ISSN: 2664-9640

Application of Transient Electromagnetic Method in Detecting Collapse Pillar in Mine

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Abstract

Accurately grasping the specific situation of the collapsed pillar is the key to the safe mining of coal mines. Timely and accurate detection of the collapsed pillar is the basis for ensuring the safe production of coal mines. Based on the response characteristics of mine geophysical technology to a collapsed column in a certain mining area, this paper proposes a transient electromagnetic technology to detect the specific situation of the collapsed column. The results show that the mine transient electromagnetic technology can accurately determine the water-rich condition of the collapsed column. This technology can overcome the limitations of traditional exploration methods and realize the precise detection of the collapsed column development. It is vital to the safe and efficient production of coal mines.

Keywords

Mine geophysical prospecting, Collapse column, Transient electromagnetic.

1. Introduction

The geological conditions of my country's coal mines are relatively complex, and the collapsed column is a particularly common type of structure in coal mining in some areas of my country. It is also a good channel for water and gas conduction due to the possible development of fractures in the collapse column. However, once the collapse column is connected to the nearby aquifer and coal seam, problems such as water inrush will occur, resulting in water disaster accidents, which will undoubtedly seriously threaten the safe production of coal mines, and cause water damage due to water damage. The resulting shutdown of mines will also seriously affect the mining efficiency of coal mines, and even flooding accidents may occur, the consequences of which are even more disastrous. Therefore, accurately grasping the specific situation of the collapsed column, especially its water-rich, is the key to the safe mining of coal mines, which is very important to the safe and efficient production of coal mines.

As an efficient and non-destructive detection method, mine geophysical exploration technology has been widely used in the exploration of coal mine disaster sources. Many scholars in my country have conducted in-depth research on mine geophysical prospecting technology, and have made great achievements in terms of its development status and key issues. Transient electromagnetic method is one of the widely used methods in mine geophysical exploration technology. Because of its high construction efficiency, pure secondary field observation and sensitivity to low-resistance bodies, it has become the preferred method in coalfield hydrogeological exploration. Therefore, the transient electromagnetic technology used in this

ISSN: 2664-9640

paper can accurately determine the water-rich condition of the collapsed column. This technology can overcome the limitations of traditional exploration methods and realize the precise detection of the collapsed column.

2. The principle of transient electromagnetic technology

Electromagnetic induction theory is the theoretical basis of transient electromagnetic technology. The transient electromagnetic technology mainly refers to the use of grounded wire sources or ungrounded return wires as a launching tool to emit a magnetic field to the underground area to be measured, and at the same time. A grounded electrode was used to observe the secondary induced eddy current field during its gap. The secondary induced eddy current field is excited by the underground conductive rock ore body. When the power supply is stopped, the eddy current field will generate a secondary magnetic field during the decay process.

The transient electromagnetic method has its decay process, which is mainly composed of three different periods: early, middle and late periods, and different periods have different characteristics. For example, in the early decay of transient electromagnetic method, the electromagnetic field has the characteristics of fast decay speed and small skin depth; while in the late decay of transient electromagnetic method, it has the characteristics of slow decay speed and large skin depth. In order to obtain the geoelectric characteristics at different depths, it is only necessary to observe the secondary magnetic field in different time periods after the power supply is stopped, and it can be obtained by summarizing its variation law with different time periods. Finally, the method of inferring the geological feature information and hydrological distribution required for detection is the transient electromagnetic method.

When the grounded wire source or the ungrounded return wire is stopped, that is, the transmitting coil is suddenly powered off, and the secondary magnetic field will not disappear. On the contrary, in order to maintain the magnetic field before the power outage, the conductive rock ore body in the ground will excite the secondary induced eddy current field. The schematic diagram is shown in Fig. 1 (Schematic diagram of transient electromagnetic half-space detection), which is composed of many "ring belt" structures. It continues to propagate reaching different depths and extents over different time periods. The equivalent current loop is like a series of "smoke rings" "blown" from the emission loop. Therefore, the process of eddy current spreading outward is vividly called the "smoke ring effect".

