Numerical Simulation of Dual Laterolog Response Based on Wireless Communication Technology

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Abstract. The current numerical simulation of dual laterolog response is mostly unidirectional, and the efficiency of numerical simulation is low, resulting in high resistivity and potential safety hazards when conducting potential processing. Therefore, the design and verification research of the numerical simulation of dual laterolog response based on wireless communication technology are proposed. Firstly, the feature extraction of numerical simulation is carried out, and the multi-level method is adopted to improve the efficiency of numerical simulation, realize multi-level grid generation of dual laterolog, establish a wireless communication numerical simulation model, and implement numerical simulation by boundary constraint processing. The final test results show that the measured resistivity is well controlled below 7 in combination with the electrical coefficient of each set point through numerical simulation processing at the depths of 1.1 m, 1.3 m, 1.5 m, 1.8 m, 2 m, 2.3 m, 2.5 m and 3 m, which indicates that this numerical simulation has relatively large coverage and strong pertinence, it has practical application value to optimize the unit simulation structure, improve the efficiency and quality of the overall numerical simulation, and minimize the difference in the simulation process.

Keywords: Wireless Communication Technology · Dual Laterolog · Response Numerical Simulation

1 Introduction

As a commonly used multi-dimensional exploration and development technology, dual laterolog processing has achieved relatively good results in current social engineering activities, greatly improving the quality and efficiency of project construction [1]. Generally, the reservoir of dual laterolog is relatively thick, and the dual laterolog response law is also very different from that of vertical wells. The existing vertical well logging interpretation methods can no longer be used in dual laterolog. Therefore, it is necessary to carry out numerical simulation processing [2] in combination with high and new technologies, equipment and devices. In fact, the research on the response characteristics of dual laterolog is relatively simple at present, which is mainly due to the influence

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of the sedimentary characteristics of the formation. In addition, the dual laterolog is generally shale formation, which has strong isotropic vertical weighting characteristics. The general rule is that components are evenly distributed along the direction of the layer interface, which is isotropic. In the direction perpendicular to the layer interface, the degree of lateral opportunism will also change correspondingly, which is characterized by high resistance. Therefore, under such a background, it is relatively difficult to conduct numerical simulation processing for dual laterolog [3]. Moreover, the formation structure of dual laterolog is relatively complex, and the reservoirs of various rocks have many fractures. The fracture dip angle will also have a great impact on the permeability of shale gas reservoirs, which is very likely to directly lead to problems such as cracking or subsidence of gas reservoirs, which will reduce the actual production efficiency [4] to a certain extent. In addition, the angular rock layer or the built-in structure of the dual laterolog often occurs the phenomenon of diameter expansion, which causes the local size change of the borehole to produce pressure on the dual laterolog response, which will also cause errors in the results of the numerical simulation. Therefore, the analysis and verification of the numerical simulation of dual laterolog response based on wireless communication technology are proposed. The so-called wireless communication technology is actually a multi-dimensional communication mode, which mainly refers to a communication form [5] that uses the characteristics of electromagnetic wave signals that can spread in free space to exchange information. The integration and practical application of this technology with the numerical simulation of dual laterolog response can further expand the coverage of actual numerical simulation and improve the accuracy and integrity of simulation [6] to a certain extent. Then, based on this, the finite element method can also be used to optimize the results of numerical simulation, and the corresponding numerical simulation scheme [7] can be formulated for the changes of anisotropy and fracture dip angle of the dual laterolog and the underlying rock layer. In addition, the current dual laterolog is widely distributed and usually has a large scale, and the reservoir space beneath the rock layer is highly heterogeneous. It is necessary to make a comprehensive analysis of the response characteristics, environmental correction and sensitive factors of dual laterolog, and describe and process the details of model construction, grid division and parameter setting in numerical simulation, it provides reference basis and theoretical reference for subsequent relevant research and practical verification [8].

