

# Research on Coal Mine Geological Exploration Based on Borehole Geological Radar

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**Abstract:** Drilling geological radar has the advantages of high resolution, large detection depth, and high flexibility in the field of underground exploration, which can provide accurate and reliable data support for geological engineering, mineral resource development, and other fields. Based on the advancements in borehole geological radar detection technology, the borehole geological radar has been successfully introduced into a coal mine in Guizhou, and the actual on-site detection application is carried out. The research results show that the roadway and the evasion chamber can be clearly seen in the detection results of the 1901 aircraft transport alley, and there is an area of obvious signal anomaly in the 1808 return lane boring surface detection section. Drilling radar is applied to coal mine underground, the detection results have strong accuracy and reference, and the promotion and application of coal mine underground have broad prospects.

**Keywords:** Coal mine; borehole geological radar; geological exploration; application.

## 1. Introduction

The drilling radar method is a broad-spectrum electromagnetic technique used to determine the distribution of underground media [1]. The working principle of drilling radar method is similar to seismic exploration method, which is based on studying the propagation time, velocity, and dynamic characteristics of waves underground. It can penetrate a certain distance in geotechnical media and is typically used at frequencies ranging from 50 to 250 MHz [2]. After years of development, the drilling radar detection technology has been relatively mature, but it is mainly used in engineering and environmental problems, detecting underground holes, cracks, etc., and the application effect is better [3-7]. The detection application of drilling radar in coal mine underground has not yet been systematically reported, and at present, the underground excavation surface of coal mines relies on multiple geological exploration holes to grasp the geological situation in front of the excavation [8-10]. Therefore, this article refers the drilling radar to the coal mine underground for geological drilling all-round structural detection test, combined with examples, and interprets and analyzes the measured data, in order to provide reference for reducing the amount of geological exploration engineering on the underground excavation face of the coal mine and improving the safety of excavation production. Practice has proved that borehole radar detection is a very powerful and highly reference detection method, which can predict the obvious structural situation of a certain range in front of the boring.

## 2. Borehole Geological Radar Detection Method

As a new geophysical exploration technology, borehole geological radar detection technology has many advantages of non-destructive, continuous and high accuracy. Drilling radar is mainly composed of the host, transmit /receive antenna, transmission cable and supporting software, etc., the physical object as shown in Figure 1, the transmitting antenna

and the receiving antenna are placed in the drill hole and push forward at a certain speed, automatic scanning detection imaging, it transmits and receives radar electromagnetic wave signals to the surrounding rock of 360° space around the borehole, which can detect the formation signal within 30m radial around the borehole. Drilling can be used to calculate and analyze the distance of harmful geological bodies in front of the orifice and the size of their abnormal development scale.



Figure 1. ZTR-7.2 mine geological radar

## 3. Coal Mine Downhole Drilling Radar Detection

In order to verify the reliability and accuracy of the mine geological radar on the structural detection results, the drilling radar detection application was carried out in the 1901 machine transport lane and the 1808 return wind lane boring face of a coal mine in Guizhou.

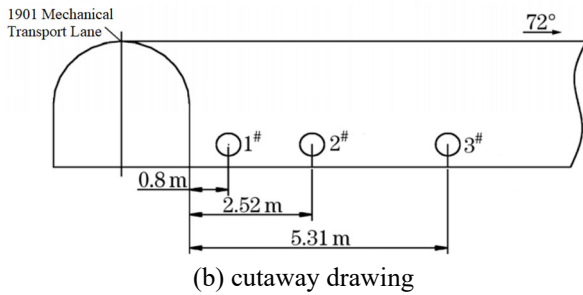
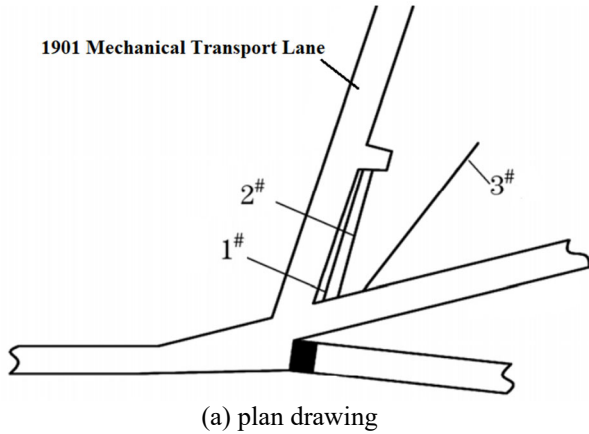
### 3.1. 1901 Mechanical Transport Lane Detection

In the 1901 machine transport lane along the roadway along the construction of 1#, 2#, 3 # a total of 3 drilling holes,

drilling parameters are shown in Table 1, and the layout plan is shown in Figure 2.

