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Research on Interwell Detection Based on Pseudo Random Electromagnetic Method

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Research on Interwell Detection Based on Pseudo Random Electromagnetic Method

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Abstract. At present, a large amount of oil reserves exist in underground oil reservoirs in the form of remaining oil. Therefore, to improve oil recovery, it is necessary to increase the recovery rate of remaining oil, and the well is a main area of remaining oil, so the detection of interwell reservoirs is of great significance. In view of this, this article first gives the general plan of the pseudo-random electromagnetic method for cross-well exploration, and analyzes the principle of the pseudo-random signal correlation identification technology based on the Wiener-He Fu equation; secondly, analyzes the common pseudo-random sequence Characteristics; again, based on the use of line source theory, a cross-well detection model is established, and the feasibility of the built model is verified; then the conductivity changes, buried depth changes and thickness changes of anomalous bodies are used for non-uniform wells. The influence of the electric potential distribution of the probe model; finally, the difference of each impulse response is analyzed.

Keyword: Pseudorandom; Detect; Electromagnetic method.

1. Introduction

At present, my country's oil extraction volume is far from being able to meet the continuously increasing domestic oil demand, which makes our country's oil dependence on foreign countries relatively high. However, the current average oil recovery rate in the world is about 33%, and my country's oil recovery rate is only about 30%. In other words, a large amount of oil has been buried in the ground for a long time. Therefore, cross-well detection is an important work [1-2]. In view of the fact that most of the current oil reserves exist as remaining oil in underground oil reservoirs, increasing the recovery rate of remaining oil is of great significance for increasing the oil recovery rate [3]. The remaining oil usually refers to the underground crude oil that has not been recovered after a certain method has been used to recover oil from a reservoir [4]. The key to recovering the remaining oil is the detection of the remaining oil, especially the exploration of its enrichment area [5]. Therefore, the inter-well area is the area where we need to focus on exploration and research [6], so the exploration of the remaining oil between the wells is particularly important.

By taking pseudo-random coded high-precision electric field signals and complex interference signals as the research objects, research on the characterization of pseudo-random electric field data driven by system identification and related detection and high-efficiency denoising research [7]. Preliminarily study the cross-correlation between pseudo-random electric field signals and complex electromagnetic interference signals, explore the terminal characterization of complex irregular electric-field interference signals, reveal the rules of pseudo-random signals and noise, and use the auto-correlation characteristics of pseudo-random codes to shield out-of-band electromagnetic interference [8]. The receiving end uses the cross-correlation features of random signals to perform calculations, adds high-density sampling nodes at the acquisition end, and establishes multi-level anti-noise thresholds [9-11]. The technology can not only suppress interference in mineral exploration under complex electromagnetic interference and three-dimensional scanning of urban underground space A new technology and new method to provide technical support and demonstration basis for four-dimensional geophysical electrical exploration [12].

Pseudo-random electrical technology has been carried out experimental research work including crisis mines and urban geophysical prospecting. The results show that pseudo-random electric field signals can achieve high-precision geoelectrical measurements [13]. On this basis, this project will condense the relevant scientific issues and issues of pseudo-random signals. Collect the geological characterization of electric field signals, clarify the research content and research objectives, and serve the transparent underground space work.

2. Application and development of pseudo-random signal in electromagnetic prospecting

Since the 1990s, radio communication technology has developed rapidly. In order to improve communication quality, pseudo-random coding methods have been used in the communication industry and have been widely used. In the communications industry, pseudo-random coded signals are used for signal spread spectrum, and at the same time, the code sequence is introduced for demodulation at the receiving end, so as to achieve the purpose of anti-interference in the signal transmission process, thereby improving the situation in the background of strong noise. The ability to recognize weak signals. In view of the successful application of pseudo-random signals in the communications industry, this signal has attracted the attention of relevant technicians, and applications of pseudo-random signals have slowly appeared in other fields.

Among them, the bandwidth of the pseudo-random signal is controllable, and its energy is concentrated on several frequencies. This signal can be described as an ideal excitation source in electrical exploration. The pseudo-random multi-frequency electromagnetic method using this pseudo-random signal as the excitation source has outstanding advantages compared with the electromagnetic method based on the traditional excitation signal.