In the detection of mine collapsed pillars, especially in the case of rich water, traditional exploration methods have many limitations such as low resolution, which is not conducive to the safe and efficient development of coal mines. The transient electromagnetic technology has an incomparable effect on the detection of the surrounding rock of the roadway, and has strong adaptability to the construction location, high vertical and horizontal resolution, strong detection direction, and has the advantages of convenient, fast and high efficiency. The bedding detection in front of the excavation face can also be used for the detection of the sidewall of the roadway, the top of the coal seam, and the floor, which provides technical means and basis for hydrogeological prediction and water disaster prevention and control. Transient electromagnetic technology can just overcome the limitations of traditional exploration methods, and realize the precise detection of the specific conditions of the collapsed column, especially the water-rich.

ISSN: 2664-9640

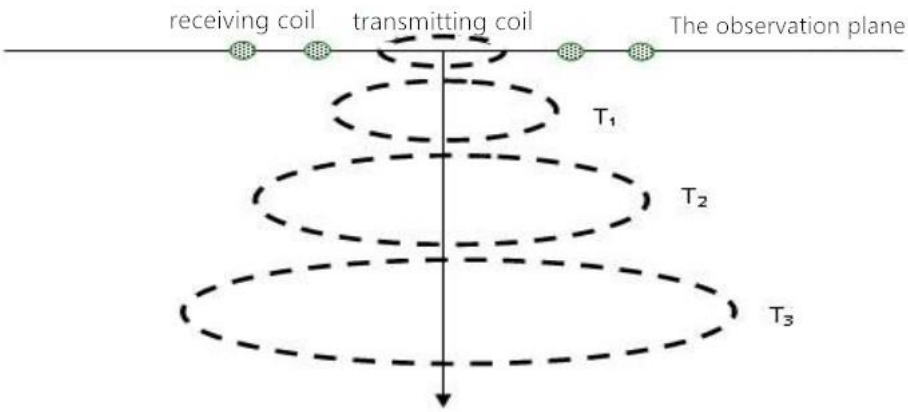

Fig. 1: Schematic diagram of transient electromagnetic half-space detection

3. Example of detecting a collapsed column

3.1. Overview of the working face

The main detection site of this exploration is located in a mine in my country (Fig. 2). The geological conditions of this mining area are relatively complex, and there are cracks in the collapse column structure of the mine, which are conducted by water and gas. Good access. Once the collapse column is connected to the nearby aquifer and coal seam, water inrush and other problems will occur, resulting in water disaster accidents, which undoubtedly seriously threaten the safety of coal mine production. Therefore, accurately grasping the specific situation of the collapsed column, especially its rich water, is the key to the safe mining of coal mines. Therefore, the purpose and task of this detection is to detect the water-rich situation of the collapsed column within the mileage of 1092m-1242m in the mining area (taking the survey area 60 degrees upward as an example), and to provide a reference for the prevention and control of water in the working face mining, so as to ensure the coal mine. safe and efficient production.

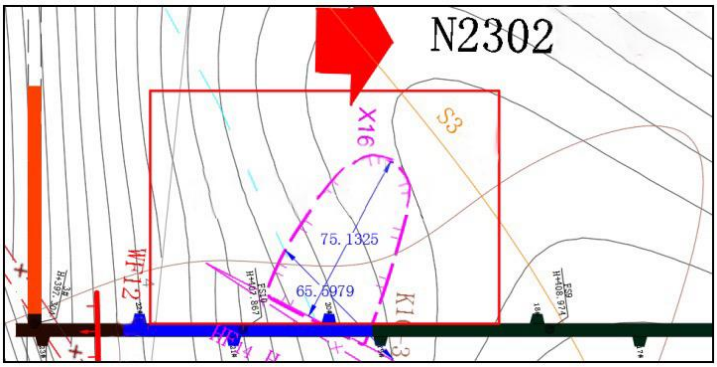

Fig. 2 Schematic diagram of detection position (red circled range)