**Table 1.** Borehole parameters of 1901 machine lane drilling

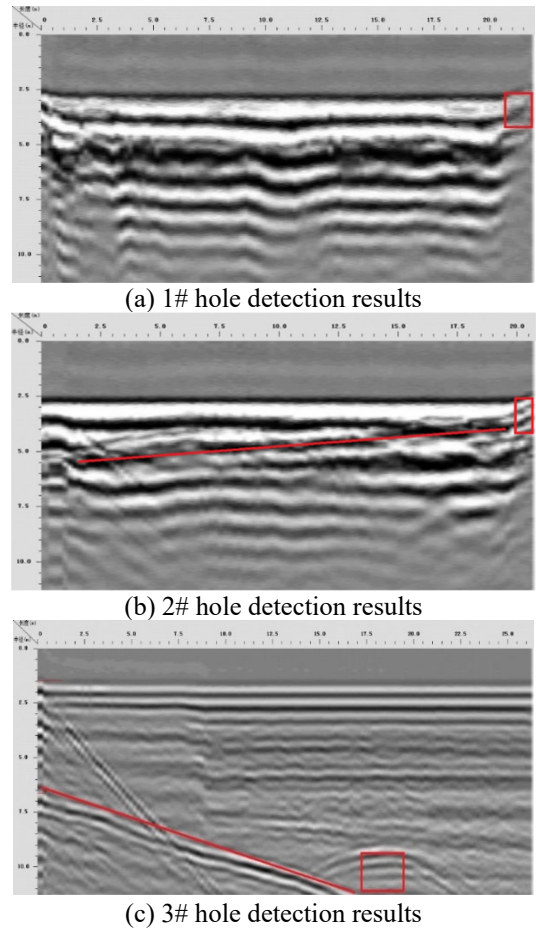
Borehole number	Length/m	Distance from The Lane/m
1#	20	0.8
2#	20	2.4
3#	25	5.4



**Figure 2.** Detection Borehole layout for 1901 mechanical transport lane

After the completion of the drilling, the ZTR7.2 mine geological radar was used to detect three boreholes next to the 1901 machine lane, and the detection results were shown in Figure 3.

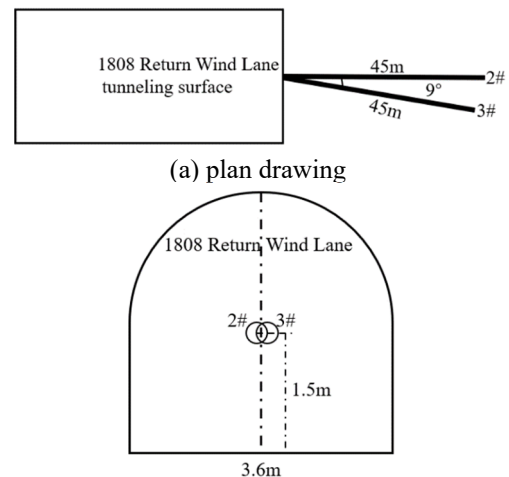
From the Figure 3(a), the drilling depth of 1# is 20.3 m, and no obvious roadway is shown in the detection results. The red box area in the figure is unusually signaled, and it is judged to be a hole (actually an evasion chamber). From the Figure 3 (b), the detection depth of the 2# borehole is 20 m, the signal in the red line area changes significantly, and it is judged to be a roadway, the orifice is about 2.5 m away from the roadway, and the bottom end of the detection is about 1 m from the roadway. The data at 20 m to 21 m are obviously abnormal, judging to be hollow (actually avoiding the chamber). As can be seen from Figure 3(c), the drilling depth of 3# is 26.4 m, the red line in the figure is the roadway, and the orifice is about 5.3 m from the roadway. The red box is hollow (actually a dodge chamber). According to the actual situation of the 1901 Mechanical Transport Lane site, the above drilling radar monitoring and analysis results are more accurate and reasonable.



