

Application of Seismic Multi Attribute Fusion Technology in Reservoir Prediction of Baer Depression

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Abstract. Seismic attribute analysis is an efficient and effective method to predict reservoir, but the strong ambiguity of the seismic single attribute for reservoir prediction may reduce the accuracy of prediction obviously, especially for the fault basin which has characteristics of multisource, facies changing fast, multiple episodes of volcanic activities, and the complex ingredients of rocks. The reservoir prediction for the technology of seismic multi attribute fusion is given. Firstly to use seismic waveform classification technique to divide study area into different regions according to sedimentary characteristics, then count the correlation coefficient of the seismic multiple attributes and reservoir information for different regions, besides to use linear fitting. Finally, using the fitting results of each region to summarize the result of reservoir prediction in the whole region. In the reservoir prediction of Nantun baer sag in Hailar Basin, with using sand ratio data of 164 wells in the target stratum and 7 selected seismic attributes, adopting gradually linear regression method to do fitting in the whole area, the correlation coefficient is only 0.52.

1. Introduction

The seismic attribute analysis is one of the most important methods to study reservoir geophysics. A large number of scholars has done lots of study and summed up many new methods and research. Still, lots of problems about characteristics of reservoir and oil by using seismic attribute technology urgently await to be solved, especially the optimization of seismic attributes. Because the relationship which is multidimensional, multidimensional and nonlinear between Seismic attributes and object predicted is complicated; it is easy to choose seismic attributes suitable for research objects when the geological conditions are relatively simple and the SNR of seismic data is high; while it's difficult to choose suitable seismic attributes when the geological conditions is complicated and the SNR of seismic data is relatively low; meanwhile, the extracted seismic attributes are not completely independent, some of seismic attributes contain the similar information, therefore to select the appropriate seismic attributes is needed[1-2].

Seismic attributes optimization and its comprehensive interpretation technique uses seismic data completely, conflating seismic multiattribute extraction and analysis, overcoming the multi solvability of seismic reservoir prediction, which can be great help for integrated geological study [7]. With the development in recent years, this technology has already been an important method to find oil and gas, showing great prospects and potential.

The Hailar basin is a typical fault basin, and their regional geological condition is complicated. It has the characteristics of multi-source, phase changing fast, multistage volcanic activity and complicated rock compositions, so it's unsuited to use the conventional seismic attribute analysis technique. Therefore, the reservoir prediction by using seismic multi attribute fusion which based on



depositional feature subregion is proposed. It has important theoretical and practical significance to guide the exploration of oil and gas in this area [3-4].

2. Geology

Baer sag is located in the Baer lake depression of the Hailar Basin, which is one of the most potential depressions in this basin. It's about 3010km², which can divide into ten structural units: Bessie slope belt, Huhenuoren tectonic belt, Bessie secondary depression, Sudeerte structural belt, secondary depression of the Middle in the Baer, secondary depression of North-east in the Baer, Buller Hongbus uplifted zone, secondary depression of east Baer (Figure1).

Its sedimentary evolution of the basin may be divided into fault depression developmental stage (Tongbomiao Formation (K_{1t})-Nantun Formation (K_{1n}) sedimentary period), rift-depression transformation stage (Damoguaihe Formation (K_{1d}) -Yimin Formation (K_{1y}) sedimentary period) and depression developmental stage (Qingyuangang Formation (K_{2q})-Quaternary sedimentary period), having the combination characteristics of "fault-depression" superposition in Mesozoic and Cenozoic. The Cretaceous formation the main deposition of the depression, which can be divided into the Tongbomiao Formation of the lower Cretaceous strata, Nantun Formation, Damoguaihe Formation, Yimin Formation and Qingyuangang Formation of the higher Cretaceous strata from down to up. Nantun Formation is the main exploration strata in the study area and it may be divided into N1 Formation and N2 Formation from down to up. Now nearly 60% of the known reserves are concentrated on N1.

