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Technique of fault interpretation

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Abstract: The accuracy and rationality of fault interpretation is directly related to the accuracy of tectonic interpretation. To explain more accurate fault, the fault can be divided into two kinds, one is large and medium-sized and another is small and studied respectively. The study found that under the guidance of the forward model, through the profile and union of photograph of coherence and the method of fault arbitrarily line can explain the large and medium-sized fault greatly. Using the upper and lower strata of the corresponding change, local amplification in section, combination of multiple attribute technology can explain the small fault well.

Keywords: *fault interpretation; forward model; multiple attribute*

I. INTRODUCTION

Fault interpretation as an important part of structure interpretation, its interpretation accuracy is directly related to the accuracy of the stratigraphic framework of space. Fault can be either as migration channel for oil gas in the period of pool-forming, or can be used as a mask to form effective concentrations of entrapment. The author set putaohua oil layer of puxi area in the northern songliao basin as an example, summarizing the fault interpretation method, to make every effort to do better for fault identification.

II. THE GENERAL SITUATION IN THE STUDY AREA

Puxi area in the central depression area in northern songliao basin, across two second-order tectonic units of gulong sag and daqing placanticline, its eastern near putaohua structure, its west to gulong syncline. Putaohua oil layer is the main development zone, its buried depth about 1500~1800 m. Sedimentary environment in the area is delta front subfacies, the main development is narrow strip underwater distributary channel, plane distribution is dendritic, channel width is 150~500 m. Putaohua oil layer’s lithology is grey, greyish-green mudstone and grey silty mudstone, argillaceous siltstone, siltstone and brown grey staining argillaceous siltstone. Siltstone and brown oil or oil powder sandstone behave as alternating layers in different thickness. Reservoir stratum up and down are huge thick mudstone.

III. THE FORWARD MODEL TO GUIDE THE FAULT IDENTIFICATION

Forward modeling is to use the source attribute characterization to calculate the distribution of field properties. The forward model can direct the fault interpretation in theory. The forward model more accord with the practical geological situation and guide the results more reliable. When the wave frequency is constant, the greater the fault slip more easily identified. Whereas at constant slip, frequency of wavelet more greater and the fault more easily identify [1]. Simulated section contains three layers: the upper for large set of mudstone caprock, its overall speed is low. Middle for reservoir whose the sandstone content is high, so velocity is high. Due to the speed increase with depth, although the lower for large set of mudstone, its overall speed is higher than the upper [2]. Eventually combining with actual lithology, giving the corresponding layer velocity and density value and designing 10 m, 5 m, 3 m's fault model in turn. Through the study of the spectrum analysis of seismic data, concluded that seismic dominant frequency is 47 Hz in this area. So choose 47 Hz ricker wavelet as the seismic wavelet and use the ray tracing method to analyze the forward. Forward modeling results show that the fault slip for 10 m which phase axis staggers obviously when the fault slip for 3m which phase axis has a slight twist under the condition of frequency of 47 Hz (figure 1). The result can guide the fault interpretation[3].

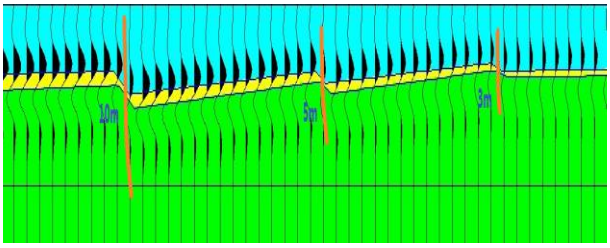
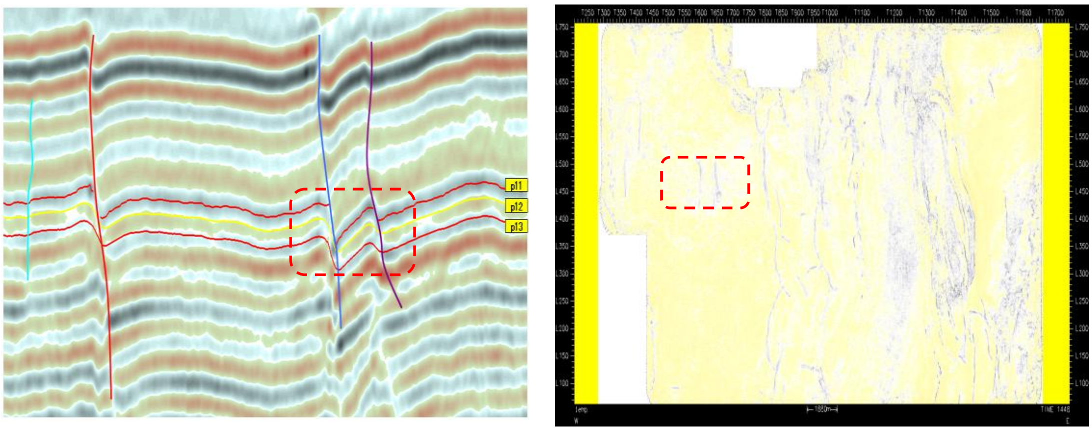


