce reflection and refraction on the interface, and also cause energy loss. Therefore, under the mine, when the electromagnetic wave encounters faults, collapse columns or other structures in the way of passing through the coal seam, the wave energy is absorbed or completely shielded, and then the weak signal or transmission signal is received in the receiving roadway, forming the so-called perspective anomaly [6].

Study on various radio wave perspective anomalies caused by the influence of coal seam, various structures and geological bodies on electromagnetic wave in mining area, so as to carry out geological inference and interpretation.

After tunneling through the working face, before the mining equipment is not installed, the clearance time of borrowing and installing the equipment is the most reasonable and advantageous for the pit penetration, and the pit penetration production is correct. At this time, the pit penetration reduces a lot of tedious preparatory work and auxiliary working hours, and makes the pit penetration work have a good environment and good results.

Radio wave perspective has become one of the effective geophysical prospecting methods in fully mechanized coal mining face due to its portable instrument, convenient and rapid data acquisition, less personnel required, large perspective distance and obvious detection effect. It is the most commonly used geophysical prospecting method for geological structure exploration in working face at home and abroad.

3.3. Audio Electrical Method

With the difference in lithology, the overall conductivity shows great differences [7]. A large number of practices show that, in general, limestone and coal seam have relatively high resistivity as a whole, but the resistivity of sandstone is relatively low. If the resistivity of clay, shale and mudstone is encountered, it is lower. In particular, many fractures are contained in many rock strata. Combined with the influence of water, the resistivity decreases significantly, which is the basis for comprehensive geophysical exploration of coal mine geology. The rock resistivity in coal measures is also quite different. The resistivity of limestone is the highest, followed by that of medium-coarse sandstone, and that of siltstone and mudstone is the lowest. Along the direction of coal measures strata, lithology changes relatively low, resistivity is bound to be very uniform, in the vertical direction, because lithology changes relatively large, resistivity will appear more obvious changes, or lower or higher. If the coal layer is relatively stable as a whole, in the vertical direction, the resistivity usually does not change greatly, and

in the direction that is relatively smooth with the formation, the conductivity is also relatively uniform. Therefore, in the geological work of coal mines, geophysical exploration technologies such as audio-frequency electrical penetration technology and underground electrical sounding technology can be selected to conduct a comprehensive detection of groundwater in coal mines, so as to carry out more targeted geological work of coal mines.

Coal measure strata are the product of sedimentation and have obvious sedimentary sequence. There are obvious electrical conductivity differences between different strata. Under normal conditions, the coal seam and limestone show high resistance value, followed by sandstone, clay rock shows low resistance value, and water resistance value is the lowest. It can be seen that there are obvious electrical differences among rocks, coal seams and water bodies of different lithology.

Due to the good electrical conductivity of water compared with other solid media, when the surrounding rock fissures, water content in the fracture zone or water accumulation in the goaf exist, there is a local low resistivity anomaly area. The stronger the water content is, the lower the resistivity is, the higher the electrical conductivity is, and the larger the anomaly amplitude is. If there is no water, it is shown as a local high resistivity anomaly. The coal seams near the fault surface on both sides of the fault are often thinner, and such zones are characterized by relatively low resistivity, while the regional resistivity developed in thick coal seams is relatively higher, see Table 1.

Table 1: Common Rock resistivity

Rock Name	Coal	Limestone	Sandstone	Mudstone	Mine Water
R/Ω·m	$10\sim10^4$	$60\sim4\times10^5$	$1\sim10^5$	1~50	1~10

4. Interference factors and countermeasures of geophysical prospecting technology in coal mine geological application

In order to improve the reliability of the obtained data and better ensure the measurement accuracy, in the selection of geophysical prospecting technology for the detection of underground water in coal mines, in addition to the strict construction according to the regulations, the following measures should be taken in combination with the specific site geological conditions:

First, in the measurement, measures such as shutdown and power outage should be taken within the scope of the measurement object, with the main purpose of reducing the negative impact of periodic environmental noise in the roadway on the measurement. Second, in order to get more effective messages, more valuable information can be obtained by increasing the density of the object detection point in the specific measurement. A large number of practices show that the distance between the receiving points of the audio electrical penetration detection is generally 10 m, and the distance between the electrical sounding measuring points is generally 20 m. When the sampling interval is carried out, the interval is generally set to 5 m. Third, the depth of detection can be targeted to increase, electrical sounding correction generally, the control depth is 80 m. Fourthly, when conducting electrical measurement, usually, electrodes M and N choose to use copper rods with the same specifications. Technical personnel should pay attention to the targeted optimization and improvement of power supply conditions in actual operation, especially the influence caused by electrode heterogeneity should be controlled to the minimum to the maximum extent. For roadways with a large amount of water, the electrode can be set in the coal wall when the technical personnel are conducting construction. If the construction site is very dry, the electrode can be watered during operation.

At the same time, if the belt conveyor is in the rotation process, it will have a certain impact on the electrode grounding. In specific exploration, attention should be paid to avoiding.

