ATLANTIS PRESS
Advances in Engineering Research, volume 121
2nd International Conference on Advances in Materials, Mechatronics and Civil Engineering (ICAMMCE 2017)

Fault Zone Preliminary Identification Study in Xinchang Block Based on Electrical Resistivity Tomography

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Keywords: Fault zone, Electrical resistivity tomography, Reverse modeling, Apparent resistivity

Abstract. For the geological disposal of high level radioactive waste, the repository boundary of fault zone may be an important channel for radionuclide migration to the biosphere. However, there are many problems in the field, such as the large area, complex geological body and limited drilling arrangement. In order to confirm the reasonable delineation of key exploration areas and the suitability of the disposal area, this paper is aimed at the influence of boundary faults on the footwall of the key preselected area, two lines are arranged in parallel and perpendicular to the fault respectively in Xichang block, try to use electrical resistivity tomography to detect F31 fault zone by reverse modeling, through preliminary interpretation of apparent resistivity, there is a large low resistivity zone along the fault zone, which shows that the larger rock mass is more broken, it may be caused by the thrust of the north to the south, experience weathering in the later stage, etc. can be used as the key point of drilling, the vertical line of the fault zone can reflect the fault core and the geophysical prospecting information of influence zone better, the detection information shows that the fault tendency is about 70 degrees and the thickness of fault core is about 1m, the width of the shattered zone of the fault footwall is no more than 100m, corresponding to the results of geological exploration, comprehensive analysis of combined with other geophysical prospecting methods. It is proved that the method is of guiding significance for the subsequent drilling of the fault zone and the selection of the excavation position in the laboratory.

Introduction

The fault zone is a kind of geological structure widely distributed in the earth's crust, which destroys the continuity and integrity of the rock mass, and may cut through different aquifers. Therefore, it is a kind of hydrogeological body with special significance. For the geological disposal of high level radioactive waste, the repository boundary (far field) fault zone may be an important channel for radionuclide migration to the biosphere. Thus, for the repository site within the area to identify fault zone and guide the study of hydraulic conductivity is an important content of repository performance evaluation, related to the long-term safe operation of high radioactive waste disposal repository and whether it can isolate waste effectively. But in most cases, due to weathering, water erosion and deposition of geological processes, it is difficult to find a good outcrop on the surface, therefore, it is often used other means to study the fault location, shape and orientation. The main means include drilling and pitting, geochemistry, geophysics and other methods. Among them, the research of geophysical prospecting method and theory is relatively new, without slotting, drilling and sampling, such as a point, a slot, a sample, has wide test range. Therefore, it has a high availability for distinguishing the fault zone, it has been widely used because of a quick layout of the electrode area and the test result is more reliable in recent years. For example, Xu Xiao-bing, *et al*. (2006) used high density resistivity tomography technology to identify the cracks and hidden dangers of gully of an ore body, the result is satisfactory[1]; A Fa-you (2008) made comprehensive use of ground penetrating radar and high density resistivity method to detect faults[2]; Li Zhi-xiang, *et al* (2003), Cheng Miao, *et al*. (2011) achieved good results by using high density resistivity method to detect buried fault[3,4]. Due to high density resistivity method has the information of sounding and section combined, so it can reflect more information of geological body. Xuan Yue, *et al*. (2011) by using the high density resistivity method to detect buried faults in Huangzhuang-Gaoliying hidden fault[5]. The above results show that the geophysical prospecting

method has a good application prospect in the fault zone detection.

The research group has carried out the detection work such as the electrical resistivity tomography method in radioactive waste disposal of Xinchang block fault zones in Beishan preselected area in Gansu, two apparent resistivity sections parallel to the fault and perpendicular to the fault are obtained, obtained core and the affected zone width and angle information through the algorithm inversion, consistent with the geological survey results, which has value of reference for the subsequent arrangement of hole position and the subsequent research of fault hydraulic conductivity.

Overview of the study area and working methods

The research point is located in the radioactive waste disposal of Xinchang block F31 fault in Beishan preselected area (fig.1). The main lithology is granite, the land is relatively flat terrain, the region as a key area to carry out a lot of research work, but there are differences in different parts of the composition. Study on the fault belongs to the Xinchang - Hongliuquan Nanshan East-West fold belt, so the northwest plate of F31 fault is moving towards the southwest, Diorite dikes, Minette vein penetration along the fault, both sides of the rock breaking strong. Fault direction: NNE. The length of fault is about 3.3km, belonging to the two level fault. The author through field reconnaissance and combined with trench observation found that the fault gouge along the fault zone on the degree of development of small, some places only a few centimeters thick, the fault silicification and breccia development, basic and medium acid vein rock are penetrated in early time, it shows that the fault is tensional. It may be a potential pathway for radionuclide migration, the impact of future nuclear waste disposal repository safety can not be ignored.