2 Design a Numerical Simulation Method for Wireless Communication of Dual Laterolog Response

2.1 Feature Extraction of Numerical Simulation

In general, in the process of numerical simulation processing, the basic features are extracted first according to the actual simulation requirements based on the conditions of the stratum itself, a core point of numerical simulation is selected, and extended simulation and numerical establishment are carried out to lay a foundation for subsequent numerical simulation [9]. This time, based on the actual situation of the dual laterolog project, the response characteristics are analyzed in many aspects, which can be divided into three aspects. One is the horizontal fracture. In the process of feature extraction, the depth of the cave center is the same as the midpoint of the fracture, and the fixed distance between the cave and the borehole wall is 20 cm. Assuming that the drilling is very deep, and the properties of cave fluid and fracture fluid are the same, the diameter of the borehole is 18.2 cm, the electrical resistivity is 0.1 Ω· m, and the matrix fracture opening is 56.8 μm. The resistivity is 2350 Ω· m, and the resistivity of borehole drilling fluid is 0.65 Ω · m [10–12]. Next, we will collect and analyze other numerical indicators according to the actual extraction demand, as shown in Table 1 below:

Table 1. Numerical simulation characteristic index setting table

Numerical simulation characteristic indicators	Initial standard value	Measured standard value
Surrounding rock resistivity/Ω · m	5.5	6
Borehole diameter/m	3.5	3.6
Anisotropic coefficient	16.35	18.55
Lateral resistivity/Ω · m	8.5	9
Resin simulation directional crack angle/°	50	65
Electrode coefficient	14.25	16.34
True resistivity/Ω · m	6.5	7.5
Reservoir Porosity	65	75

According to Table 1, set the characteristic indicators of numerical simulation. Then, on this basis, through the response analysis of horizontal fracture cave dual laterolog, it can be found that under the above circumstances, the existence of fractures will lead to a significant reduction in resistivity, and the results of deep logging are negatively correlated in the difference of characteristics; In the case of a single fracture, the influence of caves on dual laterolog is relatively small. In the analysis, the logging tool, fracture and cave center are all placed at the same depth, and the corresponding impact is analyzed. Through the analysis, it can be found that if the cave is relatively close to the borehole, the value of bilateral resistivity will be smaller. However, it should be noted that the lateral wells of horizontal fracture cave combination have been negative amplitude difference for a long time [13–15].

The second is the dip fracture characteristics of dual laterolog. This part is mainly in the case of inclined fractures, the response of lateral wells will be controlled by the fracture occurrence. When low angle fractures are developed, the difference in resistivity of lateral wells is positive. In this case, compared with the response of lateral wells with a single fracture, the response of lateral wells is controlled by the presence of caves to a certain extent, and in the specific analysis process, it can be found that the inclined fracture will not affect the response of lateral wells due to the change of inclination angle. Under different environments, the data of critical angle of positive and negative amplitude difference change of lateral wells are basically the same.

The third is the vertical fracture characteristics of dual laterolog. Different from inclined fractures, vertical fractures have a wide range of characteristics. When analyzing vertical fractures, it can be found from the analysis results that caves will cause the response value of adjacent dual laterolog to gradually decrease. In the case of vertical fractures, the positive difference of resistivity is very obvious. In the case of vertical fractures, the specific response identification range of lateral wells is very similar to that of a single cave. So far, the extraction of numerical simulation characteristics has been completed, and the collection of basic data and information has been realized, which can be used to measure and verify the subsequent numerical simulation in the project area.

2.2 Multilevel Grid Generation of Dual Laterolog

After the feature extraction of numerical simulation is completed, then, combined with wireless communication technology, the grid of dual laterolog is divided. In mesh generation, the more the number of mesh nodes and the finer the elements, the higher the accuracy of the solution, but the calculation time will also increase. The mesh division is too sparse. Although the required calculation memory is small and the calculation time is short, the calculation accuracy is correspondingly low. Combined with the wireless communication technology of knight errant, the grid is divided scientifically and reasonably, and different density grids are selected in different solution areas to ensure the calculation accuracy of the model while reducing the time consumed in calculation. Triangle grid is used for division. Due to the large size contrast of geometric model, the wellbore, fractures and strata are divided into sub domains. The mesh is dense at the instrument and fracture, and sparse at the infinite distance of the stratum. The running time of the program can be greatly reduced by using different meshes to divide the domain. The mesh generation in the solution area shall meet the following requirements:

(1) At the junction of different dual laterolog domains, the elements dissected cannot cross the interface;
(2) Elements of dual laterolog do not overlap each other;
(3) The grid of the generated dual laterolog covers the whole solution area;
(4) The closer the triangulation mesh is to the equilateral triangle, the better the quality of the triangulation mesh and the more stable the construction state;
(5) Combined with acquisition characteristics, ensure proper grid density of dual laterolog.

