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Evaluating Deformation and Failure of Underground Panel's Roof Using Electric Data

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Abstract Coal seam mining coal face roof deformation and damage characteristics of overburden strata is an important technical parameter of coal mine water prevention and controlling work. According to the coal mining face in the process of mining roof strata deformation and failure characteristics, the electric parameters is used to observe and evaluate the coal face roof strata failure law. Through in the roadway roof design elevation drilling in the electrode cable installation, combined with the progress of extraction all-round electric field parameters were collectedin the coal winning face space. According to a field potential, current parameter calculation, the roof strata deformation and failure process of electrical parameter distribution characteristics were gained and regularities of strata and highly effective judgment were developed. The measured results of a coal mining face in Huainan show that a field current on rock fracture deformation and development position has good sensitivity and instructions, to probe that effect is good and can provide effective technical parameters for the scene.7o
Keywords electric field parameter, roof strata, deformation and fracture , evaluation standard

Introduction

Coal seam mining damage will result in the formation strata destruction "three zones" (caving zone and water flowing fractured zone and bend subsidence zone), for the working face itself similar strata in stope and the future of mining under the condition of the waterproof coal (rock) column provides the basis for design, drilling in underground roadway layout, adopt parallel electrical detection method, to analyze the detection of coal seam mining process of the overlying rock destruction and the dynamic relationship between. For the current in the evaluation of the deformation and damage of the coal mining face roof strata to the electric field parameters mainly include: natural potential, the current excitation potential, a field, apparent resistivity, apparent chargeability, etc. Sp is under natural conditions, do not need to underground power supply, the potential difference between two points on the ground to watch the certain, this suggests that there is a natural underground current field, hereinafter referred to as the natural electric field(Wu et al. 2013). To drilling electrode on the outside world in the current case collection and the formation of electric potential, can well reflect the stratum in the overburden rock deformation and failure process of electrical differential development(Wang et al. 2009). Excitation potential, or for a potential, is in the formation are motivated by the excitation potential supply of electric current. Excitation potential and exciting current apparent resistivity can be decided by calculation, it is currently in the evaluation of the stress changes of roof application is relatively common. Field data show that exciting current in the process of mining face strata stress change is more apparent, the sensitivity also significantly than other electrical parameters.

Spatial relations between monitoring hole and mining strata

The detection is applied to the mining area of a face in Huainan mine. The surface of three upper mining area is located in the west, east west hill, three mining area to pan 3 - butyl sets in the west of mine field border, north to F20-1 fault, south to F20 1 350 m south of the fault. The design length of 1414.5 m, the average length of 175 m. 13-1 the surface of coal thickness 3.1 ~ 5.0 m, 3.9 m thick, occurrence of coal (rock) layer of 180° ~ 220° < 2° ~ 15°.

In the face of "two belts" construction of borehole electric method monitoring system. Decorate in the hole which electrode, using the parallel method for data collection, according to the hole, hole electrical method inversion, exciting current imaging to detect roof damage change rule. Figure 1 to crack high electrical method detection and drilling stratigraphic section. In the working face under the monitoring of drilling straight forward less than 50 m, for monitoring sensitive stage, the working face every advance 5 ~ 10 m acquisition data can meet the requirements. Most of the electrode in the borehole, influenced by mining, bad electrode coupling, and the power supply current is very small, is expected to finish high stability which destroy the basic drilling. Through the crack in other mining roof high detection experience, good inversion result of the power supply electrode current continuity, to the power supply electrode current inversion results overlying rock destruction to analyze development situation.