Fig. 1. Measuring line layout

Because of the particularity of nuclear waste disposal site area, needs careful exploration, along the fault direction, whether it has been influenced by thrust faults of the north-south border of Xinchang, forming two faults and geological defects; Along the fault line, exploring the influence zone of in situ fault on the footwall, the two prospecting and surveying line are arranged in yellow line in Figure 1. Figure 2 is the field layout of electrical resistance tomography. Arranging the electrode network at a certain polar distance to measure on the ground. Resistivity Images can be obtained in different directions, so as to form the understanding of the target position and shape. Contrast conventional resistivity method, it has the following characteristics: (1) The electrode arrangement is completed once, this not only reduces the fault and interference caused by electrode setting, it also lays the foundation for fast and automatic measurement of field data; (2) It can effectively carry out the scanning measurement of many kinds of electrode arrangement, thus, can obtain the geological information of the structural characteristics of the geoelectric section abundantly; (3) Field data acquisition achieved automation or semi automation, not only the fast acquisition speed, but also to avoid the errors caused by manual operation; (4) Compared with the

traditional resistivity method, low cost, high efficiency, rich information, easy interpretation.

Fig. 2. Electrode layout and field work drawing

Data interpretation

Electrical resistivity tomography is based on the study of the differences in the electrical properties of rocks and minerals in the earth's crust, a kind of geophysical exploration method to solve the geological structure or to find useful minerals by using the spatial distribution of electric field. The basic theory of electrical resistance tomography is exactly the same as that of traditional resistivity method, a lot of electrodes are arranged on the measuring line at the same time, through the control of electrode automatic converter, to realize the automatic combination of resistivity method in different devices, different polar distance, thus, arranging electrode can measure a large number of apparent resistivity once, and then get the inversion image.

Among geophysical exploration, the physical model of geological body is established according to the geological state (shape, orientation, spatial location) and physical parameters(density, magnetism, electricity, elasticity, speed, etc.), furthermore, the process of calculating the theoretical value of the geophysical field by the mathematical model is called forward modeling. In contrast with the forward process, the process of determining the occurrence of geological bodies(shape, orientation, spatial location) and physical parameters(density, magnetism, electricity, elasticity, speed, etc.), according to distribution of the geophysical field is called inversion problem. Inversion is the precondition of achieving resistivity imaging.

Two dimensional inversion section of high density resistivity tomography is an important basis for data interpretation, also includes one of the chromatography high density electrical prospecting main maps. In the aspect of data inversion, the research group has adopted Res series software developed by Dr. M.H.Loke and AGI's Earthimage series. This paper attempts to compare the two algorithms, according to sectional drawing which shows that the characteristics of electrical distribution, to judge apparent resistivity range of geological body, to delineate the electric anomaly point(such as boulders, fracture zone, fault, underground water, etc.). Full application of known geological data and electrode device, and analysis of the causes of electrical anomalies, judge the location of the target. In order to improve the accuracy, the electrode distance on the measuring line is 1m in this paper.

Through the comprehensive interpretation of inversion results as shown in Figure 3 below, Preliminary application of AGI and Loke inversion of two algorithms found that the delineation of the fault cores width is about 1m(The core width of the 0.8-0.9m exposed by the trench is roughly the same), observed and measured the width of influence zone of the fault is about 100m in the inversion map; There is a large range of low resistivity zone on the influence zone, shows that the rock mass is relatively broken, it is preliminarily determined that the impact of the thrust fault is caused by the subduction of the north and south of the block. In addition, it is found that there may be a secondary fault in the vertical direction of the fault, should cause attention. Preliminary and more elaborate determined the feasibility of using this area as a good preselected site, drilling hole will be later arranged, need further geophysical data to interpretation, will be discussed in the following article.