Then, based on this, directional analysis of dual laterolog electrode, borehole, fracture and formation grid generation is conducted in a two-dimensional axisymmetric manner. The mark subdivision processing is carried out through triangular extremely refined grid, and the subdivision is densified near the electrode of the dual laterolog tool, with the minimum unit size of 0.016 m. Due to the large potential change at the contact surface between the dual laterolog tool and mud, the contact surface between the borehole and the fracture, the contact surface between the borehole and the formation, and the contact surface between the fracture and the formation, the refined grid subdivision is selected, combined with wireless communication technology, to ensure the accuracy of the simulation. An auxiliary point is added at the center of all electrodes to facilitate the reading of the overall potential of the electrodes and to improve the quality of grid generation. From the electrode to the infinite distance, the number of grids gradually decreases, the grid becomes more and more sparse, and the side length of the triangle gradually increases. This reduces the time of model calculation, which is conducive to the establishment of the later numerical simulation environment and the control of errors. The numerical simulation will be balanced and symmetrical. The specific principle is shown in Fig. 1 below:

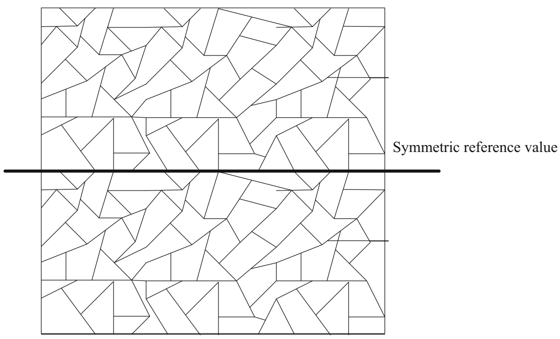


Fig. 1. Symmetry diagram of dual laterolog response numerical simulation

According to Fig. 1, complete the analysis and research on the symmetry of numerical simulation of dual laterolog response. Next, because the solution area of the upper and lower axisymmetric model is 1/2 of the axisymmetric model, the reduction of the solution area is convenient for calculating the dual laterolog response value of the micro fracture. Triangular extremely fine mesh is also used for mesh generation. The mesh generation is relatively dense near the electrode system, and sparse in the remote stratum. Based on the two-dimensional model, the three-dimensional model is meshed. A reasonable mesh generation can not only ensure the correctness of the solution, but also effectively shorten the time of model calculation, which affects the calculation accuracy of the model. In the 3D model, the mesh is generated from inside to outside, from dense to sparse. Dense dissection is carried out near the electrode system. However, in this part, it should be noted that because the electrode occupies a small part of the whole stratum, the infinite region and part of the stratum boundary can be hidden first when processing the grid and setting the materials. Recovery calculation shall be performed after application. The finer the regional grid near the well is, the thinner the regional grid far away from the well is. If the potential is zero at infinity, the coarser quadrilateral grid is selected. In the 3D model, the contrast between the fracture and the electrode and the stratum area is large. Combined with wireless communication technology, the difficulty of mesh generation is increased, and the calculation time of mesh generation is increased. Subdivision subdivision can avoid the large amount of computer memory occupied by mesh subdivision, shorten the calculation time, and achieve accurate simulation results. Through the establishment of three-dimensional model, it is considered that the two-dimensional axisymmetric and two-dimensional up and down symmetric models cannot meet the simulation of fractures with different dip angles. Even though the borehole, instruments and formation have axial symmetry, the fractures with different dip angles in the formation do not have axial symmetry. Due to the large amount of 3D model calculation, each mobile instrument needs to be re divided and solved. Combined with wireless communication technology, multi-level local division is carried out to lay a foundation for subsequent numerical simulation.

