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Reservoir characterization technique based on geostatistical inversion method

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Abstract: *Reservoir characterization technique is a quantitative description and characterization of three dimensional spaces. Namely, you should make a reservoir model reflecting structure, sedimentation, diagenesis, fluid characteristics of the reservoir. Especially, in the later period of the exploitation of oilfield, it is a seriousness problem for every oilfield to predict sand body shape by core data, logging data and seismic data. But ordinary inversion can't meet demand of reservoir characterization technique in the later stage of the exploitation of oilfield. So reservoir characterization technique requires some more meticulous inversion method to meet resolution demand. Now geostatistical inversion method shows that it is different from other ordinary inversion method. By geostatistical inversion method, we can revise sedimentary facies that is based on logging data. Meanwhile, we can correct river course direction, accurate channel width and make sedimentary microfacies combination reasonable. At last, we can finish reservoir characterization technique and adjust injection production relationship. What's more, reservoir characterization technique, based on geostatistical inversion, can guide the oil and gas field development.*
Key words: *reservoir characterization; geostatistical; seismic inversion; sandstone body; river course*

The reservoir description is a quantitative description and characterization of various parameters of the reservoir, which is to establish a reservoir model reflects the characteristics of reservoir structure, sedimentary, diagenesis, fluid and so on. Reservoir description is the basis and key to develop the development plan, adjust injection production relationship and find the remaining oil position, and adjust the development policy of the oil and gas field. Especially in the later stage of oil and gas field development, the combination of core, logging, and seismic, fine prediction of the shape of sand body becomes the problem that every oil and gas field must face. By using well as the starting point,we make the first reservoir description. Log data have a high vertical resolution, but well spacing control, lateral resolution is relatively low, it is required to combine seismic data to control lateral resolution of logging data. However, the conventional sparse pulse inversion technique has been unable to meet the requirements of fine description of reservoir in oil and gas field development, and it needs to use a more precise inversion method to complete the seismic inversion, which can meet the requirements of reservoir fine description. The geostatistical inversion method based on the probability density function and the variable difference function is based on the inversion method of the probability density function and the variation function[1-8].

The author takes the transitional zone of northern Daqing. The study area is located in the northeast of Changyuan in the central depression. the area is 11.4km^2, and has 484 wells. The purpose geosphere is SII and SIII, and sedimentary environment is complex, which belongs to fluvial delta deposit. Sedimentary facies change fast, the heterogeneity is strong, and the sand thickness is small. The average thickness of sand in 2.4m. Due to the limitations of the geological conditions, it is necessary to use geological inversion method to make a fine description of reservoir.

I. Realization of geological statistics inversion

1.1 Geological inversion method

The technical flow chart of the inversion is shown in Figure 1. The geological inversion is based on the probability density function, and the image variogram function.

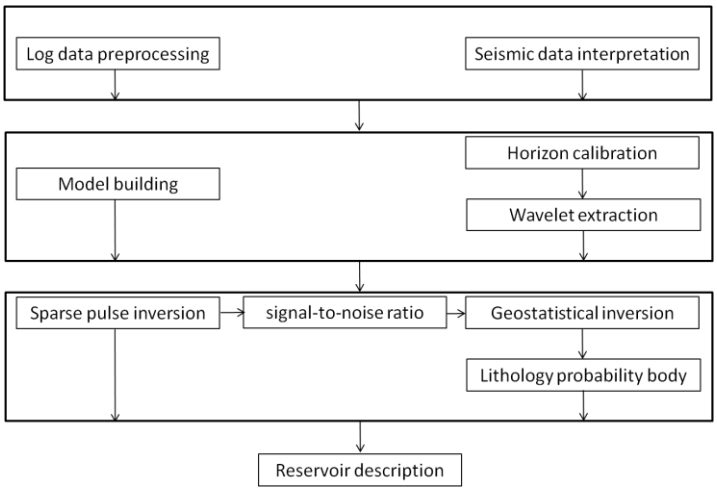

Fig.1 The flow chart of geostatistical inversion

1.2 Log date preprocessing

Log data preprocessing is mainly to reduce the error between the various logging tools, and the system error caused by different test time and different logging methods. There are five sets of wells in the study area. By using the standard of log curve,it is possibility to improve the reliability ofAC, DEN and P-imp curve.

