Reservoir Description Based on Computer Comprehensive Application of Seismic Attributes and Seismic Inversion

Chengyu Zhang1,*

1Reservoir simulation Office in Exploration and Development Research Institute of Daqing Oilfield, China, 163712

*Corresponding author e-mail: zhangchengyu@petrochina.com.cn

Abstract. Oil field exploration is a common phenomenon of geographical observation in daily life. However, the areas where oil fields appear are always unlucky. There are always various problems in its structure. People don't want to encounter the difficult reservoir problems in the process of oilfield exploitation[1]. It will affect the economic development and technological progress of the oilfield development process in our society. On this basis, the related problems of computer-based earthquake prediction have gradually attracted the attention of some experts in the academic field. The structure of the study area where earthquakes often occur is complex, and the lateral structure of its reservoir changes greatly. Therefore, it is urgent to analyze the seismic attributes and seismic inversion by computer.

Keywords: Comprehensive Application, Seismic Attribute, Inversion

1. Introduction

With the deepening of seismic exploration and the lack of regional structural analysis, it is more and more important to find the hidden structural reservoir purposefully. However, it is also very difficult to determine. In recent years, the emergence of seismic inversion technology in reservoir characterization is far ahead. Because of the complexity of reservoir geological conditions and the emergence of the variability of lateral structure, they affect the wide application of seismic inversion technology to a certain extent. With the rapid popularization of computer technology, seismic inversion technology has finally found the corresponding technical support to undertake[2].

In the process of oil and gas exploration and development, reservoir description is always the key and difficult content of well location design. At present, people mainly use seismic inversion technology to predict and investigate reservoir. However, the period of seismic inversion is relatively long. It is almost impossible to use high-precision seismic inversion technology in some oilfield
exploration work which needs to be completed in a short time. In order to shorten the period of inversion technology, the reservoir description technology of comprehensive application of seismic attributes and seismic inversion appeared.

2. Analysis of the basic idea of comprehensive reservoir prediction

2.1. Basic ideas of forecasting

Based on the combination of well seismic structure and fine structure, the comprehensive utilization of geological drilling and logging is a necessary technical means. In the first step, researchers need to carry out a study of reservoir prediction based on post stack seismic attributes[3]. In the second step, researchers need to carry out pre stack and post stack seismic inversion for reservoir prediction. The last step is the comprehensive reservoir prediction and evaluation of the actual situation.

2.2. The basic idea of actual emergencies

Each preferred option should be equipped with a secondary one. In the process of oilfield development, there may be various reservoir problems. The internal structure of the reservoir is something we can't see. We can only predict the basic structure of the reservoir by computer simulation. In the process of development, what happens in the reservoir is unimaginable. This theory is similar to Schrodinger's cat experiment. The basic idea of sudden occurrence mainly includes pre stack and post stack reservoir structure predicted by computer (see Figure 1).

![Figure 1. Post stack seismic inversion map based on computer](image)

3. Reservoir prediction technology based on computer integrated seismic attributes

3.1. Summary of reservoir prediction technology based on seismic attributes

In fact, there are many kinds of reservoir prediction methods based on computer seismic attributes. In the process of research, researchers need to adhere to the principles of the combination of exploration and development, seismic and geological, dynamic analysis and static analysis. Using this principle can effectively solve the technical problems in the process of exploration and development. This technology can achieve better geological results in the exploration and development of oil fields.
3.2. Analysis technology of seismic attributes

There are a lot of geological information in seismic data. The attributes extracted from seismic data volume can reflect the characteristics of geometry, dynamics, kinematics and mathematical statistics. Moreover, the values of different attributes may have great correlation with some geological parameters. Seismic attributes are not only widely used in hydrocarbon detection and reservoir parameter prediction. It can also analyze more difficult geological problems in special reservoir environment.

3.3. Seismic waveform classification technology

According to the review of geography related literature, the overall change of seismic waveform is the comprehensive reflection of the amplitude, frequency and phase of seismic wave. It is an important parameter of seismic attribute. The classification technology of seismic waveform makes full use of the richness of seismic information, which can depict the lateral variation of seismic signal through the analysis of seismic information of a reservoir.

3.4. Seismic frequency division processing technology

Seismic frequency division processing technology can extract the corresponding attributes of unit geological body. It can overcome the disadvantages of conventional attribute extraction methods and layer dependence. It can make use of the discrete characteristics of thin-layer harmonic body to analyze the change of complex rock layer thickness. Through the corresponding analysis, it can effectively determine the time thickness change of the reservoir and the lateral discontinuity change of the reservoir geology. This method can describe the spatial variation of reservoir characteristics.