Fig.1 The fault forward model

IV. FAULT INTERPRETATION

4.1 Large and medium-sized fault interpretation

This kind of fault slip is big, so profile features obvious. Means of interpretation mainly includes the following aspects:



a. seismic section b.coherence slices along the layer

Fig.2 Seismic profile and coherence

(1)Profile interpretation combines with coherence to identify fault (figure 2)

Coherence technology stands out stratigraphic discontinuity and generate fault's image without deviation. When explaining along the tendency of the fault, conventional time slice is effective, but to accurately pick up the fault which is parallel to the direction on time slice is very difficult. The coherence technology can identify faults in any direction and help to improve work efficiency, to make the results more objective and reasonable. Combination profile interpretation technology (phase axis disconnect, distortion, bifurcate, merger, variable density display, reverse polarity, etc.) with coherence identification technology can complement and check each other and validate the rationality of explanation.

(2) Interpretation of fault arbitrarily line

Through browsing the preliminary data, fully understand the fault distribution characteristics in the study area. When the fault oblique crossing the Inline or Xline, rely on the Inline and Xline line explanation is bound to cause the phenomenon of faults complicate and difficult to explain. In the process of this kind of fault interpretation, mainly adopts arbitrarily line vertical to fault strike to explain can improve the fault interpretation precision.

4.2 Small fault interpretation

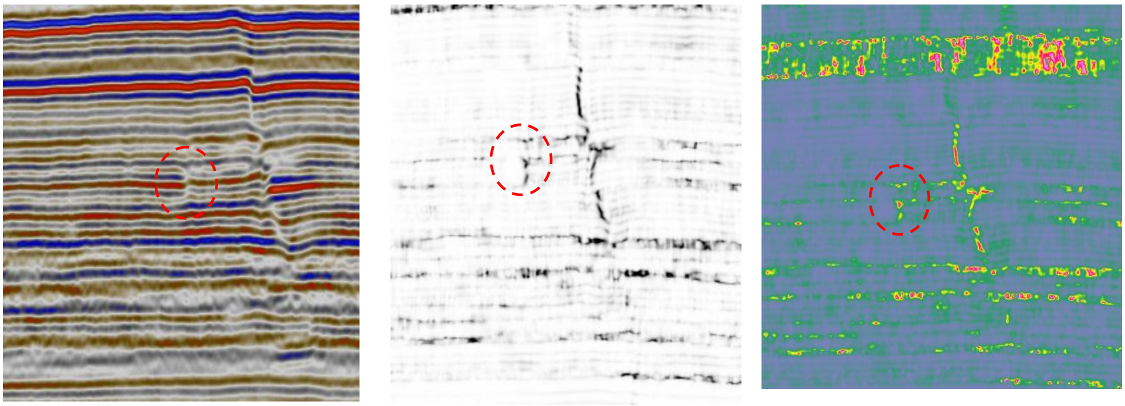
For small fault, the characteristics on the seismic section is not obvious, but can visible energy dithering phenomenon in the section in phase axis, so large and medium-sized fault identification method is more difficult to be applied to small fault recognition. The author summarizes this kind of fault interpretation methods are as follows by researching:

(1)Some small fault wave distorted, but trough may be wrong. This kind of fault on the normal profile, because people are used to observe wave characteristics information while ignoring the troughs, is often difficult to judge fault or lithology changes. On the variable density profile, peaks and troughs are color packing, informations of peaks and troughs display in front of the interpreter at the same time, can work more accurately for small fault interpretation and as a basis to identify small fault.