3.2. Detection results of transient electromagnetic technology

This transient electromagnetic detection blind area is about 15m. In this exploration, the relative apparent resistivity value of the strata explored by the transient electromagnetic method in the figure is the value of the contour line, and the numerical change of the resistivity is represented by different colors in the figure. The redder the marked color, the higher the resistivity value of the place, and the bluer the color marked in the figure, the lower the resistivity value of the place. Due to the fracture of the rock formation, the development of fissures, or the good water richness, the resistivity value may be low, so it is necessary to pay attention to such places in the process of coal mine excavation.

Analysis by N2301 auxiliary mileage 1092m-1242m transient electromagnetic detection collapsible column detection 60 degrees above the plane (Fig. 3):

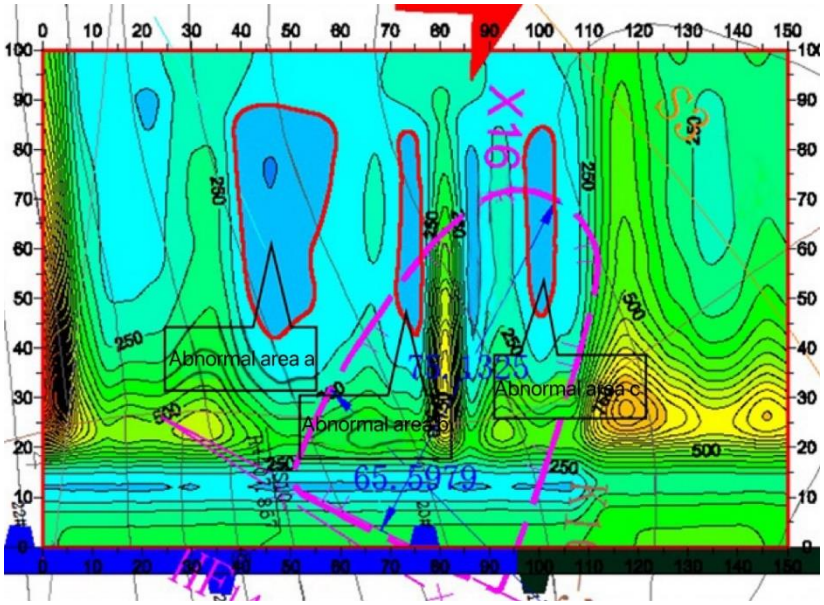

Fig. 3 Plan view of transient electromagnetic detection 60 degrees upward

There are three low-resistance anomalous areas within the detection range.

Abnormal area 1: the detection distance is 37m-60m, and the depth is 42m-85m;

Abnormal area 2: detection distance 70m-77m, depth 45m-85m;

Abnormal area 3: The detection distance is 95m-105m, and the depth is 45m-85m.

Among them, the abnormal area 1 is determined by comprehensive analysis to be caused by the influence of the on-site drilling rig; the abnormal area 2 and abnormal area 3 are determined by comprehensive analysis to be caused by the local water-rich coal seam in the working face and the influence of the on-site feng shui pipeline and belt frame. Attention is needed.

4. Conclusion

(1) Through the practical application of transient electromagnetic technology on the working face studied in this paper, it is confirmed that mine transient electromagnetic technology is a very effective means of geophysical prospecting.

(2) The transient electromagnetic technology can accurately determine the water-rich condition of the collapsed column, and can accurately detect the low-resistance abnormal area. This technology overcomes the limitations of traditional exploration methods. It is vital to the safe and efficient production of coal mines.

(3) The transient electromagnetic method can accurately detect low-resistance abnormal areas, but it is also interfered by other factors, such as on-site drilling rigs, on-site feng shui pipelines and belt racks, etc. Therefore, it is necessary to check the factors that may cause interference before detection. deal with.

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