2.3 Establishment of Wireless Communication Numerical Simulation Model

After completing the multi-level grid generation of dual laterolog, next, combined with wireless communication technology, a wireless communication numerical simulation model is established. Corresponding conductivity devices shall be set in the numerical simulation area and marked measuring points. The conductivity value is the reciprocal of resistivity. The set conductivity and dielectric constant are convenient for subsequent analysis of dual laterolog response characteristics of the same filled mineral fractures. According to different materials, the default response numerical simulation boundary of the system does not need to be set separately, and the boundary conditions are automatically met during the solution process. The potential at infinity is 0, the electrode surface potential is equal, and the normal derivative of the potential of the insulating material is 0, preventing the current from directly passing through the insulation boundary. Combined with wireless communication technology, the electric field distribution in the research area is calculated by potential superposition in the bilateral numerical simulation. In the deep detection mode of the two-dimensional model, the reference ratio of the power supply electrode is 2.3 and the shielding electrode ratio is 5.4. Combined with the principle of electric field superposition, the three electrodes send out currents to form three electric fields, forming the basic numerical simulation environment of the model.

Next, combined with wireless communication technology, the response state of dual laterolog is visualized, so that the reservoir can be visually described and closely combined with geological evaluation; However, at present, imaging logging is expensive, and its detection depth is shallow, so it has limited effect on fractures and holes that extend farther. As a conventional logging technology, dual laterolog has the advantages of low cost and large detection range, so it is of great significance to study the response characteristics of dual laterolog of fractures and vugs for logging interpretation of fractured vuggy reservoirs such as carbonate rocks. Firstly, a basic numerical simulation model is designed based on wireless communication technology. One is stratum model. The key point of this model design is to carry out forward modeling of the dual laterolog response of the fractured vuggy formation, grasp the characteristics of the dual laterolog response of the hole, preliminarily discuss the problem of hole identification, and further study the impact of the hole on the fractured vuggy formation. Therefore, the dual laterolog numerical simulation model can be divided into two cases, namely, dual laterolog hole model and dual laterolog fracture hole model, as shown in Fig. 2 and 3 below:

According to Fig. 2 and Fig. 3, the setup and analysis of dual laterolog hole model numerical simulation and dual laterolog fracture hole model numerical simulation are completed. Next, the model is reasonably processed and adjusted in combination with wireless communication technology to form a complete numerical simulation process

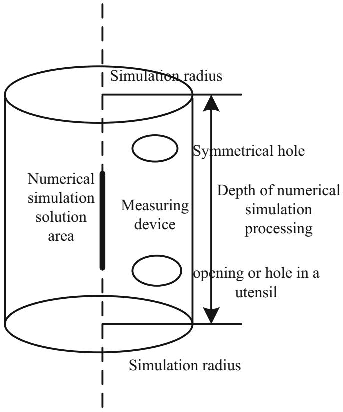


Fig. 2. Numerical simulation of dual laterolog hole model

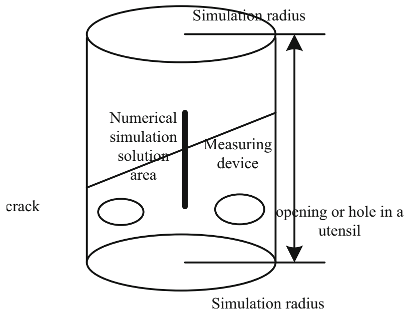


Fig. 3. Numerical simulation of fracture cavity model of dual laterolog

and a targeted processing structure, so as to further strengthen the application capability of the model.