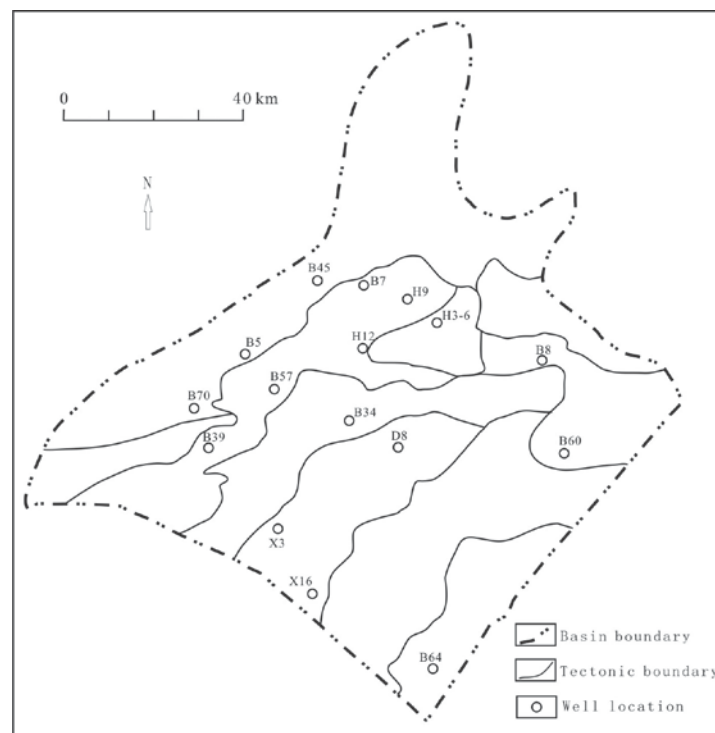


Figure 1. Division of structural units in Baer Depression of Hailaer Basin

3. The prediction method of seismic multi attribute fusion

Using the technology of waveform classification based on extraction and optimization of seismic attributes, the study formation in Baer Depression can be divided into different sedimentary areas. As well as analyzing reservoir structure and fitting relationship in each region, we can determine the geological relationship between each region. The specific workflow can be divided into the following steps: Preliminary optimization of seismic attributes that is optimizing the unrelated seismic attributes and can reflect the reservoir information when it's under the constraint of seismic attributes with clear geological significance (Figure2).

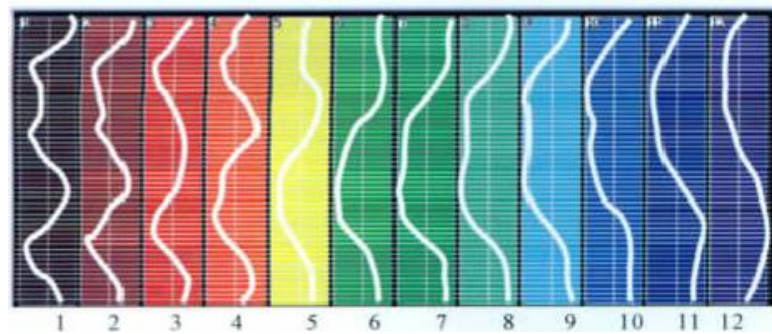


Figure 2. Wavelet classification model traces and its corresponding colors

To divide study area into different areas according to sedimentary features by using seismic waveform classification technology, and analyzing reservoir structure feature and fitting relation in each region; To do correlation analysis of the preliminary selection seismic attributes and sandstone percent, and to calculate the correlation coefficient of these two at the sample point, then selecting seismic attribute with good correlation. To do regression calculation by using the method of stepwise regression, and to analyze the mathematical relationship between regional fitting seismic multiple attributes and reservoir information; Analyzing fitting degree, with combining geological analysis to adjust fitting relationship, and improving the fitting degree by iterative analysis; Synthesis Mapping, comprehensive analysis of well-point fitting, and to analyze result with geological knowledge(Figure3).