4. Application of computer-based seismic inversion reservoir prediction technology

Seismic inversion is a computer-based comprehensive seismic processing technology which has been rapidly developed in recent years. It can convert the conventional interface seismic profile into the synthetic acoustic logging profile, and through the computer related simulation technology. It can even study the plane variation law of various reservoir parameters\(^4\). We can think of it as a key technical means in the research process of reservoir prediction.

4.1. Post stack seismic inversion technology

The essence of log constrained seismic inversion is the joint inversion technology of seismic and logging. The computer simulation technology can represent the combination of different acoustic velocity and density under specific conditions as different lithology. With the calibration of drilling data, it can predict lithology and thickness and analyze the basic law of lithology distribution. After the inversion of waveform impedance after stack, the lithologic information and interpretation of reservoir can be extracted in a sedimentary cycle.

4.2. Pres-tack seismic inversion technology

After the post stack seismic inversion, we can only get the impedance information of the longitudinal waveform of the reservoir. In this case, the geological information we get is limited. In fact, the
amplitude of post stack earthquakes is related not only to the longitudinal waveform of the lower layer, but also to the Poisson's ratio of the lower layer. Pre stack seismic inversion technology fully covers the shortcomings of post stack inversion technology. In addition, it can also effectively judge the physical properties and gas bearing property of the reservoir. It provides necessary means for seismic description of complex reservoirs (see Table 1).

| Seismic attributes                      | Seismic inversion |
|-----------------------------------------|-------------------|
| Attribute analysis technology           | Post stack inversion |
| Seismic waveform analysis               | Pres-tack inversion |
| Seismic frequency division processing technology | - |

5. **Prediction effect of comprehensive application of seismic attributes and seismic inversion based on computer**

5.1. **Reservoir prediction effect of seismic attributes based on computer**

Researchers can extract seismic attributes closely related to low-rise structures in the studied area. Through computer prediction, we found that the areas with high frequency attribute values are generally the source of sediments[5]. Through the analysis of seismic waveform classification in the study area, we can think that when the number of waveform classification is six according to the types of sedimentary microfacies, the coincidence between seismic classification results and actual drilling results is relatively high. Generally speaking, the areas of red and purple waveforms are fan-shaped.

5.2. **Reservoir prediction results of seismic inversion based on computer**

By analyzing the prediction results of effective porosity of each oil formation, we can know that the reservoir porosity of oil formation is gradually increased from north to south. The porosity distribution characteristics of some oil formations show that the physical properties of reservoirs are good. If the effective porosity of the reservoir ranges from 15% to 30%, we can conclude that the physical properties of the reservoir are gradually improving from deep to shallow. If any single attribute can not determine the difference between the reservoir and the oil-bearing reservoir, we can use the intersection analysis of two or more attributes[6]. At present, reservoir analysis by computer seismic inversion is a relatively perfect prediction technology for oilfield development.

6. **Conclusion**

With the continuous deepening of the exploration and development of the oilfield, the actual situation requires that the seismic reservoir prediction technology needs to continue to develop in the direction of high precision. According to this theoretical experiment, we can find that the combination of seismic attribute reservoir prediction technology and seismic inversion technology can form the application of effective geological information acquisition under appropriate conditions.
Acknowledgments

This work was financially supported by Application of seismic waveform characteristic inversion in horizontal well deployment and tracking.

References

[1] Ning Z X , Wei S , Bo Z M , et al. The Application of Seismic Attributes Analysis to Lithologic Gas Reservoir Description[J]. Journal of Jilin University(Earth ence Edition), 2006, 36(2):289-294.

[2] Guang-Ke M A , Da L I , Bo S , et al. THE APPLICATION OF SEISMIC MULTI-ATTRIBUTES BASED ON THE INTEGRATION RECONSTRUCTION TECHNIQUE TO RESERVOIR PREDICTION[J]. Geophysical & Geochemical Exploration, 2013, 37(6):993-997.

[3] Yin X Y , Zong Z Y , Wu G C . Research on seismic fluid identification driven by rock physics[J]. Science China Earth Sciences, 2015.

[4] Bahorich M , Peyton L , Vassiliou A A , et al. The Use of Seismic Attributes for a Geostatistical Based Integrated Reservoir Description and Uncertainty Assessment[M]// Stratigraphic Analysis Utilizing Advanced Geophysical, Wireline and Borehole Technology for Petroleum Exploration and Productioni: 17th Annual. 1996.

[5] Alexey G . Neural-Computer Modelling for Reservoir Properties Prediction From Stochastic Seismic Inversion Results (Russian)[J]. 2006.

[6] Wang, Yanguang, computer, et al. EXTRACTION OF SEISMIC ATTRIBUTES AND THEIR APPLICATION TO THE RESERVOIR PREDICTION AND CHARACTERIZATION[J]. Scientia Geologica Sinica, 1999.