

## **The study of fine reservoir characterization base on high precision seismic inversion prediction**

Mingxu Lu<sup>1</sup>, Boyuan Zhang<sup>2</sup>, Shoulun Zhang<sup>3</sup>

<sup>1</sup>(College of Earth Sciences, Northeast Petroleum University, China)

<sup>2</sup>(Electric Power Group, Third oil production department of Daqing Oil Field Co, China)

<sup>3</sup>(The first oil production, Fourth oil production department of Daqing Oil Field Co, China)

---

**Abstract** : According to the potential of fine adjustment in Daqing Oilfield in high water cut stage, this study meet in dense well network condition more high precision reservoir description requirements. The study area of reservoir II and III reservoir formation in Saertu oilfield, Daqing oil field is studied. Through the full investigation of the ideas and methods of the reservoir characterization, this study tries to improve the seismic attribute resolution by a variety of inversion methods, and thus a set of high accuracy seismic inversion and prediction of underground real situation is formed. This study first analyzes the reliability of the well seismic combined with the correlation analysis of the scientific rigorous seismic inversion data and the reservoir log data. Then in the analysis of various factors to describe the influence of, and combined with the seismic sedimentology, research ideas, based on high precision seismic inversion to prediction of reservoir sand body fine then characterize. Has an important guiding significance, tapping the research results on the late stage of oilfield development.

**Keywords** - Well seismic combination, Seismic sedimentology, Reservoir characterization

---

### **I. Introduction**

The north east block of Saertu reservoir in Daqing oilfield has been in high water cut period, and the distance between wells is very dense, while the depth of reservoir fine description is far more than other oil fields. In 2007, it was possible to develop a comprehensive and high precision 3D seismic data acquisition in Daqing oilfield, so this study is intended to explore a set of effective method to guide the reservoir sand body by high precision seismic inversion data.

### **II. Correlation Analysis Between Seismic Attributes And Reservoir Sand Bodies**

After treatment by various methods of seismic multi-attribute analysis, logging constrained inversion and stochastic inversion precision, seismic attribute sections and sandbody correlation statistical results extracted, trend and sedimentary unit sand seismic attribute sections are basically the same trend, the coincidence rate of sand is higher, but the coincidence rate is Hejian sand low, due in part to the rich river drilling belt rate is not high, so in order to help that characterize reservoir description more precise, better use of seismic attribute sections to improve precision of the microstrip sedimentary unit, and combined with seismic work before the seismic attribute slice and reservoir sand body correlation analysis, resulting in the existing technology the level can reach the precision of seismic sections, through correlation analysis summed up what is the prediction of sand body in different parts of the credibility of attribute sections, so as to guide the use of artificial combined with seismic data describe the phase diagram.

#### **1. Correlation analysis of seismic attribute slices and reservoir sand bodies in vertical**

After multiple inversion technique to improve the longitudinal resolution of the reservoir prediction, were randomly selected from 32 wells intercepted eight verify the inversion profile. After the test profile correlation analysis in the selected eight profile statistics showed that more than 3 meters of sand the coincidence rate reached 86.6%, 2 to 3 meters sandstone with rate reaches 75.1%, less than 2 meters of sandstone coincidence rate was 63.5%, namely vertical 2m above the sand body in multi channel, high reliability. However, 2m below the river and can not effectively identify, thin sandbodies predictions can only be as a reference to the trend. To select a B4-364-E76~B261-457 8 wells to verify correctness of the inversion profile and the use of the same color Dan Jingsha body thickness data comparison char, Fig.1.

Except for the thickness of sand body, profile effect profile attribute slice with rate factors still has a lot of, for example, two sedimentary unit or a plurality of sedimentary units in the same vertical to the development of river, when interlayer thickness in 2M below, the log data can be distinguished, but attribute slice it is difficult in the section difficult to distinguish. The statistical results are as follows, interlayer thickness greater than 5m of time, channel sand with rate was 84.2%; thickness between the 2m~5m meet rate was 73.5%; when

less than 2m coincidence rate is only 52.1%. That is different between sand layer thickness of the interlayer is the higher reliability of seismic attribute sections.