2.4 Numerical Simulation by Boundary Constraint Processing

After the establishment of the numerical simulation model of wireless communication, the final numerical simulation is realized by boundary constraint processing. When collecting and analyzing the response state of dual laterolog, due to the convenience of finite element mesh generation and the advantages of complex boundary conditions processing, specific boundary constraint conditions or standards can be set in combination with wireless communication technology. The wireless communication technology and finite element method are used to set the basic numerical simulation solution interval for discrete calculation, so as to transform the calculation of partial differential equation with continuous solution area into the linear measurement of finite nodes (degrees of freedom). The specific numerical simulation setting process is as follows:

(1) The solution area of dual laterolog is discretized according to the range of wireless communication coverage unit and node identification range

(2) Determine cell range difference function or numerical simulation shape function
(3) Combine the stiffness matrix of each element
(4) Assemble the element stiffness equations to form the total stiffness equations for numerical simulation
(5) Directly impose the given boundary constraints on the numerical simulation conditions
(6) Load and solve the total stiffness equations, and calculate the potential function of dual laterolog
(7) Processing of dual laterolog electrode system and calculation of dual laterolog response

Based on the above process, the numerical simulation processing of dual laterolog response can be realized. Then, the next stage of discretization processing is carried out. Because the finite element mesh is relatively free, the shape and size of the formed finite element elements are also more irregular. Therefore, the finite element method is more applicable and the calculation accuracy is relatively higher when solving the complex boundary conditions in the region. The size and distribution of the field field quantity in the internal response process of dual laterolog are properly measured and numerically collected. Under the condition of using fewer nodes, the ideal calculation accuracy is achieved through the reasonable distribution of nodes. In general, the discretization of the finite element solution area has the following discrete principles, as shown in Table 2:

Table 2. Setting of Discrete Indexes for Numerical Simulation of Dual laterolog

Discrete index for numerical simulation of dual lateral logging	Directional parameter values	Controllable parameter values
Medium comprehensive ratio	3.2	4.1
Coincidence ratio in numerical simulation of dual lateral logging	6.5	6.8
Boundary basic values	16.35	18.44
Infinite boundary simulation element values	2.1	2.6
Grid encryption difference	0.21	0.16
Concave four times/time	10	18

According to Table 2, complete the setting and analysis of discrete indicators for numerical simulation of dual laterolog. The accuracy and stability of numerical simulation are improved by using boundary constraints, which lays the foundation for subsequent engineering construction.

In summary, the flow chart of numerical simulation research on dual lateral logging response based on wireless communication technology is shown in Fig. 4.

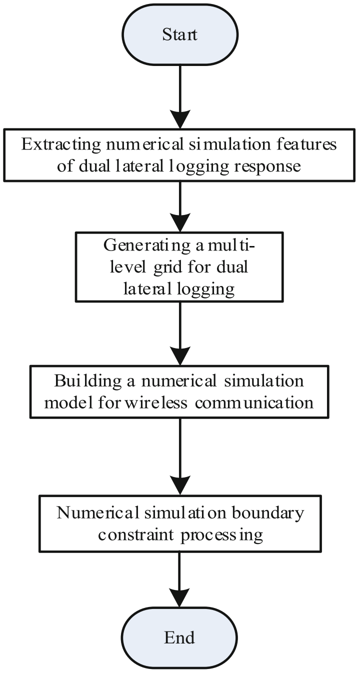


Fig. 4. Flow chart of numerical simulation research on dual lateral logging response based on wireless communication technology

3 Method Test

The main purpose of this study is to analyze and validate the practical application effect of the bidirectional side nail response digital simulation method based on wireless communication technology. To ensure the authenticity and reliability of the test results, comparative analysis was conducted and the G bidirectional side nail construction project was selected as the main test object. Collect basic data and information of the project using professional equipment and facilities, summarize and integrate them, and classify them according to different categories for future use.

Based on the actual needs of numerical simulation processing and changes in standards, comparative research was conducted, and basic testing environments were established and set up by integrating wireless communication technology. Dedicated to analyzing and verifying the effectiveness of this digital simulation method in practical applications, in order to evaluate its feasibility and effectiveness. By comparing and analyzing the actual situation, conclusions can be drawn and suggestions for improvement and optimization of this method can be provided. This research is of great significance for improving the practical application value of the digital simulation method for bidirectional nail response.