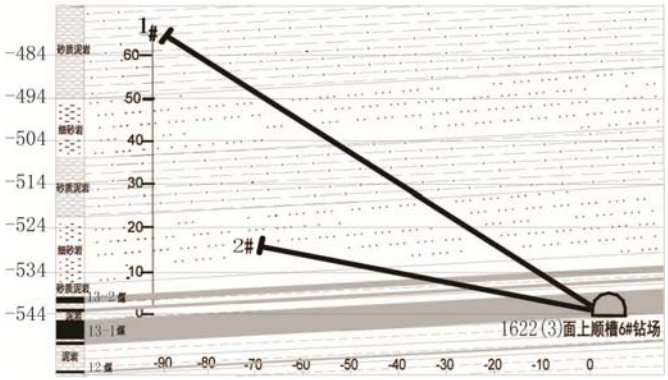

Fig.1 *Profile of electric method detection borehole layout section*

Electric parameter acquisition inversion principle

Exciting current collection

Exciting current collection apparatus using the parallel electric method, realize any electrode power supply, all the rest of the electrode potential measurement at the same time, the measuring line layout 64 electrodes, for AM method of acquisition, either the electrode power supply, the remaining 63 electrodes acquisition potential at the same time, so the data acquisition efficiency compared with the series collection, collection efficiency at least 62 times, can clearly reflect the detection area of natural potential, a potential power supply field, the change of exciting current, collect data efficiency than traditional high-density electrical method and greatly improve. Now in many coal mine using the instrument for the detection work many times, has obtained the good effect(Wang et al., 2009 & Cheng et al., 2000).

Exciting current inversion

Electrode current is mainly controlled by the grounding resistance, and the size of the grounding resistance of the anomalous resistivity variation characteristics of point directly. Usually, the bigger the rock resistivity value, the smaller the electrode power supply current. Influenced by mining stress, each electrode point location by compaction, tensile deformation and damage, caused the electrode current intensity changing. Choose one day when not affected by the mining stable electrode current value as the standard, the rest of the time the detection value and that the ratio of electrode current value as the research parameters, did not significantly change the scope of the electrode current ratio is 1, the current ratio is greater than 1, the electrode current strength increase, rock resistivity value decreases; The current ratio is less than 1, indicating electrode current intensity is reduced, rock resistivity value increases, reflect the change of the rock fracture. Drilling will be the same place two electrodes unified coordinate system, all point to the electrode current ratio kriging

interpolation inversion processing, can inversion of borehole in the system changes of the electrode current ratio, which reflects the electrode near the point of rock fracture.

Field data detection results

Results of drilling the exciting current ratio

From background value test on 22 May 2013, July 11, to the whole observation period, both for single electrode in the borehole drilled in the system, observing system for AM method of data collection. Changes of electrode current data stability, so the electrode current data inversion. As the outstanding change effect, May 22 (xinhua) pole excitation current value as the standard, the rest of the time the detection value and its ratio as the parameters. All current ratio results image adopts unified icon, blue-green area (cold tonal) as the low current ratio, red area to a higher current ratio. Now the explanation on the results of some typical cases .

