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# Seismic Intelligent Prediction of Thin Interbedded Sand Body--Taking Heidimiao Reservoir in X43 Block as an Example

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**Abstract:** The Upper Cretaceous Nenjiang Formation in Songliao Basin is characterized by delta front subfacies, with a large area of thin channel sand and sheet sand, which is a typical problem of thin interbed identification. In this paper, based on the theoretical basis of seismic sedimentology and artificial intelligence algorithm, the application layer slicing technology and seismic data after 90 ° phase shift processing are used to carry out artificial intelligence prediction of thin interbedded sand bodies, which is in good agreement with wells.

**Keywords:** Artificial intelligence; 90 °Phase Shift; Stratigraphic slice; Thin interbed.

## 1. Introduction

With the exploration and development of the Songliao Basin for many years, the middle and shallow Heidimiao oil layer ( the third member of Nenjiang Formation ) has gradually attracted attention. The sedimentary model of the third member of Nenjiang formation in Changling sag is mainly underwater branch channel, estuary dam and sheet sand deposition of delta front subfacies [ 1 ]. The reservoir is mainly composed of thin interbeds and sand mudstone interlayers. It is difficult to quickly predict the distribution range of thin interbeds. For this reason, Zeng Hongliu proposed the concept of ' seismic sedimentology ' to improve the lateral resolution of seismic data to make up for the lack of resolution of the original seismic data [ 2-5 ]. In this paper, taking the I sand group of Heidimiao oil layer in X43 block as an example, the boundary and morphological distribution characteristics of thin sand layer are quickly and finely characterized by stratum slicing, 90 ° phase shift technology and artificial intelligence method, and good results are obtained.

## 2. Seismic response characteristics

The I sand group of Heidimiao oil layer in the study area is a typical lithologic reservoir. The sedimentary period is dominated by delta front subfacies, some of which are pre-delta subfacies. Channel sand body and thin sand body are the main reservoir types. The thickness of channel sand body is 10-15 m, and the thickness of thin sand body is 2-5 m. The difference of sedimentary environment leads to the difference of sand body deposition, the change of lithology combination of sand body, which makes the seismic wave interfere with each other, the characteristics of seismic waveform combination are not uniform, and the phenomenon of ' cross axis ' appears in the seismic axis ( figure 1 ).

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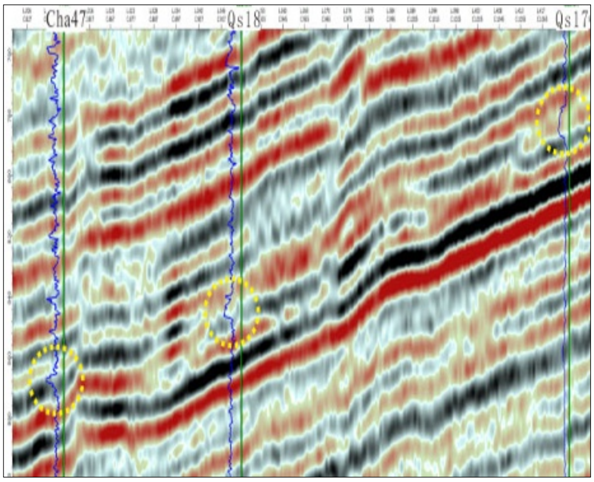


Fig.1 The ' cross-axis ' seismic profile of the I sand group of the third member of Nenjiang Formation

From the seismic profile, the wells drilled in the river have obvious seismic response characteristics, which are ' complex trough ' or ' lenticular ' seismic reflection characteristics. However, the boundary of channel sand body is vague, and the boundary of sand body needs to be further described in detail.

## 3. Seismic data analysis and processing

In seismic sedimentology, stratigraphic slice technology is one of the key technologies. A series of isochronous interfaces are realized by interpolating slices in equal proportion between two isochronous interfaces. Each isochronous interface is a comprehensive reflection of isochronous strata. The seismic attributes extracted by isochronous interface reflect the real stratigraphic attributes. Stratigraphic slices can reflect the distribution of sand bodies, which can be more effectively used to study the shape and distribution of sand bodies on the plane and the distribution characteristics of sand bodies in vertical direction [ 6-7 ].

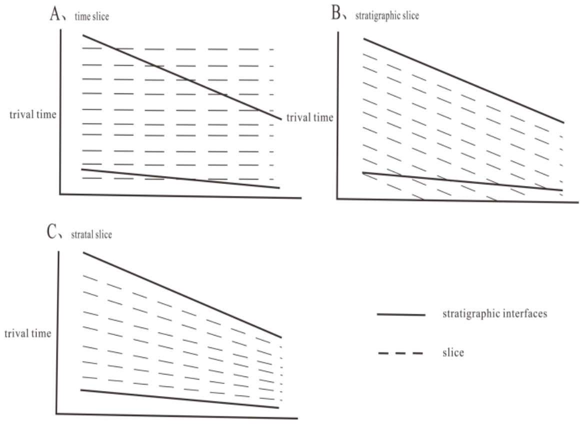


Fig.2 Time slice, layer slice and stratum slice technology ( the difference and comparison of the three )

In the original seismic profile, the seismic axis of the sand group I of the Heidimiao oil layer in the Heidimiao oil layer appeared " through the axis " and other phenomena as shown in 3. After 90 ° phase shift processing, the seismic reflection characteristics of the corresponding trough are unified. The profile can clearly describe the thickness change of the sand body, and the corresponding relationship between the reservoir thickness and the trough reflection width is consistent : the seismic reflection characteristics of the wells with thicker reservoirs, such as Qs17 well, are wide trough characteristics ; the width of the trough in the seismic reflection characteristics of the thin reservoir, such as Cha47 well, becomes narrower ( Fig.3 ). The thin sand body, morphology and distribution range can be described more accurately by fine interpretation of the processed seismic data and extraction of wave impedance attributes( Fig.4 ).