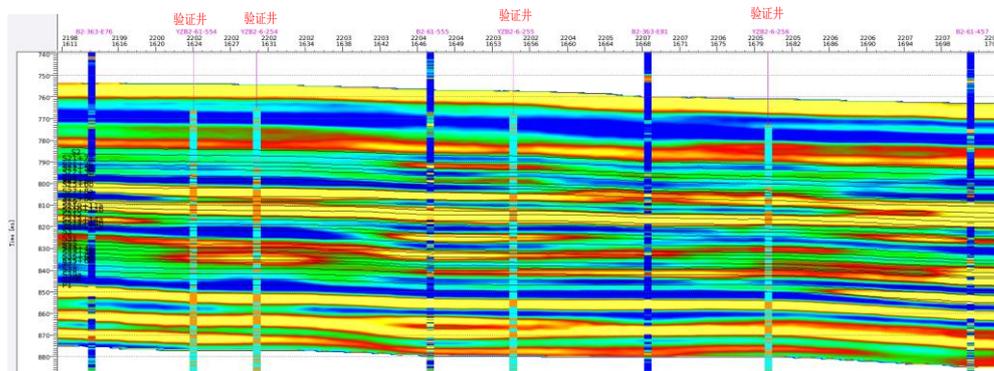


Fig.1. The Inversion validation profile of B4-364-E76~B261-457

## 2. Correlation analysis of seismic attribute slices and reservoir sand bodies in plane

In the process of plane correlation analysis, it is compared with the plane high precision seismic section to reduce the influence of artificial factors, therefore, the selection of a type of sandstone thickness data rather than the deposition phase diagram. The coincidence rate of each layer is found by comparing the seismic attribute sections and one type of sandstone thickness data.

The sand bodies with larger size and thickness, the seismic attributes and logging data are in good accord with the data. The results show that: the channel width is  $>250\text{m}$ , the compliance rate is 78.3%, but when the channel width is  $<80\text{m}$ , the coincidence rate is only 62.5%. Thickness of sand body is still the plane with the significant factors affecting the rate: greater than 3 meters of sand the coincidence rate reached 93.6%, 2 to 3 meters sandstone with rate was 85.1%, less than 2 meters of sandstone with an accuracy of 73.5%, the reason with rate is so high because attribute slice is the use of a number of sandstone according to the inversion results, if the effective data of sandstone are compared and analyzed. The results each coincidence rate decreased by about 15%, because of considering the effective sandstone pore, permeability and saturation three parameters, was not involved in the inversion process, and these three data greatly affects artificial flat surface characterizations.

In addition, some of the factors that can not be used to describe the quantitative description of the data are also affected by the degree of the seismic attribute slice and a type of sandstone thickness data. Such as the same cell layer, different channel thickness, the size of the gap larger, or a river on the edge of interchannel sand thickness larger, even more than over the same period, other place of channel sand body, such as SA III+2a unit inversion attribute graph and a kind of sandstone thickness isoline maps. The results lead to the weak river channel is identified in the seismic attribute slices. Therefore, in terms of sedimentary micro phase diagram of reservoir to strictly according to logging data to identify the channel based, with seismic attribute sections as a guide, give full consideration to the the various influencing factors in the prediction of river boundary.

## III. Study On The Spatial Distribution Of Single Sand Body Based On The Combination Of Well Seismic

Based on the analysis results of the correlation between the properties and the reservoir sand bodies, the sedimentary facies distribution map of 1136 wells with 28 wells, which is based on well logging data, is described. Research design in reference to the seismic sedimentology, reservoir layer fine description method, which discusses front phase combination of well and seismic research content is mainly determine the river and the direction of the boundary. In this study, the sedimentary facies of the block of the block is mainly delta front facies in the north of the two block. So in accordance with the seismic sedimentology, reservoir fine description method based on, taking full account of the particularity of the study, summed up the combination of well and seismic data, the idea is as follows:

### 1. Combination of well seismic and seismic prediction of sand body

According to preliminary investigation and sedimentary facies of the mapping results concluded, channel types in the study area mainly developed in low sinuosity - Shun straight type channel sand body. This kind of channel sand body development scale is small (the channel sand body width is less than the well distance), the river width is generally  $<150\text{m}$ , such channel sand body even in dense well network condition, the well network control level is still very low, often appear "river no source" and so on. Therefore, it is still the key to determine the direction of the river course. Considering the correlation between the plane and the reservoir

sand bodies, the coincidence rate is 78.3% when the channel width is 80m~250m, but when the channel width is <80m, the coincidence rate is only 62.5%. So the process of using the method of "mud to find sand" is still strictly follow the log data, only in the area of the non well data or the sand body prediction.