1.3 Horizon calibration and Wavelet extraction

Horizon calibration is the key to the whole inversion results. By the horizon calibration, the information of the depth domain of the well logging data is matched with the information of the time domain of the seismic data. Through the P-imp curve fitting the reflection coefficient relationship, and the extraction of the average wavelet convolution, obtained the synthetic record, and finally the synthetic record with the original seismic data, get the correlation coefficient. By adjusting the wavelet shape, the correlation coefficient of the horizon calibration is improved. The average correlation coefficient is 0.87. There are 152 wells that their correlation coefficernt is over 0.9.

1.4 Geostatistical inversion method

The geological statistics inversion is the process of using the probability density function and the variation function, combined with logging data and seismic data. How to predict the variation of the sand is very important, and the spatial anisotropy is characterized by the variation function. Vertical and horizontal variation functions are calculated from the well data and seismic data. Combined with the signal to noise ratio, the weight of seismic data in the whole inversion process is determined, and the vertical resolution of log data and seismic data are fully display. Finally, the inversion parameters are optimized by controlling the variable.

As shown in Figure 2, it is a section plan of B3-20-P88, B3-20-P91, and B3-20-P90. In the section plan, the inversion prediction of sand body thickness and well logging interpretation is consistent. Compared to ordinary sparse pulse inversion method, geostatistical inversion in the prediction of thin sand distribution has higher vertical resolution. In the section plan, the connectivity patterns of sand can be clearly seen, and the distribution of sand is credible.

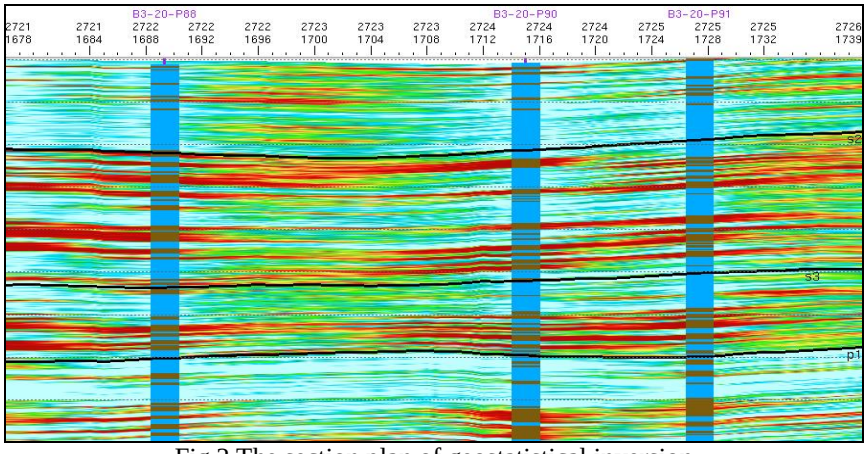

Fig.2 The section plan of geostatistical inversion

II. The inversion results guide the fine description of reservoir.

Reservoir description is the core of the development of oil and gas fields. It is important to improve the accuracy of reservoir description, and how to describe the thin sand becomes a difficult problem. This study combines the sedimentation phare diagram based on logging curve and geostatistical inversion, completes the fine description of reservoir [9-11]. We using the inversion section to guide the reservoir fine description. The inversion section is the prediction of the geological statistics inversion of the sandstone. And this time, we use the lithology probality body. The inversion section is the prediction of the thickness of sandstone. Through the inversion section, we can master the sand developmental condition between the well to the others.Through the fine description of the reservoir, we can guid the development of oil and gas fields. In view of the distribution of sand, the fine description of reservoir is mainly in the following three situations, as shown in figure 3.