3.1 Test Preparation

Combined with wireless communication technology, set and overlap the numerical simulation processing environment of G dual laterolog construction project. First, the basic numerical simulation boundary conditions are set in combination with the actual numerical simulation processing direction and the directional conversion standard, and the higher-order basis function is calculated first, as shown in Formula 1 below:

$$D = \alpha^2 - \sum_{i=1} \beta i + (1 - \alpha)^2 \tag{1}$$

In Formula 1: D represents a higher-order basis function, α represents the conversion coefficient, β indicates the directional numerical coverage, i Indicates the number of conversions. According to the above settings, the calculation of higher-order basis functions is completed. Set it as the most basic processing dimension value in the numerical simulation structure. Combined with wireless communication technology and three-dimensional finite element analysis principle, reasonable mesh generation method is used to estimate the initial interpolation ratio of higher-order basis function. Combining with the selected two-way logging response of Project G, the value of sparse mesh generation simulation unit is scientifically adjusted, as shown in Formula 2 below:

$$L = (1 - \nu \times \frac{\beta \nu}{m + n})^2 + m\nu^2 \tag{2}$$

Equation 2: L represents the value of the subdivision simulation unit of the sparse grid, ν indicates coverage, m represents the analog accuracy value, n indicates the precision deviation, β represents year-on-year linear interpolation. According to the above settings and analysis, the calculation of the simulation unit value of the subdivision of the sparse grid is completed. At this time, judge whether the numerical simulation environment is reasonable according to the change of the simulation unit value of sparse grid subdivision, and calibrate the change position of the dual laterolog response, connect with the initial simulation structure to form a complete processing system, and clarify the processing standards of each link for future use.

In the G project, 6 points are selected as the actual numerical simulation measurement area, and the electrode coefficient of the logging response at this time is measured in combination with the high-order basis function and the variation of the simulation unit value of the sparse grid division.

In general, the response of different logging locations will be different, and the traditional numerical simulation will only simulate one point. Although this method can achieve the expected simulation tasks and objectives, it is not targeted, and will also form uncontrollable problems in the face of complex processing and measurement environments. In addition, due to the changes in the external environment and the impact of specific factors, the final processing results of Dow numerical simulation will also have errors, affecting the implementation and improvement of subsequent work. Therefore, the range of numerical simulation and basic index parameters are set to improve the simulation structure and ensure the authenticity and reliability of the final numerical simulation, as shown in Table 3 below:

Table 3. Basic indicators and parameter settings of numerical simulation

Basic indicators for numerical simulation	Initial controllable parameter standards	Standard for measured conversion parameters
Year on year linear interpolation basis function	+11.35	+15.24
Same unit simulation difference	3.05	4.21
conversion rate	1.2	1.6
Deep lateral truncation error	0.21	0.15
Coefficient of dual laterolog electrode system	+10.15 −3.2	+13.18 −2.5
Number of local simulations/time	12	18
Vertical response ratio/%	89.34	90.12

According to Table 3, the basic indicators and parameters of numerical simulation are set and verified. Next, according to the changes of the collected values, combined with the selected six point locations, the information is summarized and classified, and combined with wireless communication technology and finite element analysis principles, the grid division and boundary processing are carried out to ensure the stability and reliability of the initial numerical simulation measurement environment. Set the setting process of numerical simulation conditions in combination with boundary standards, as shown in Fig. 5 below:

According to Fig. 5, complete the design and analysis of the flow structure of the setting of numerical simulation conditions. At this time, a directional numerical simulation structure is designed according to the terrain characteristics of the area, the preset values and reference values are imported into the structure, the response state at this time is measured, the wireless communication technology and finite element design method are integrated, the set numerical simulation boundary conditions are fused, and the basic test environment is set. Next, the wireless communication technology is used to, conduct specific test and verification analysis.

