Research on Constrained Sedimentary Facies Reservoir by Well-seismic Inversion

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Abstract. The combination of well and seismic is a geophysical method to describe sedimentary microfacies. Seismic inversion is mainly used to predict the continuity of cross-well sand bodies, the geometric shape of sand bodies and the boundary of cross-well sand bodies, to make up for the lack of cross-well information. Combining logging information, reasonable combination and prediction are made according to certain sedimentary model, and the distribution of different sedimentary microfacies sand bodies is described.

1. The method and principle of well-seismic inversion combined with seismic inversion

The research area has entered a high water cut period. With the increase of well pattern density, the conditions of mining objects are getting worse, which puts forward higher requirements for development adjustment and fine tapping potential. Therefore, on the basis of clarifying the macroscopic distribution of sand bodies, it is necessary to describe the sedimentary characteristics of local channel sand bodies. Many years of exploration and development practice in the research area shows that the higher the well pattern density, the higher the degree of sand body control, and the clearer the reservoir recognition. Because of the complex changes of various types of reservoir microfacies plane, there are still great limitations in the cross-well channel sand body characterization based on logging data alone at the same time.

Well-seismic combined with seismic inversion is a combination of seismic data with high lateral resolution and logging data with high vertical resolution with geology for seismic inversion. The interface reflection seismic data is inverted into formation attribute parameters such as unit wave impedance of strata, and reservoir description is carried out with strata as the target.

Through scientific mathematical algorithms and computer software, integrated application of seismic, logging and geological data, and to combine them organically into an organic whole, the seismic data contains rich lithology, physical properties, fluid information inversion into rock unit type speed of wave impedance data or stratigraphic data and lithologic and stratigraphic petrophysical data, such as the porosity.

It can be directly compared with drilling and logging data, and can be used to describe geology and reservoir with the aim of rock formation. It has unique advantages in studying the spatial characteristics and thickness variation law of reservoir. In the process of sandstone and mudstone division, it is divided into three types: the second type sandstone, the first type sandstone and the effective sandstone. In the division of sedimentary facies, the above three kinds of lithologic indexes are considered comprehensively. In the division of single well facies and the selection of curves, it is...
also the same to judge single well facies by comprehensive resistivity curves (microelectrode, deep and shallow lateral, etc.), spontaneous potential curves and other curves.

Specific methods are as follows: eliminating the influence of borehole collapse and calcium content by curve pretreatment (standardization, baseline migration, homogenization); Sensitivity analysis and reconstructed curves are used to identify the first type sandstone, second type sandstone and effective sandstone effectively, which provides a good basis for subsequent reservoir inversion.

Through a series of methods, such as reaction test, denoising, overcoming modeling and increasing sampling rate, the inversion accuracy is improved, so as to provide an accurate reservoir inversion model for well-seismic combination with corrected sedimentary facies.

2. How to use the inversion results to correct sedimentary microfacies
After completing the inversion model, the corresponding seismic inversion slices can be selected according to the need to correct the sedimentary facies. The combination of well and seismic correction of sedimentary microfacies includes five steps.

Check SP and microelectrode (potential) curves of single well (box, bell and finger), and determine sedimentary microfacies of single well according to sandstone thickness and effective thickness. Based on the existing sandstone database, the SP curves of single well are checked, and the effective sandstone development of single well is further analyzed by combining with the microelectrode (potential) curves. The sedimentary microfacies of each single sandstone layer of single well are determined together to ensure that the sedimentary microfacies of drilling single layer is completely consistent with the interpretation data of sandstone body.

The base maps are selected from the appropriate small layer impedance slices. The vertical evolution of the channel sand bodies can be seen visually through the slice observation of the inversion model. Through the information and the original figure, and single well facies zone sandstone (sandstone equivalent figure, effective thickness, the equivalent figure) contrast carefully, and choose the most can reflect the channel sand body and the original phase match with the highest degree of slice as reproduction, in depicting sedimentary facies belt graph, on the basis of well point, using inversion section of river channel sand body distribution, the continuity of the channel sand body and to modify the boundary of the channel sand body.

The channel periods are analyzed, and the boundary of different channel sand bodies in the same single sand layer is determined by using layer impedance slices. River sedimentation is a result of long-term and multiple superimposition.

Due to the change of sedimentary environment, some rivers have better inheritance in the process of sedimentation, and the changes of early and late rivers are small; Some rivers are constantly swing in g, and the transformation of river sand body by water flow often makes the river course multi-period obvious. By using the morphological difference of logging curves, multiple river courses can be identified, but the boundaries of each single river channel are hard to identify. The inversion slices can reflect the vertical evolution of the channel sand bodies, namely the trend and boundary of each single channel. In this paper, well-seismic combination method is used to identify single-stage channel. Firstly, multi-stage channel is identified by the difference of log curve shape and elevation, and the boundary of each stage is determined by inversion slice.

Inversion profile further implementation of sand body width, continuity and trend.

The inversion section can show the sand body's development form. Combining with the inversion section, the development of inter-well sand body and the width, connectivity and strike of channel sand body can be further confirmed.

3. Conclusion
The method of well-seismic combination with fine characterization of cross-well channel sand body under dense well pattern is applicable in this research area. By making full use of the vertical superiority of drilling and logging data and the lateral superiority of seismic attribute information, the
influence of subjective factors on cross-well channel sand body characterization based on well data is reduced.

Compared with the original sedimentary facies map, the changes of channel sand bodies in well-seismic combination sedimentary facies can be divided into two types: one is the identification of channel periods; the other is the changes of channel direction, scale and combination. On the basis of fully referring to the original sedimentary facies map, the channel period, spatial distribution and vertical evolution law are analyzed by inversion of attribute slices along the stratum, and then the scale, extension length, strike and contact relationship of channel sand bodies between wells are accurately determined by inversion section, thus the original sedimentary facies map is corrected. The vertical contact relationship between sand bodies and the spatial distribution of sand bodies are accurately located. This method makes full use of seismic attribute information to accurately locate inter-well channel sand body, and has certain guiding significance for tapping potential of remaining oil and well pattern adjustment in the late stage of oilfield development.

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