For example: the 5+6a sedimentary time unit of the three oil layer group B2 - 4 - P61 well, B 062 - 24 well area ,Figure 5a, the sedimentary microfacies types are the main channel sand in the delta front, and the average width of the channel is less than 120m. According to the characteristics of conventional log microfacies, the thinking of sedimentary micro facies is plotted to determine the two channels are different from the branch of the river, which is not connected with each other. Two profiles were selected from the same location on the sedimentary facies diagram and the Properties section,B2-4-P061 and B2-4-P062, B2-4-P061 and B2-D5-P053 ,Figure 5b.

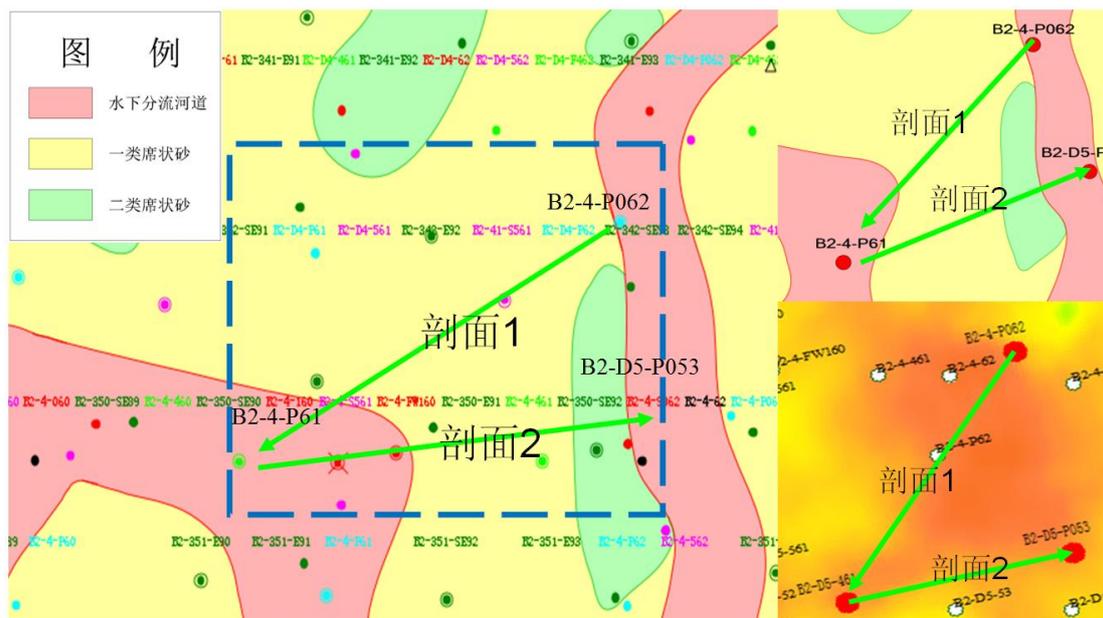


Fig.5(a), well combined with the former sedimentary facies distribution map of the sand body trend Fig.5(b),respectively, in the sedimentary facies diagram and the properties of the same location on the same location selected two sections.