3.2 Test Process and Result Analysis

In the above built test environment, combined with wireless communication technology, set the actual requirements and standards for numerical simulation of G project, and conduct specific testing and analysis. Analyze the response of the dual laterolog built in the selected area, and extract the actual response characteristics. This part mainly carries out analysis and research from different angles, namely different widths, different inclinations and different filling degrees. Combining with the actual measurement requirements, the potential function under multiple environments is calculated, as shown in Formula 3 below:

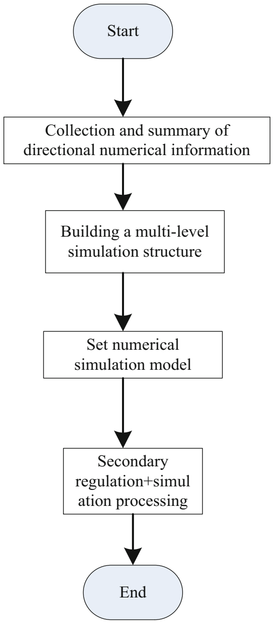


Fig. 5. Flow structure diagram of numerical simulation condition setting

$$H = h - \gamma \times \frac{\Im_2(\gamma + 1)}{\kappa \Im_1} \tag{3}$$

In Formula 3: H represents the potential function, h represents the constant value of conversion potential, γ indicates the recognition range of directional features, κ represents the cell value, $\Im_1$ and $\Im_2$ represents the controllable response range and the measured response range respectively. The specific value of the potential function can be obtained based on the calculation requirements of the. Then, after the basic setting is completed, the surrounding environment needs to be adjusted and integrated. In dual laterolog, the logging tool axis is vertical or nearly vertical to the formation level, and whether the formation, borehole or mud invasion shape is considered to be rotationally symmetric around the tool axis. For the change of construction requirements and standards of the project, the dual laterolog does not actually have strong symmetry, and the symmetry of borehole and mud invasion shape no longer exists.

Therefore, in order to increase the authenticity and reliability of numerical simulation, in the process of formation exploration, analyze the data and information related to the response of logging tools, such as formation attributes, borehole shape, mud invasion status, and instrument measurement location. The formation properties of dual laterolog include dip angle, strike, lithology, porosity and fluid properties in the porosity. When the logging tool is oblique or parallel to the formation plane, the measurement result of the tool is related to the measurement orientation. If the formation is evaluated in the vertical well mode, it will produce a large error. When the well passes through the reservoir, the upper and lower dense surrounding rocks also affect the instrument measurement response, the unequal thickness of the reservoir relative to the borehole also affects the measurement results of some instruments, the pore type of the formation and the fluid property in the pore affect the mud invasion and the fluid distribution in the space around the borehole, these will affect the measurement results.

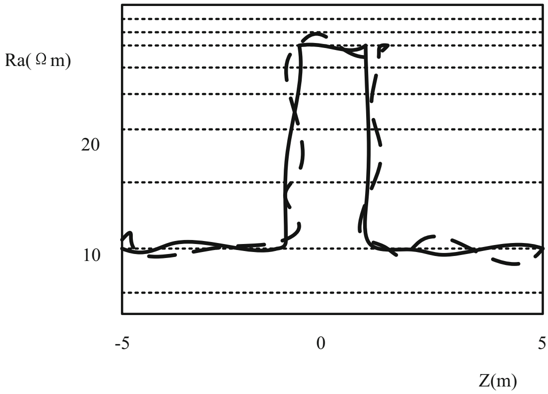
After the above settings and adjustments are completed, the next step is to integrate the wireless communication technology and finite element simulation program for the next stage of settings. Set the wireless communication unit area within the coverage range, and set a certain number of nodes to obtain real-time data and information. The program is used to analyze the influence of the target stratum, intrusion zone, surrounding rock, instrument eccentricity and tilt angle and other stratum structures on the instrument measurement results in detail, and to set the basic measurement simulation indicators and related parameters, as shown in Table 4 below:

Table 4. Basic Numerical Simulation Indexes and Parameter Setting Table

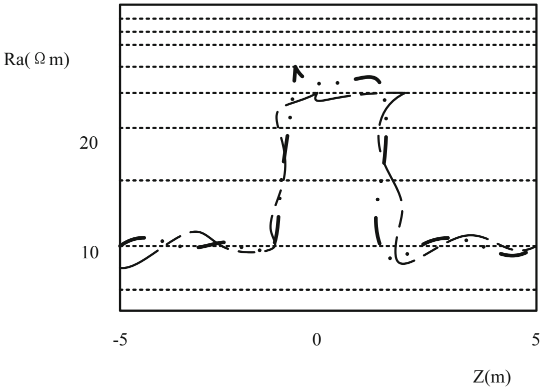
Basic numerical simulation indicators	Directional indicator parameter standards	Measured index parameter standards
Constant ratio	2.01	2.16
Analog conversion deviation limit	16.35	17.55
Shallow lateral apparent resistivity	6.5	8.5
Deep lateral apparent resistivity	10.5	16.5
Stratum thickness/m	3.5	4
Virgin zone resistivity	8.5	9
Motor coefficient	3.16	4.22
Electrode reflux value	21.38	26.34

Set and adjust the basic numerical simulation indicators and parameters according to Table 4. Next, based on the actual situation of the current engineering stratum and wireless communication technology, a stable numerical simulation environment is built. Four positions are selected as the marker points for numerical simulation, and the output responses of different electrodes are measured, as shown in Fig. 6 below:

According to Fig. 6, the collection and display of output responses of different electrodes are completed. Then, based on this, the collection and collection of values and information are carried out for the four set points. Wireless communication technology is used to associate the set communication monitoring nodes for conversion and replacement of real-time data and information. Perform numerical simulation on the ground at different levels and get basic simulation results. Set multiple depths and determine the final numerical simulation index parameters to determine the final resistivity, as shown in Formula 4 below:



Numerical simulation points 1-2



Numerical simulation points 3-4

Fig. 6. Diagram of output response of different electrodes

$$U = \eta^2 \times \sum_{e=1} \Re e - \gamma\eta + \Im e^2 \quad (4)$$

In Formula 4: U is the resistivity of numerical simulation, η represents the conversion ratio, η represents the value of lateral analog unit, e Indicates the number of one-way simulations, γ represents the conversion deviation, $\Im$ represents the inverse mean. According to the above determination, complete the comparative analysis of the test results. At this time, set the depth of 1.1 m, 1.3 m, 1.5 m, 1.8 m, 2 m, 2.3 m, 2.5 m and 3 m for numerical simulation measurement, and measure the resistivity of each marking point, as shown in Table 5 below:

According to Table 5, complete the analysis of the test results: conduct numerical simulation processing for the depths of 1.1 m, 1.3 m, 1.5 m, 1.8 m, 2 m, 2.3 m, 2.5 m and 3 m, and combine the motor coefficient of each set point, the measured resistivity is well controlled below 7, indicating that this kind of numerical simulation has relatively large coverage and strong pertinence, it has practical application value to optimize the

Table 5. Comparison and Analysis of Test Results

Numerical simulation to determine depth	Motor coefficient	Numerical simulation of resistivity
1.1m	1.03	3.5
1.3 m	1.16	4.1
1.5 m	1.23	4.5
1.8 m	1.29	4.9
2 m	1.31	5.3
2.3 m	1.36	5.6
2.5 m	1.42	5.8
3 m	1.52	6.4

unit simulation structure, improve the efficiency and quality of the overall numerical simulation, and minimize the difference in the simulation process.

4 Conclusion

This article studies a numerical simulation method for bidirectional nail response based on wireless communication technology. Adopting multi-level methods to improve the efficiency of numerical simulation, achieving multi-level grid generation of bidirectional side nails, establishing a wireless communication numerical simulation model, and achieving numerical simulation through boundary constraint processing. In a word, the above is the design verification study of the numerical simulation of dual laterolog response based on wireless communication technology. With the assistance and support of wireless communication technology, the numerical simulation effect of dual laterolog is further guaranteed. Although the acquisition and acquisition of response values will be affected by caves, geological layers and other conditions, the daily numerical simulation error is greatly reduced, and the simulation accuracy is further improved. Moreover, under the effect of wireless communication technology, the numerical simulation range of dual laterolog has gradually become more scientific and reasonable, showing a normal linear correlation, which also provides reliable data for the determination of the location of dual laterolog and the marking of monitoring points, thus providing technical support for subsequent logging work.

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