**Figure 3.** Detection results of 1901 mechanical transport lane

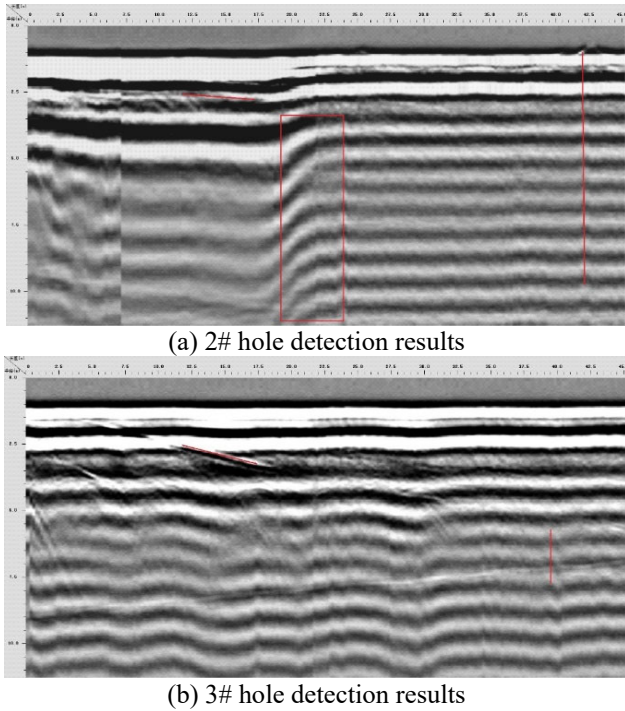
### 3.2. 1808 Return Lane Boring Surface Detection

Drilling geological radar detection test was carried out on the excavation surface of 1808 return wind lane. Before the drilling radar detection, in the 1808 return wind lane boring surface along the midline position from about 1.5m from the bottom plate, respectively, a depth of 45m, an inclination angle of about 1° 2# hole and next to it (to the right) to play a depth of 45m, an inclination angle of about 1°, and a 9° angle between the No. 2 hole 3# hole, the geological exploration hole arrangement is shown in Figure 4.



**Figure 4.** 1808 return wind lane boring surface geological exploration hole design

After the completion of the drilling, the ZTR7.2 mine geological radar was used to conduct a comprehensive detection in front of the 1808 return wind lane boring, and the detection results were shown in Figure 5.



**Figure 5.** 1808 return wind lane boring surface drilling surface geological radar detection results

From the Figure 5, the area circled by the curve is the area where the radar signal is obviously abnormal, and the preliminary judgment is that the area is a tectonic area: In Figure 5(a), the depth of the drilling hole is 45m, the location identified in the figure is near 12.5m for the structure, and the anomaly from 20 to 25m is judged to be lithological change or fragmentation, and the crack near 42m is a crack. In Figure 5(b), the depth of the detection drilling hole is 45m, the construction near 12m is a structure, and the crack at 40m (the angle between the 3# hole and the 2# hole is about 9°, and the anomaly position is consistent with the corresponding depth of the 2# hole. Through the drilling radar data analysis results of the 2 holes in the middle hole (2#) and the middle right (3#) of the 1808 return wind lane boring surface, it can be seen that the 2# hole is from the hole depth of 12.5m to 17m, the structure appears at 1.5m from the drilled hole, and the abnormality occurs at 20~25m, which is judged to be lithological change or fragmentation, and the fracture occurs at about 42m, and the fracture width is about 0.5m, and it is recommended to do corresponding prevention and control measures when boring.

According to the drilling construction record of the Coal Mine Geological Exploration team, the 3# drill hole encountered geological structure when drilling into the 48th drill pipe (that is, about 34.0m), and the 2# drill hole encountered drilling hole when drilling the 59th drill pipe (that is, about 44.5m), and the abnormality in the actual construction record was basically consistent with the analysis of the detection results of the drilling geological radar.

## 4. Conclusion

The drilling radar detection results of the 1901 machine transport lane and the 1808 return wind lane boring surface of a coal mine in Guizhou are generally consistent with the analysis of the actual drilling results data and excavation record data of the mine, which increases the detection range of the radial structure of the drilling hole, verifies the feasibility, reliability and accuracy of the drilling radar to conduct all-round detection of geological exploration holes under the coal mine, and has a strong promotion and application prospect in the coal mine.

## Acknowledgments

This work is financially supported by China Coal Science and Industry Group Co., Ltd. Special Key Projects of Science and Technology Innovation and Entrepreneurship Funds(2022-2-TD-ZD009), Enterprise independent scientific research key research and development project (2022ZDXM11), which are gratefully acknowledged.

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