3. Method

3.1. Basic framework

In the field of electromagnetic exploration, the earth and underground space can be regarded as a linear and complex geoelectric system. Traditionally, the step method and frequency method are used to obtain the response characteristics of the geoelectric system, such as amplitude or phase. This paper proposes a cross-well pseudo-random electromagnetic method to realize the detection of cross-well anomalies, using impulse response to express the response characteristics of the cross-well detection model. The specific scheme design is shown in Figure 1. First, establish a cross-well geological model and apply a pseudo-random signal excitation source to the model; then, receive the output response signal of the model; Finally, pass the input signal and output response signal of the model Correlation calculations are used to identify the impulse response of the cross-well probe model.

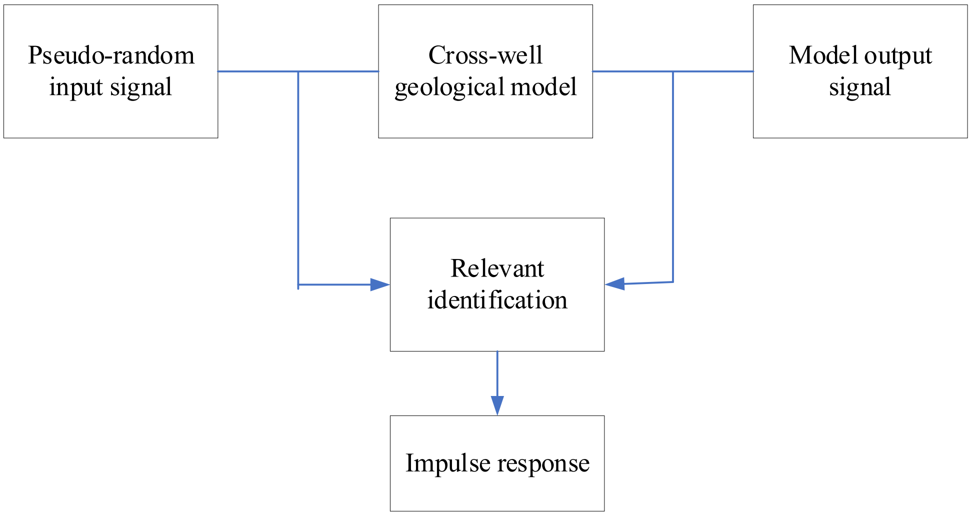

Figure 1. Pseudo-random electromagnetic method to streamline exploration

3.2. Pseudo-random signal sequence and characteristic analysis

Pseudo-random signal, a long-period signal, whether its randomness will appear is related to the length of observation time. In the time longer than one cycle, it is a deterministic periodic signal, showing its non-random characteristics; in the time shorter than one cycle, it is a random binary signal, showing its randomness. The autocorrelation characteristic of pseudo-random signal is very similar to white noise, and its correlation function is quite sharp; it has a wide power spectrum band; its anti-interference ability is good; it is unrecognizable for non-receiving targets.The correct identification and extraction can be carried out because the law is known. Due to the rapid development of the communications industry, there are now a variety of pseudo-random sequences, such as the common m-sequence, inverse repetitive m-sequence, Gold sequence, and M-sequence. Below, this article will introduce some of their characteristics separately, and use them accordingly. The pseudo-random signal source used in this article makes a choice.

3.3. Cross-well exploration model

The numerical simulation calculation model established in this paper is a scaled-down model. In the actual research process, we often encounter problems that cannot be solved directly or completely by the use of advanced mathematics, so we directly turn to experiments. This paper establishes a scaled model based on the similarity theory and at the same time is based on the controlled variable method. In the research process, the parameters of non-research variables were idealized to simplify the model. In this way, the simplified model is very convenient for numerical simulation and analysis, simplifies the mesh division, and reduces the amount of calculation.