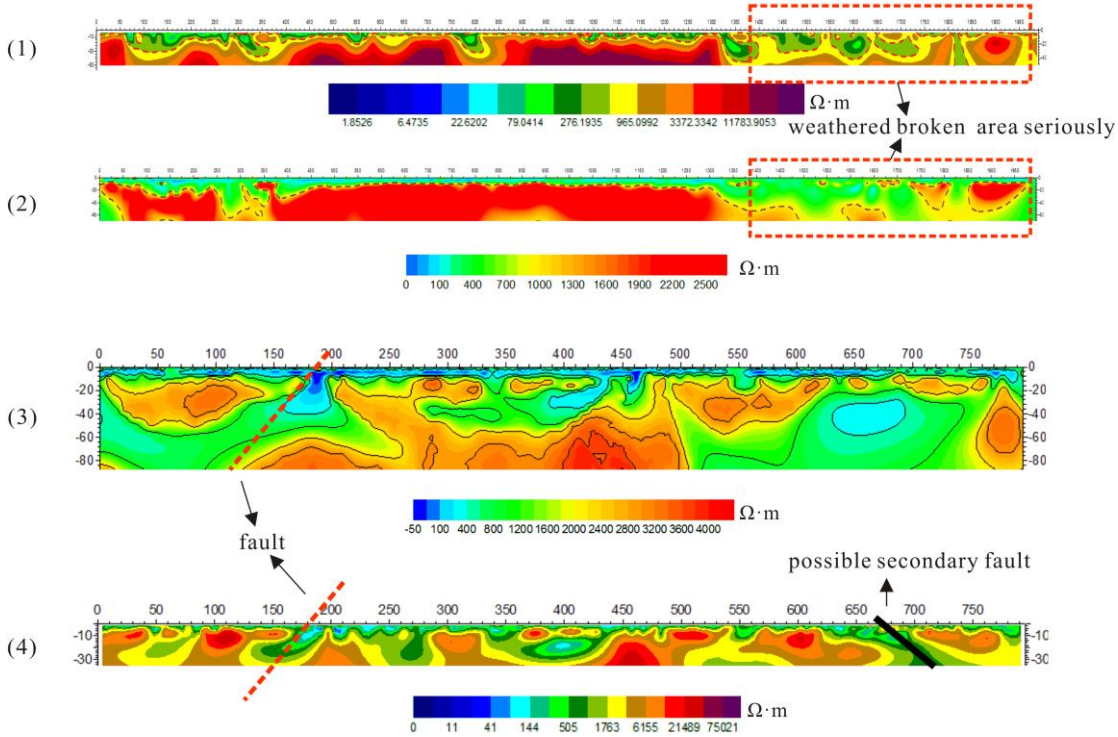

Fig. 3. AGI and Loke Chromatography electrical resistivity method inversion profile of parallel to the F31 fault and perpendicular to the fault

(1) AGI inversion of parallel to fault direction,(2) Loke inversion of parallel to fault direction,(3) AGI inversion of perpendicular to fault direction,(4) Loke inversion of perpendicular to fault direction

Conclusion

The resistivity tomography method inherits the nondestructive and low cost characteristics of geophysical exploration methods, it can meet the requirements of engineering geophysical exploration. In this paper, firstly through investigating the geological structure of the fault zone in the area, the geological parameters of possible faults in the area are obtained, for example, buried depth, general trend and so on.

Then combine these information, arrange exploration line scientificly, the two AGI and Loke algorithms used in electrical resistivity tomography inversion are better for the weathering fracture zone and fault, the map is clear, the delineation of the fault zone width is approximately 100m, fault dip angle is 70 degree, there is a large area of broken weathering zone in the direction of fault. In this paper, the influence of the subduction zone of the north and south faults can only be preliminarily determined, in the direction perpendicular to the fault, a small secondary reverse fault may be found, may have an impact on the field zone, need to follow the layout of its drilling to be discriminated. The conclusion above is more reliable, it is of great significance to the further investigation work of the later period.

Indeed, this paper has a certain significance in further delineation of affected zone etc. In particular, study on the determination of setback distance of nuclear waste disposal area which deep underground of about 500m is not enough. This paper only makes a preliminary analysis of electrical resistance tomography, in this area, the author also makes a comprehensive evaluation of seismic exploration method, relevant results are still being sorted out, subsequent studies will be reported. At the same time, combined with the existing domestic and international technical specifications, etc. There is no rule to follow, therefore, this research will continue to combine nuclear waste disposal according to the setback distance of the proposition to further deepen. In this paper, a new method of combination decision will be discussed in detail.

Achnowledgements

This resesarch presented in this paper has been supported jointly by the State Key Development Program for Basic Research of China (Grant No. 2013CB036001) and National Program for High Radioactive Nuclear Waste Disposal.

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