Application of Shallow Seismic Exploration in Concealed Fault Detection in Coastal Areas

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Abstract

With the rapid development of China's economy and the acceleration of the urbanization process, the development and construction of coastal areas are becoming more frequent. However, the complex and changeable geological conditions and active crust movement in coastal areas make the distribution of underground resources extremely rich, but at the same time, there are various hidden dangers of natural disasters. Therefore, it is very necessary to conduct a comprehensive and systematic study of the geological environment in the coastal areas.

Keywords

Seismic Exploration; Coastal Areas; Hidden Fault.

1. Regional Structural Background

1.1 Regional Formation

The strata in the coastal areas are mainly composed of Paleozoic to Cenozoic rocks and sediments. Among them, the ancient to Mesozoic magmatic rocks, volcanic rocks and granite are the important parts of the area. Most of these rocks were formed between 150 million and 140 million years ago, forming a series of fold and fault zones. In addition, there are some important deposit resources in the area, such as iron ore, manganese ore, copper ore and so on. However, the diverse topography and greatly influenced by sea level changes make it difficult to fully understand the underground structure. Therefore, studying the deep geological structure in this area is challenging. In order to better understand the geological structure characteristics and development rules of this area, the strata in this area are needed. At present, a large number of geological survey work has been completed, including geophysical exploration, drilling sampling, logging and other means. Through the comprehensive analysis of these data, the geological structure of this area can be preliminarily understood. However, due to various factors, these data still do not fully reflect the geological tectonic characteristics of the region. Therefore, it is particularly necessary to further carry out the deep geological exploration work.

1.2 Regional Structure

The area of this study is a part of the southeast coastal area of China, where the geological structure is more complex. From a tectonic point of view, the region is mainly composed of South Chinese and South Asian plates. Among them, the South China Plate is part of the edge of the Pacific plate, and the South Asia plate is part of the Indian Ocean plate, which is connected to the Eurasian continent plate. The collision between these two plates forms a series of fold zones and fault zones, and these structural lines are very important for the influence of the deep crust structure. Specifically, the south China plate is divided into multiple sedimentary basins and volcanic rocks, such as the Pearl River Delta Basin, the Qiongzhou Bay Basin, the South China Sea Basin and so on. These basins are rich in oil and gas resources, so they have become one of the important target areas of oil and gas development at home and abroad. At the same time, because the area is located in the Marine

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circulation zone, the erosion effect of the sea water on the rocks is also very strong, making the Marine erosion landform is also very rich and diverse. In addition to the tectonic lines, there are several significant geological events in the area. In short, the tectonic background of this region is very complex and changeable, which is challenging for deep formation detection.

1.3 Regional Neotectonic Movement

Over time, new tectonic movements are taking place on the earth's surface. These tectonic movements not only affect the surface geomorphic morphology and geological characteristics, but also have an important influence on the underground magmatic activities and crustal deformation. Therefore, it is important to understand the regional neotectonic movement for geological research. In this study, we found from the sediment at home and abroad that the neotectonic movement in this region is mainly manifested by the frequent occurrence of plate collisions and subduction, volcanic eruptions and seismic activity. Among them, plate collision and subduction are one of the main causes of seismic activity in this area. Plate collision refers to the collision of land plates between two continents or ocean basins, which causes the problems of crustal deformation and rock fracture. In this region, the plate collisions caused by the northward movement of the Pacific plate are more obvious. Crustal deformation and rock rupture caused by such plate collisions often lead to seismic activity. In addition, volcanic eruptions are another important factor in seismic activity in the region. When a volcano erupts, a lot of heat is released, triggering seismic activity. Therefore, the influence of plate collision and subduction should be fully considered before Marine seismic exploration.

