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Density Curve Reconstruction of Putaohua Reservoir in Gaotaizi Area Based on Multiple Linear Regression

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Abstract

Putaohua reservoir in Gaotaizi area is located in the lower Cretaceous Yaojia Formation. The main types of reservoirs are subtle reservoirs such as complex lithology, faults and micro-amplitude, and the distribution of oil and water is complex and irregular, so it is difficult to explore and develop. In this area, the impedance curves obtained from acoustic curves can not distinguish sand and mudstone well, and the density curve of the work area is seriously missing. It is difficult to invert high-precision geostatistics with such inversion results. In view of this situation, although the density curve of this work area is seriously missing, the existing density curve can better distinguish sand and mudstone, so in this study, the natural potential, resistivity and other curves are used to reconstruct the density curve, so as to obtain the wave impedance curve which can better distinguish lithology.

Keywords

Multiple linear regression; Curve reconstruction; Geostatistics inversion; Reservoir prediction.

1. Introduction

The density of the converted sound wave maintains the original trend of sound waves, but if the sound wave data can not distinguish the sand mudstone well, the density curve obtained by the Gardner formula can not reflect the change law of the lithology well, which is not conducive to the characterization of reservoir by wave impedance inversion. Therefore, the author proposes a multiple linear regression density curve reconstruction method to analyze the sensitivity of curves such as spontaneous potential, gamma ray and resistivity to lithology, optimize the reconstruction curve, and then fit the regression formula to obtain the most ideal mathematical model for the reconstruction of density curve. The result can effectively solve the problem of missing density curve and obtain the density curve reflecting reservoir characteristics [1-4].

2. Technical Key Points

The ultimate goal of curve reconstruction is to improve the inversion accuracy of geostatistics. The reconstructed curves need to have stronger ability to distinguish reservoirs than the original curves, and also need to ensure that they can represent the actual geological characteristics. Only in this way can the reconstructed curves be convincing and the accuracy of inversion results be guaranteed. Therefore, the following key steps need to be guaranteed at the end of curve reconstruction:

2.1 Preprocessing and standardization of logging curves

The accuracy of the original density curve is very important for this reconstruction, and the density curve is greatly affected by the wellhead environment. Therefore, it is necessary to pre-process the density curve according to the caliper curve and other information of formation.

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Curve standardization is to eliminate the errors caused by external factors such as acoustic time difference, spontaneous potential, resistivity and other curves involved in reconstruction, and to ensure the datum of inversion data. [5-10]

2.2 Sensitivity analysis of logging curves

Logging curves show different performances in distinguishing sand and mudstone of different reservoirs in different work areas. In order to ensure the accuracy of reconstructed curves, lithologic sensitivity analysis is needed. According to the geological characteristics of the work area, the sensitivity of distinguishing sandstone and mudstone by different curves in the study area is analyzed, and the log curve which can effectively distinguish lithology is used to reconstruct the curve. [11]

2.3 Curve reconstruction

Based on the above curve processing and geological analysis, the density curve is reconstructed by the mathematical method of multiple linear regression.

3. Geostatistical Inversion and Effect Analysis

According to the actual geological conditions of the study area, The geodetic inversion is performed by using the density calculated by Gardner formula and the density curve after reconstruction, and two inversion data volumes are obtained. The density curve calculated by Gardner formula and the reconstructed density curve are used for geostatistical inversion, and the reconstructed density curve is evaluated through comparative analysis of section and plane.

A total of 10 wells are selected as posterior wells in this inversion. Fig. 4 is the inversion profiles of two inversion bodies passing through 5G29-21 and other posterior wells. It can be seen from the graph that the wave impedance inversion profiles obtained by conventional Gardner reconstruction method (Fig. 4a) are difficult to distinguish lithology, and the coincidence rate between the point of the posterior well and the lithology curve is very low, so the inversion effect can hardly be used in the fine reservoir prediction work afterwards. The wave impedance inversion profile (Fig. 4b) obtained by the method of multi-curve linear regression reconstruction density is good for lithology discrimination, and the post-wellbore points are basically consistent with the lithology curve, and the lateral continuity is good. Therefore, the method of reconstructing density by multi-curve linear regression is used to improve the inversion accuracy of geostatistics in this work area. The following table is the coincidence rate of the posterior wells of the two seismic inversion bodies. It can be seen from the coincidence rate of the posterior wells that the reconstructed posterior wells have a higher coincidence rate and the inversion results are more credible.