What is better used here is the transient electromagnetic exploration technology, which belongs to the time-domain electromagnetic method in the application of coal mine geological exploration. It uses the pulse current as the field source in the ungrounded loop or ground wire to stimulate the detection target to generate the secondary current, and through the detection of the secondary field changing with time, the relevant situation of the target is verified. Compared with other types of exploration technology, the main characteristics of this technology are that the corresponding form is relatively simple, the volume effect is relatively small, the penetration is relatively high, and the stratification ability is relatively strong. At the same time, in the process of use, it can also achieve the synchronous completion of the profile detection effect, which is more obvious for improving the effect of mine hydrogeological exploration.

In the interpretation of data, the resistivity of various types of tectonic geological bodies in the coal mine range is generally quite different. Usually, the resistivity of coal and Cambrian limestone is relatively high, and the resistivity of water-bearing faults or cracks in rock is relatively low. At the same time, after different types of faults communicate with different types of strata, with the difference of broken objects contained in them, the specific characteristics are also quite different, including water-richness and permeability. In general, the overall resistivity of sandstone and limestone is relatively low, but its water-richness is relatively good, showing the opposite effect in sandy mudstone and mudstone. It is necessary to take these characteristics as the basic basis for the exploration of aquifer water abundance and formation fractures when using the electromagnetic method. In specific use, different types of exploration lines need to be set up, combined with specific exploration work needs, the relevant lines are targeted encryption or sparse. Before starting exploration, necessary experimental tests should be carried out to improve the accuracy of the test work.

5. Conclusion

Although the mine geophysical prospecting technology has been greatly improved, with a large number of mining of coal resources in China, coal resources under shallow buried depth and good geological conditions have been exhausted. Coal enterprises have to mine coal resources under unfavorable geological conditions. For the future geophysical prospecting technology faces new challenges, there are the following problems:

1.At present, the development of geophysical prospecting technology in China is relatively backward. The detection equipment and supporting software are basically imported from abroad, and the independent research and development are insufficient. In particular, the geophysical prospecting instruments that are suitable for China’s complex geological conditions and deep mining stage are few.

2.Application technology leading theory. For new methods and new technologies are developed in the basic theory, China's mine geophysical prospecting technology focuses on practical application, and the research on the basic theory is very lacking, which leads to the lack of independent research and development technology in China. Therefore, theoretical research must be paid attention to.

3.Geophysical prospecting technology has high accuracy under certain buried depth. With the continuous exploitation of coal resources in China, the depth will inevitably increase. Therefore, it is necessary to improve the accuracy of large-depth detection.

4.With the increase of mining depth, the probability of water inrush and coal and gas outburst accidents increases, and there is a lack of mature and reliable means of interpretation for the above geological disasters.

In summary, many coal mines are still facing severe forms of coal mine geological exploration. In coal mine geological work, the application of geophysical prospecting technology with high quality and high efficiency is more obvious to improve the geological effect of coal mines. From the specific application of geophysical prospecting technology, various types of interference factors also exist in large quantities. Therefore, technical personnel should closely combine the actual geological conditions and hydrological characteristics, and scientifically apply geophysical prospecting technology to better detect the occurrence of underground water in coal mines. Under the background of resource shortage, in order to effectively improve mining efficiency, coal mining enterprises should pay full attention to the application of geophysical prospecting technology, so as to carry out in-depth investigation of coal mine geological structure, provide valuable geological reference materials for mining units, and greatly improve the efficiency of coal mining. At the same time, the application of geophysical prospecting technology in coal mine geological mining can also effectively monitor the occurrence of various geological disasters and water disasters, so that mining units can formulate targeted preparatory solutions in advance, so as to effectively ensure the safety of mining and construction personnel, and promote the healthy and sustainable development of coal mine geological mining industry in China.

Geophysical prospecting technology is to understand the geological anomalies existing in coal mine, which is of great significance for coal mine safety production. Its technical research has been in the hot direction. The future development of geophysical prospecting technology mainly focuses on the following three aspects:

1.High precision, large range and strong resolution. At present, the geophysical prospecting technology has the disadvantages of low precision, limited detection distance and weak resolution, which has great influence on the geophysical prospecting effect and affects the final interpretation of geophysical prospecting. In the future, it should develop in the direction of high precision, large exploration distance and strong resolution.

2. Intelligent detection technology. Intelligent working face has been widely used in China. Combining traditional geophysical prospecting technology with intelligent mining, real-time detection in the process of mining and tunneling, and real-time interpretation of geophysical results can greatly improve the production efficiency of coal mines.

3.Cooperative observation and coupling analysis. With the further complexity of geological conditions, a variety of geophysical exploration technology coupling research should be carried out in the detection process to overcome the limitations of single geophysical exploration technology. Combined with the coupling analysis of fracture, seepage and geophysical field, the observation method and technology should be improved to develop new geophysical exploration technology.

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