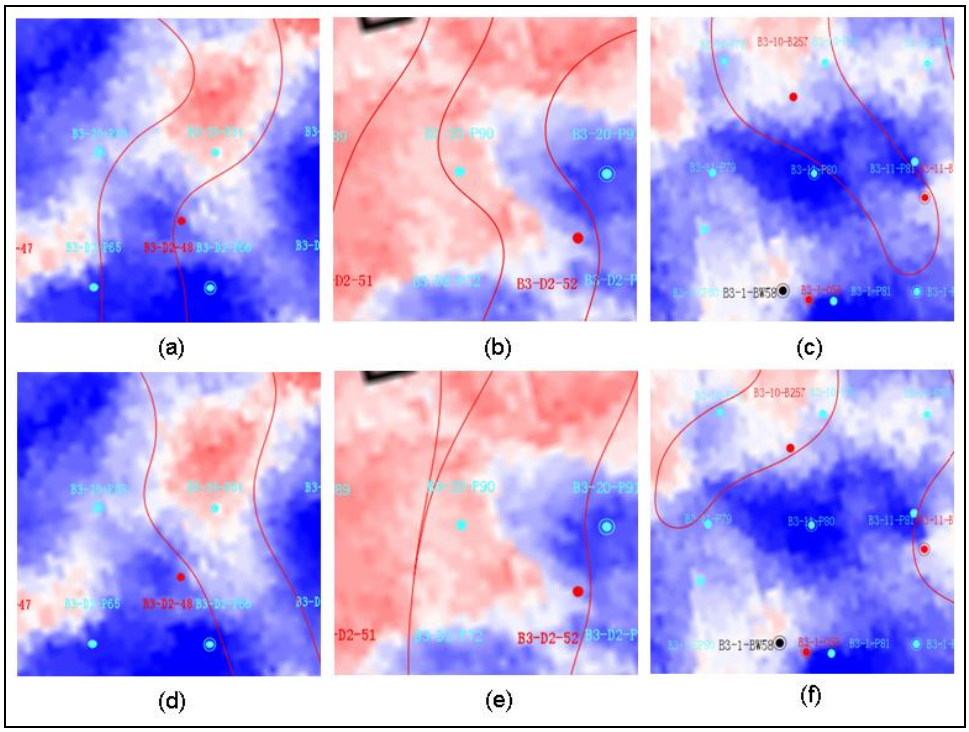

Fig.3 The chart of the change of river boundary of sedimentary facies based on inversion slice

2.1 Accurately determine the direction of the river

Because of the original data in the study area, it is difficult to determine the connectivity of the underground sand, and it is difficult to determine the dynamic development of the underground sand. Through the comparison of Figure 3 (a), (d), the river from the B3-20-P84 development, how to extend the South has been divided. In the absence of geological statistics inversion sand prediction diagram, the prediction is no basis. Through the geological statistics inversion sand prediction diagram, determine the river along the B3-D2-P66, B3-D2-48 South extension. In the later period, the mistake of the adjustment of injection production relationship can be avoided, because of the fine reservoir description.

2.2 Fine description of channel width

In the use of well logging data to describe the reservoir, it can not be entered into the plane distribution of the river because of the difference between the well spacing.Especially in the study area, the distribution of sand in the well is predicted, which brings a lot of trouble to the old development zone. As shown in Figure 3 (b), the SII1+2b horizon is based on log data, and the channel width is 93m. But in Figure 3 (e), the channel width is 137m. At the same time, the sand is connected with the B3-20-P91. The lack of the geological statistics inversion, the prediction of the channel width only rely on the log data, so that the whole sedimentary phase diagram reliability is reduced, increasing the cost of oil field development.