(2)The existence of fault is often not isolated, there may be a corresponding change in the upper and lower strata. For small faults, the corresponding changes in the upper and lower strata are also exist. It can be use as a standard to identify small fault. At the same time analyzed with the adjacent line, using the adjacent section exists such characteristics or not to determine whether the fault exists.

(3)Make full use of the interpretation system's flexible display function. According to the actual situation of the explaination horizon, can change the display mode, such as changing longitudinal and transverse ratio. The method can be used to interpret the small faults and small changes in the attitude of stratum.

(4) Based on making comprehensive analysis of similar body section, the simple difference of body section and variable density profile, can find that fault fracture features in profile is enhanced. Thus it can be used in identifying the profile shapes of fault (figure 3)



a. variable density profile   b. similar body section   c. simple difference of body section

Fig.3 Comprehensive analysis of multiple attribute profile

4.3 Combination of the fault plane

Principle of the fault combination: combining variation conditions of the nature of the fault, tendency, slip, the change of regional stress field with coherence slices along the layer and Dip angle map of reflecting layer[4] to guide the combination of the fault plane. To implement fault plane combination one by one and improve the accuracy of the fault combination. At the same time the principle plays a leading role in determinating the extension length of fault. The combination relation of faults in section and fault plane in plane must come to an agreement. Making clear the primary and secondary between faults.

1. Coherence slices along the layer

Dark shadow on the coherence slices on behalf of the coherence degree is low, the bright region on behalf of the high degree of coherence. Due to the poor continuity of reflection wave near fault, so shows dark lines or bent characteristics. So according to the coherence slices along the layer can accurately carry on the fault plane combination(figure 2b).

2. Dip angle map of reflecting layer

Dip angle map of reflecting layer is to calculate the time-dip in each grid point, the process is actually a kind of the differential time chart. Each trace point of time are considered to have a relationship with two adjacent points in the orthogonal direction. The final time plane limited by the three point determines a tilt vector one which has the size and direction. Based on schedule each point on the surface of these parameters is calculated and to display images, to get the dip angle map. In dip angle map, large inclination data stripe corresponds to the fault. If large inclination data stripe does not accord with explanation of fault location, should check the fault interpretation of the reflecting layer (figure 4).

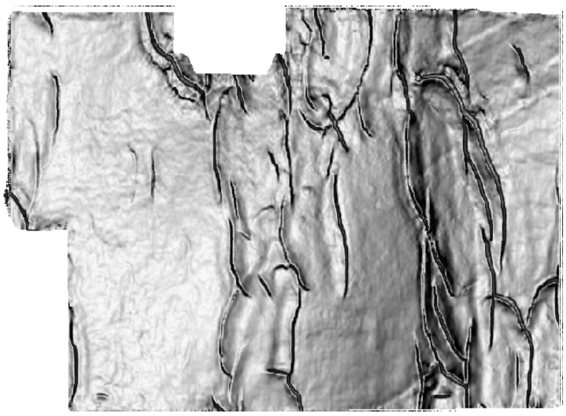


Fig.4 Dip angle map of reflecting layer

V. FAULT SPACE DISTRIBUTION PATTERN

The study area is a nose structure complicated by fault. Fault density is 0.25 strip/km2. Maximum slip is 68m. Generally slip is 4~30 m. Fault extension length in 0.5~6 km. The largest extension length is 7.8 m. Fracture plane shows "echelon" or "side column type" combination into dense zone. Rift - base type combination mode fracture density performance for small "graben", among the fracture density is " horst" and in the plane of the fracture distribution of uneven density. Eventually form the structure of the "long - concave" alternate with low amplitude structure. Fault strike gives priority to northwest direction and nnw direction, followed by north-south direction and ne-trending. Small faults are arranged pinnate associated near large fault [5].

VI. CONCLUSION

On the premise of fully understanding the geological characteristics, giving play to the initiative of the interpretation system, using fault forward model. Combined with similar body section, the simple difference of body section, variable density profile, coherence slices along the layer and dip angle map of reflecting layer can interpret fault very well. These can help to establish a more accurate space stratigraphic framework and lay a good foundation for the fine structure interpretation and reservoir evaluation.

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