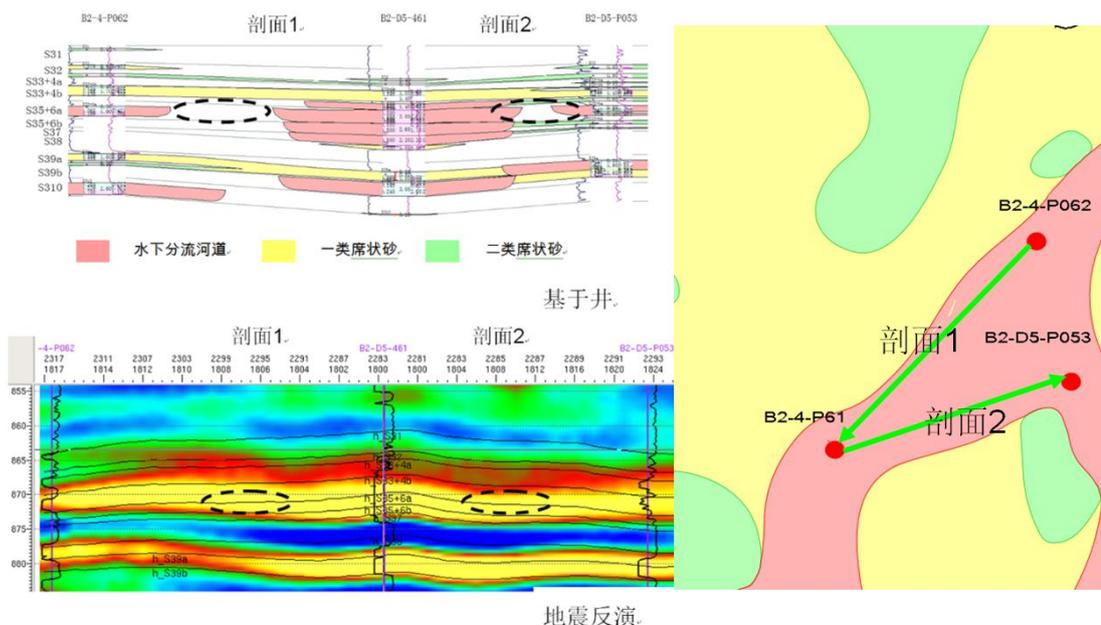


Fig.6(a), Comparison between reservoir and seismic inversion section  
Fig.6(b), Phase diagram of the combination of well and seismic

Through the observation of the plane inversion, and the inversion profile and the reservoir profile analysis and comparison (Figure 6a), the two section of the reservoir profile is not connected, but the relationship between the formation of the channel is changed, and the sedimentary facies diagram (Fig. 6b) is modified by the combination of the well.

#### **IV. Conclusion**

This study is based on the data of 3D seismic data and time division in Changyuan Daqing. The research is based on the multi attribute fusion and analysis technology, and a series of high precision seismic inversion and prediction system is formed.

High precision seismic attribute slice and reservoir sand body correlation analysis work, in guiding the well seismic combined with the guidance of reservoir characterization plays a vital role, in order to the correlation analysis of the normalized method, give a general basis for the work experience of the reservoir is very thin, more scientific judgment.

Application of high precision attribute slice guidance storage layer of fine description of the results, the reservoir in the horizontal and vertical to the physical property changes more clearly, thus single sand bodies in different types of remaining oil distribution know more clearly and improve the residual oil mining design for, the extra high water cut period oilfield fine adjustment and tapping possess important significance.

#### **References**

- [1] Zhang, Tan Yundong. World shale gas resource potential and exploitation of the status quo and the development prospects of China's shale gas [J]. petroleum and petrochemical, 2009,03:9-12+18+49.
- [2] Liu Zhenwu, SA liming, Zhang Xin, Shi Tai Dong, Ganley lamp. China petroleum seismic exploration technology application status and future development proposals. Acta petrolei Sinica, 2009,05:711-716+721.
- [3] Lin Zhengliang, Wang Hua, Hong Jing Li, Jiang Huajun, Showtime, shu-e Zhao, CHEN Si. Earthquake sedimentology research status and progress [J]. Geological science and technology intelligence, 2009,05:131-137.
- [4] Yu Xinghe, lishengli. Clastic rocks of oil and gas reservoir beds sedimentology of development and hotspot problem thinking. Acta sedimentologica Sinica.
- [5] Hao Lanying, Ya Jie Guo, Li Jie, Qi Jincheng, Yan Li Jiao. Seismic sedimentology in Daqing placanticline dense well pattern condition preliminary application of fine reservoir description [J]. Science Frontiers, 2012,02:81-86.
- [6] Meng Yan. Multi attribute combined with seismic reservoir prediction method [J]. Journal of oil and gas, 2013,10:82-86+7.