Corresponding to the uniform cross-well detection model is the non-uniform cross-well detection model. "Inhomogeneous" refers to the existence of anomalies contained in the above-mentioned uniform cross-well detection model. The so-called anomalous bodies are high-resistance bodies or low-resistance bodies that are different from the physical parameters of the formation. High-resistance bodies are objects with a resistivity higher than the resistivity of the formation, and low-resistance bodies are objects with a resistivity lower than that of the formation. The existence of these abnormal bodies has changed the characteristics of the original uniform cross-well detection model. Among them, the buried depth changes, thickness changes, and electrical differences of the abnormal bodies may cause the characteristics of the cross-well detection model to change. Therefore, studying the different characteristics of the inter-well detection model under the different influences of anomalous bodies will help guide the exploration and identification of inter-well oil and gas resources in practice. In this article, the description of the abnormal bodies in the non-uniform cross-well exploration model is shown in Figure 2. The four abnormal bodies are rectangles with a width of 10m and a height of 3m. Among them, No. 1 and No. 4 The anomalous body is 22m away from the ground, and the anomalous bodies No. 2 and 3 are 12m away from the ground.

4. Conclusion

Based on the pseudo-random correlation identification technology, impulse responses were performed on the open-hole cross-well detection model, the uniform cross-well detection model, the non-uniform cross-well detection model containing only low-resistance bodies, and the non-uniform cross-well detection model containing only high-resistance bodies. Relevant identification and analysis of the difference of each impulse response, it is concluded that the maximum value of the uniform cross-hole detection model impulse response is much smaller than the maximum value of the open hole cross-hole detection model impulse response, and the maximum value of the non-uniform cross-well detection model impulse response The value is smaller than the impulse response of the uniform cross-well probe model, but the impulse response value of the cross-well probe model containing only high resistance.

As shown in Figure 2 below, compared with the aforementioned uniform cross-well detection model, a series of abnormal bodies (some high-resistance bodies and low-resistance bodies) are added to the stratigraphic domain in the non-uniform cross-well detection model. These abnormal bodies are represented by rectangles. In order from left to right: low resistance body, low resistance body, high resistance body, and high resistance body, marked as No. 1, No. 2, No. 3, and No. 4 abnormal body respectively. In the model, the shape, location and other characteristics of the abnormal body can be arranged according to the specific content direction to be studied. For example, in the model shown in Figure 4-3 below, the purpose of setting anomalies in this way is to make this series of anomalies contrast with each other, and then reflect certain laws and other characteristics. Among them, the two abnormal bodies on the left (both are low-resistance bodies) can reflect the influence of low-resistance bodies at different distances from the launch tube on the response characteristics; the two abnormal bodies on the right (both are high-resistance bodies) It is possible to compare the effects of high-resistance bodies at different distances from the launch tube on the response characteristics; the two anomalies on the left and the two anomalies on the right are equidistant from the launch tube (that is, the two anomalies on the 2nd and the Anomalous Physique No. 3.

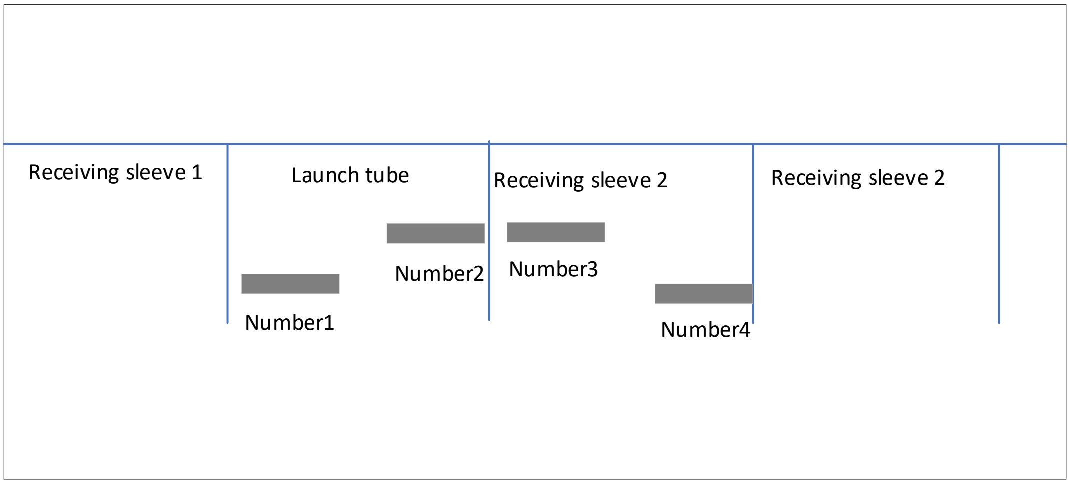

Figure 2. Non-uniform cross-well detection model

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