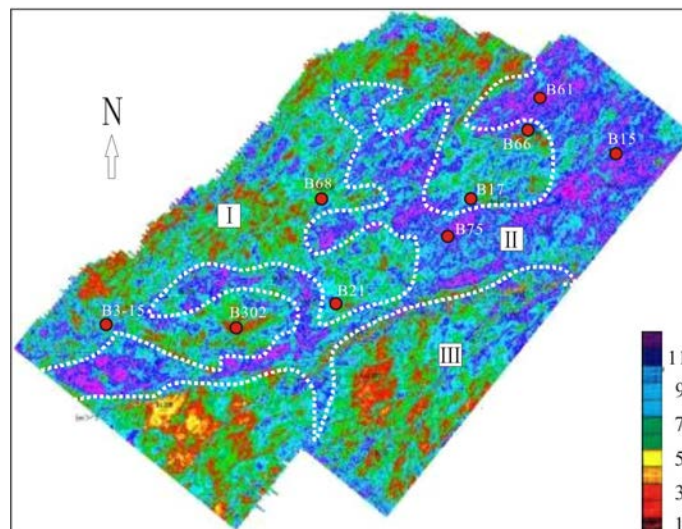


Figure 3. Seismic waveform classification map of the first member of Nantun Formation in Beixi area, Beier Depression

4. Extraction and optimization of seismic attributes

There are lots of methods to extract seismic attributes to get better results by using suitable ways such as studying the exploration degree of the study area, the study object and the problems to be solved. This study extracts seismic attribute based on events that is the formation attribute. It is related to the interface, providing the changing information about geological interface or the boundaries between interfaces. It's an average response of the seismic wave information in a layer. There are 11 kinds of seismic attributes extracted according to the characteristics of the reservoir in the target layer.

There are 8 kinds of amplitude, including RMS Amplitude, Average absolute amplitude, Maximum peak amplitude, Average peak amplitude, Maximum Valley amplitude, Average Valley amplitude, Maximum absolute amplitude and Total absolute amplitude(Figure4); Two kinds of statistic of the

compound seismic trace, including average instantaneous frequency and average reflection strength; One kind of spectrum statistics, which is arc length. The optimization of seismic attributes should obey the basic principles below: The seismic attributes after optimization has a certain correlation with the study object, can classify samples effectively. Optimization of seismic attributes structure, to form low dimensional seismic attribute space by using seismic attributes of mutual independence as far as possible. To reduce the loss of useful information, and to eliminate the seismic attributes having interference effect.

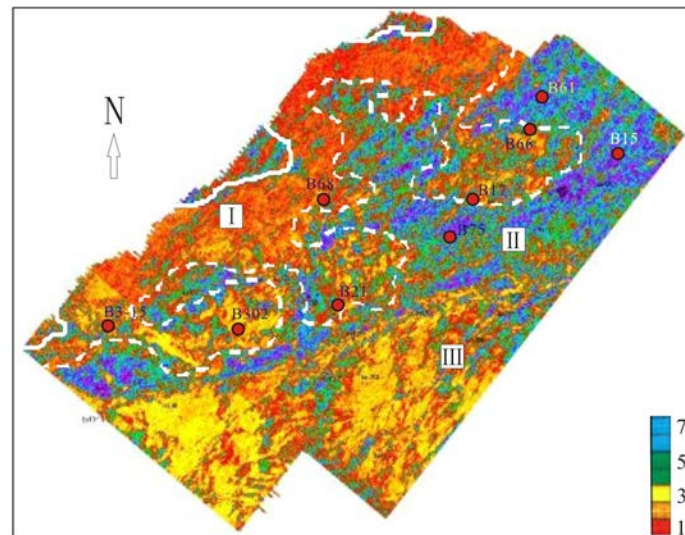


Figure 4. Multi-attribute fusion map of the first member of Nantun Formation in Beixi area, Beier Depression

5. Conclusions

To use technology of seismic waveform classification to divide Baer Depression into areas with different sedimentary characteristics, because of the transverse continuity of the actual sedimentary strata, the adjacent waveform seismic channel is similar. The final result of the seismic waveform classification is a number of plane regions with different types.

To divide all the sample points of Baer Depression into different types by sedimentary characteristics, then the linear relativity between the seismic attributes and sandstone percent increased obviously. It shows seismic multi-attributes reservoir quantitative prediction method which based on depositional feature sub-region can provide a new idea for reservoir prediction.

6. References

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