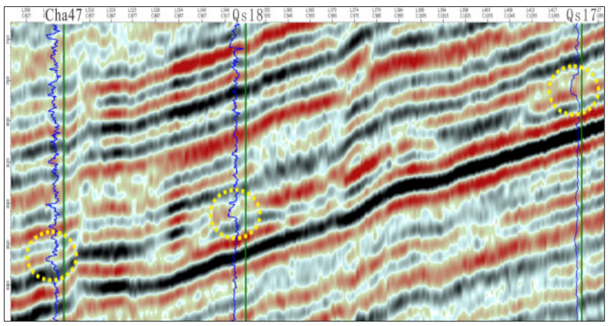


Fig.3 Seismic profile after 90-degree phase shift through the I sand group of the third member of Nenjiang Formation

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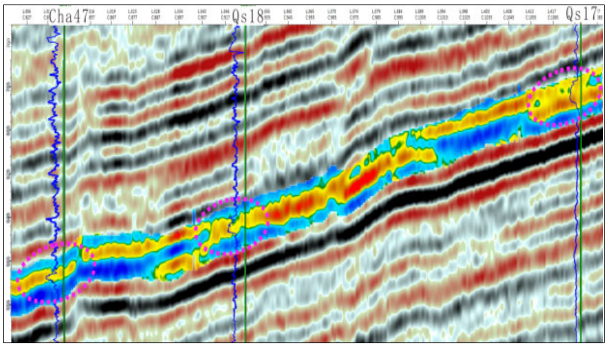


Fig. 4 wave impedance attribute profile and seismic profile superposition diagram

Reservoir prediction using seismic attributes is an important means for people to understand and detect reservoirs. Due to the complex nonlinear relationship between seismic attributes and reservoir parameters, traditional linear prediction methods ( regression analysis, discriminant analysis, etc. ) are difficult to achieve satisfactory prediction results. In contrast, neural network has better self-learning ability, associative storage ability and fast optimization ability. Therefore, in recent years, neural network technology has been increasingly applied to the field of prediction, and has better performance in reservoir prediction. The topology of BP neural network with a single hidden layer is shown in ( Figure 5 ), including input layer, hidden layer and output layer. The input layer and output layer are generally one layer, and the hidden layer can be set to one or more layers according to the actual situation. The neurons between adjacent layers are fully connected, and there is no connection between neurons in the same layer.

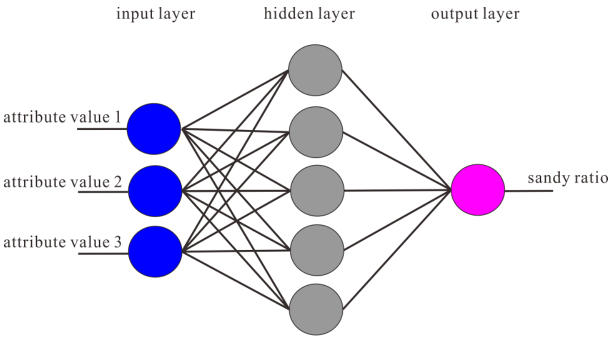


Figure 5 BP neural network topology structure

## 4. Conclusion and analysis

Based on the seismic data volume after 90 ° phase shift processing, the impedance attribute is calculated to obtain the wave impedance body, and the attribute extraction is carried out by the formation slicing technology. The BP neural network is used to model and predict the thin sand body information of the well point. The prediction results show that the main diversion channels in the study area are mainly developed in the bands of Qs17 and Qs18 wells, which are the red areas in the figure. The thin-layer river channel is mainly developed in the Qs16 and Cha13 well areas, which are the yellow areas in the map. The sheet sand reservoir is mainly developed in the Cha28 and Cha29 well areas, which is the blue area in the map ( Figure 6 ), which is in good agreement with the well point information.

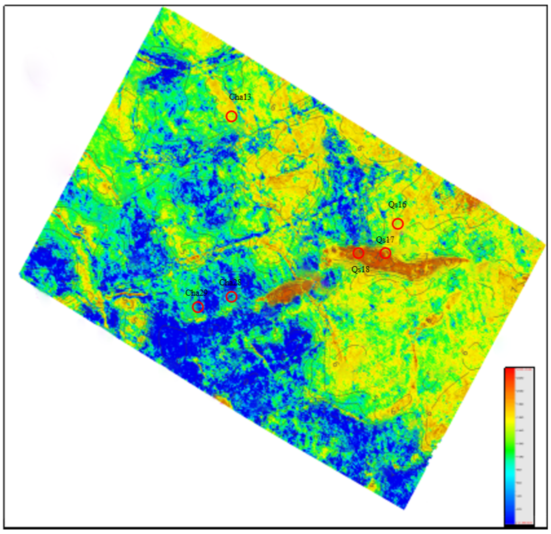

Fig. 6 River sand and thin sand superposition diagram

## 5. Conclusion

①The channel boundary can be quickly and finely characterized by stratum slicing and 90 ° phase shift technology.

②Combined with the calculation results of wave group antibody and well point data, the prediction of artificial intelligence thin sand body can better describe the boundary and morphological distribution characteristics of thin sand body.

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