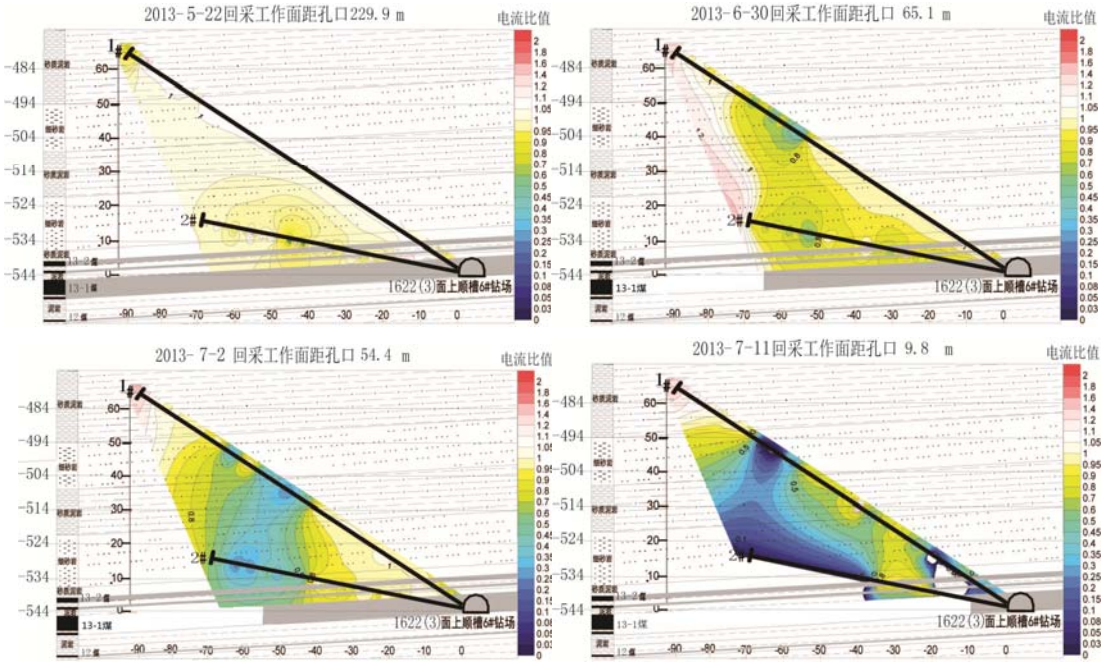

Fig.2 *Distributing map of the strata distribution of current ratio in rock of collapsing belts*

Exciting current CLP pole location accurate, sensitive ratio changes, reflecting the changes of three zones clearer. Figure 2 for the imaging detection electrode current ratio on 22 May as a result, because of the working face more than 130 m from the orifice position, basic electrode system is not affected by mining face drilling, drilling control strata have no obvious deformation, basically stable electrical characteristics, basic measured current ratio around 1. Near the rock layer interface, only a small change, reflect rock layers near the interface exists weak interlayer, electrical has certain change; On June 30, face away from the orifice position is 65.1 m, 0~6 m high on the left side of the sandy mudstone, current ratio is between 0.9~1, may for the delamination crack development, reflect the range related to the mining stress in advance. This shows that the range of 10~30 m away from orifice has been affected by the mining stress in advance, is apart from the working face advance zone with 47.7 meters; By July 11 detection results can be seen, the height of the caving zone "for 10~15 m, considering the 13 coal roof 11 m for fine sandstone and sandy mudstone interface position, and the

height of the development" "caving zone, often at the interface between the lithology, the current ratio dropped to below 0.05, for the typical" caving zone "electrical characteristics; In fine sandstone formation, the electrode current ratio dropped to below 0.5, for the typical "water flowing fractured zone" electrical characteristics; Above sandstone formation, in the local scope of electrode current ratio has dropped below 0.5, for the electrical characteristics of "bending subsidence zone".

Analysis of strata failure

The crack face high drilling control section mining height are broken range 3.40~5 m, average m to 3.9 m thick, high crack influence roof lithology is given priority to with sandstone type of formation, type is a hard roof type(Hu et al., 2008 & Yang et al., 2009 & Zhang et al., 2000 & Li et al., 1991). With the working face advancing, occurs not only in the old cavity roof strata movement and failure, ahead of the working face abscission layer or fissure is also in constant development, with the phenomena of roof periodic, continuous development. Changes with working face in front of the current ratio could represent the advanced stress zone, under the effect of lead stress, the scope of the fracture development, lead to current decreases, the working face is apart from the working face advance mining stress zone with range from 25 to 47.7 m. Tiny roof bedding direction current ratio range between 10 and 12 m in vertical height, may reflect the caving zone height; About 50 m under the vertical height of roof, significantly lower than the current ratio of 0.5, reflecting fracture zone; About 50 m more than the vertical height of roof, the basic current ratio above 0.5, no obvious changes, along with the mining for bending subsidence zone. Based on analysis, for the coal bed mining strata destruction "three zones", detection result is: the caving zone height of 12 m, at the interface between fine sandstone and sandy mudstone. Water flowing fractured zone height is 50 m, is located in medium sand strata.

Conclusion

(1) The hole lane electrical method monitoring results compared with high ground crack control hole validation, two belts highly consistent with related disciplines and research data, the deformation and damage of the upper strata of coal seam mining process characteristic response significantly, shows that the reliability of detection results.

(2) Monitoring for the "two belts" of height value is consistent with the downhole measured results, showing that using electric field change of rock stress sensitivity parametric excitation current, the effect of the dynamic testing continuous visual image, is of strong comparative.

(3) Strata damage includes a variety of influencing factors, including coal seam mining height are broken, mining thickness, mining velocity, rock type and parameters such as depth of water flowing fractured zone height play a dominant role (Zhang et al. 2006, Zhang et al. 2009, Zhang et al. 2011). Evaluation vector quantization, therefore, for more coal mining face stress changes, the future study on the relationship between a variety of electric parameters and destruction rules is still needed.

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