2. Shallow Seismic Exploration

2.1 Shallow Seismic Exploration Methods

Shallow seismic exploration is a common geological survey technology, whose main purpose is to obtain the information of the underground structure by studying and analyzing the elastic wave propagation characteristics of the underground medium. This technology can effectively reveal the physical properties of the rocks under the surface and the interrelationship between them, so as to provide an important reference basis for the subsequent engineering construction. The basic principle of shallow seismic exploration is to use the seismic waves generated inside the earth to transfer these fluctuations to the crust surface and record them, and then calculate the elastic parameters of the underground medium. At present, the common shallow seismic exploration methods include inversion method, transmission method, reflection method and other types. Among them, the inversion method is one of the most commonly used methods. Based on the variation pattern of the velocity of seismic waves in different media, the elastic parameters of the underground medium. Moreover, the Doppler effect can be used to improve precision and reliability. In short, shallow seismic exploration, as an effective means of geological exploration, has a wide application prospect and development potential.

2.2 Interpretation of Seismic Data

Seismic data is essential when conducting seabed geological research. Through the analysis and interpretation of seismic data, information about the geological structure of the seabed can be obtained to provide a basis for subsequent research. Therefore, how to effectively explain the seismic data is a very important link. First, a preliminary processing of the seismic data is needed. This includes removing noise interference, eliminating bias errors, and calibrating the time series. The purpose of these operations is to make the seismic data more accurate and reliable to reflect the actual physical phenomena. Secondly, the seismic data need to be analyzed. This mainly includes the determination of source position, wave speed calculation, amplitude estimation and other aspects. These results are of great significance to determine the geological structure of the seabed, and also help to improve the application value of seismic data. Finally, the seismic data need to be explained. This process is mainly designed to combine seismic data with known geological conditions, so as to draw conclusions and make corresponding predictions or decisions. Specifically, whether there are potential problems

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or anomalies can be judged by comparing seismic data with existing geological survey results. In addition, the knowledge and experience of geophysics can also be used to further interpret the seismic data. In short, seismic data interpretation is a complex process, which requires a comprehensive use of a variety of technical means to achieve better results.

3. Application of Joint Inversion Technique in Concealed Fault Detection

3.1 Principles of Joint Inversion Technology

Joint inversion technique is a common seismic exploration technique, the basic principle is to use the mutual contrast between two or more sensors to improve the resolution and seismic wave signal quality. This method can effectively reduce noise interference and improve data quality and reliability. The application of joint inversion technology is of great significance. The basic steps of joint inversion technology include first arranging two or more sensors in the same area; then processing the data of each of the sensors to obtain the seismic signal recorded by each sensor; and finally comparing the size of the signal recorded by the various sensors to obtain information about the underground structure. The advantage of the joint inversion technology is that it can effectively reduce the influence of noise, while improving the accuracy and stability of the data. Therefore, it is widely used in geology, geophysics, oil and gas exploration and other on. The application of joint inversion technique has also been great attention. Due to the complex and changeable deep structure, the traditional single-sensor method is often difficult to obtain enough seismic wave signal to reveal the characteristics of underground structure. The joint inversion technology can enhance the signal intensity and frequency range by increasing the number of sensors, and then better reveal the characteristics of the underground structure. In addition, the combined inversion technology can also realize the imaging of lower surfaces at different depths, which provides new ideas and means for the study of deep structure. In short, the joint inversion technology plays an important role in the concealed fault detection, and will play a more important role in the future development.

3.2 Application of Joint Inversion Technology in Practical Engineering

This study aims to investigate the advantages and limitations of the combined inversion technique in the concealed fault detection in coastal areas. Through the application of this method, we find that it can effectively improve the identification rate and accuracy of underground structures, so as to provide strong support for the subsequent geological disaster early warning work. Specifically, we conducted a deep seismic exploration on the coastline of an island and found some potential fault locations. To further confirm the location of these faults, we employed a joint inversion technique for detection. After many tests and comparative analysis, we believe that the joint inversion technique is a very effective method, which greatly improves our detection efficiency and accuracy. At the same time, we also noticed some shortcomings of this method, such as the need for higher technical level and high equipment input costs. Therefore, in the future research work, we will continue to explore how to overcome these problems to better serve the needs of geological disaster early warning work.

4. Conclusion

To sum up, joint inversion technology, as a new technique, has been widely applied and developed. Although it has some limitations and defects, it can become one of the important tools in the field of geological disaster early warning.

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