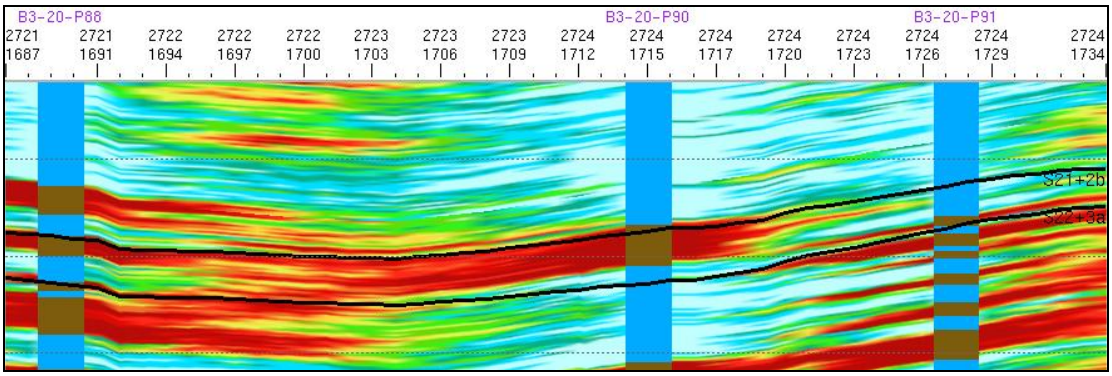

Fig.4 The section plan of depositional time unit of SII1+2b of

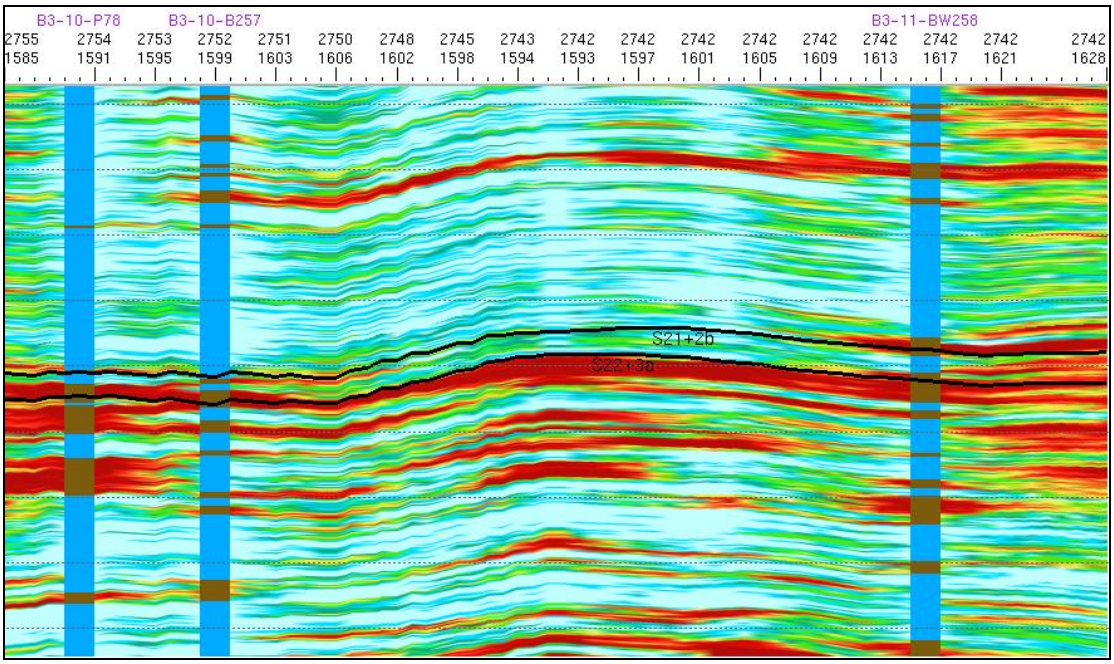

Fig.5 The section plan of B3-10-P78、B3-10-B257、B3-11-BW258

2.3 Reasonable sedimentary microfacies combination model

It is a complex process that how to combine these single well sedimentary microfacies with the well logging facies model. In the absence of inversion sections, sedimentary microfacies are combined according to the morphology of the modern channel and deposition law. In theory, it can be combined with a single well, but this combination method can not reflect the actual development of the underground reservoir. Figure 3 (c) is determined by logging data. But B3-11-BW258, B3-10-P78, andB3-10-B257 are divided into the differ river. Through the inversion of sand prediction diagram, we find that B3-11-BW258, B3-10-P78, andB3-10-B257 are divide intu the same river in Figure 3 (f).

III. Conclusion

Domestic oil and gas fields have been developed into the later stage of development, and the logging data and seismic data are becoming more and more complete. In Daqing oilfield northern transitional zone, reservoir description based on geostatistical inversion, can clearly explain the distribution of sand in the space, complete description of thin sand, and improve the development efficiency of old oil fields. This study mainly made the following conclusion:

1. In the later stage of oil and gas field development, the fine description of reservoir is very difficult to accurately describe the san, and it needs to be combined with the geological inversion to determine the distribution of sand.

2. In the use of the geological inversion sand prediction diagram of fine characterization, there are mainly three kinds of application: I accurate determination of the direction of the river; II fine description of the channel width; III provide a reasonable combination of sedimentary microfacies.

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