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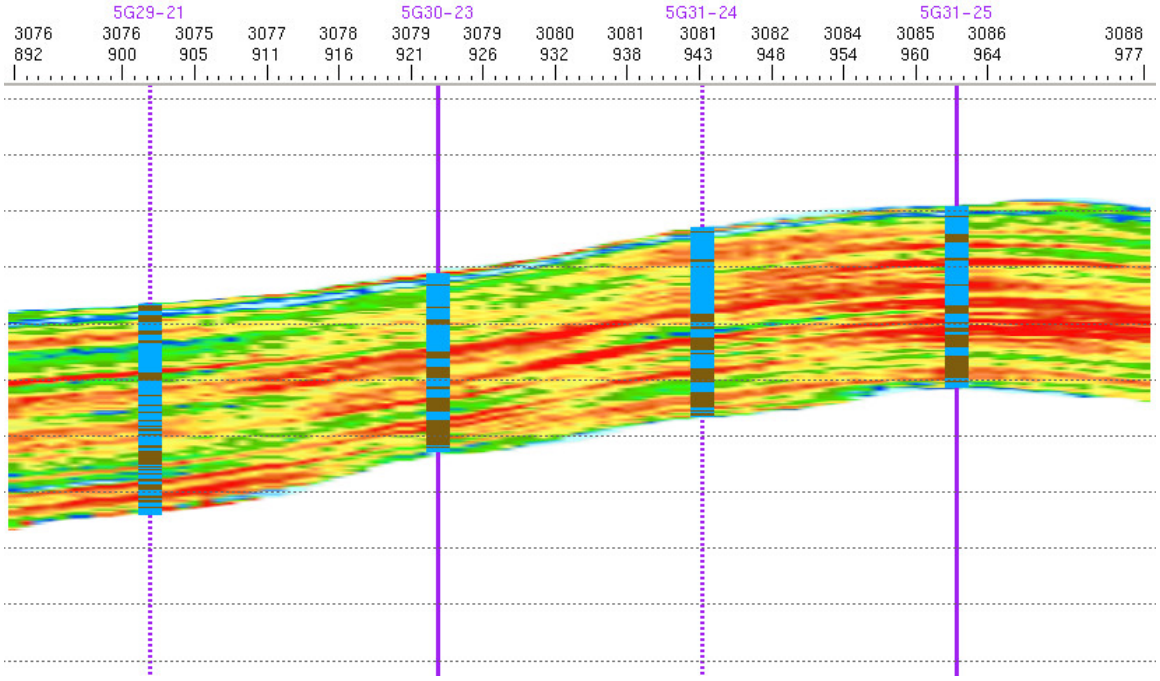

Fig.1 Cross-section comparison of two reconstruction methods

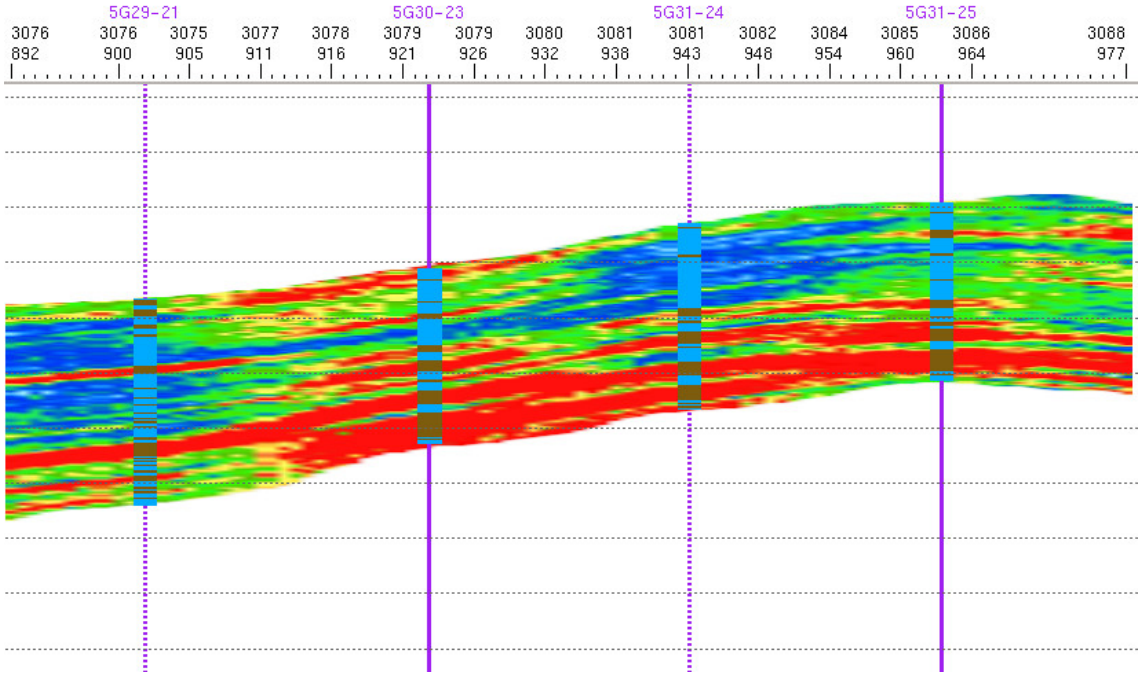

Fig. 2 Inversion profiles obtained by density reconstruction method of multivariate linear regression

4. Conclusion

The method of multivariate linear regression density reconstruction is mainly aimed at the situation that a large number of density curves are missing and acoustic curves can not distinguish lithology well, but it is not limited to this. For the case that density curves can not reflect reservoir characteristics well because of formation factors such as borehole collapse, local correction of density curves can also be carried out according to this reconstruction technology. The influence of layer factors.

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