

Research Article

Effect Evaluation of Seismic Inversion--- A Case Study of Gao-3 Reservoir in the Xingbei Area

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Abstract: Make full use of the theory and methods of the comprehensive interpretation of geophysical and seismic data, to play the advantages of joint research in many disciplines. Different seismic inversion methods have different technical characteristics and application conditions, application example of combining the block layer, storage reservoir characteristics and oil and gas reservoir types, seismic inversion, feasibility analysis, select well vibration combined with reconstruction, according to the evaluation results of seismic inversion to achieve fine reservoir prediction. The results show that the accuracy of reservoir description can be further improved by selecting suitable seismic inversion method, which can achieve the goal of longitudinal identification of small layer capability, sand body prediction and solving complicated geological problems.

Keywords: seismic inversion; reconstruction inversion; sand body prediction.

INTRODUCTION

Seismic inversion is usually divided into two major categories: pre stack and post stack inversion [1]. Pre stack inversion technique is a technique for the interpretation of stratigraphic lithology and oil-bearing properties by using the information of amplitude, frequency, phase and other information recorded by pre-

stack gather data. The advantages and disadvantages of seismic inversion impact the later storage layer deposition directly. Therefore, it is necessary to analyze and prove the feasibility of the inversion to improve the resolution and increase the reliability of the seismic inversion (Figure 1) .

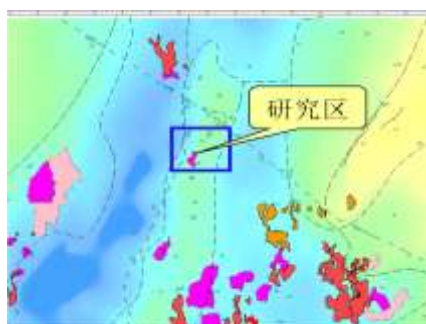


Fig-1: Overview of the study area

The study area is located in Daqing Changyuan, the entire range is Gao-3 reservoir, the earthquake area of about 342.7Km². According to the geological characteristics of the study area, this paper demonstrates the feasibility of seismic inversion to predict the distribution of sand bodies (Figure 1).

SELECTION OF INVERSION METHOD

Inver Trace Plus inversion method

Wave impedance inversion in EPS software by

using the wave impedance generated by the normalized acoustic time difference curve [2]. Figure 2 is a combined well profile for the retrieval of the use of the method, as you can see from the profile, EPS inversion reflect sand body is better, the sandstone is in good agreement with the well, but the vertical resolution is poor, so it is very difficult to reach the requirement of reservoir fine description of the target layer in the study area.

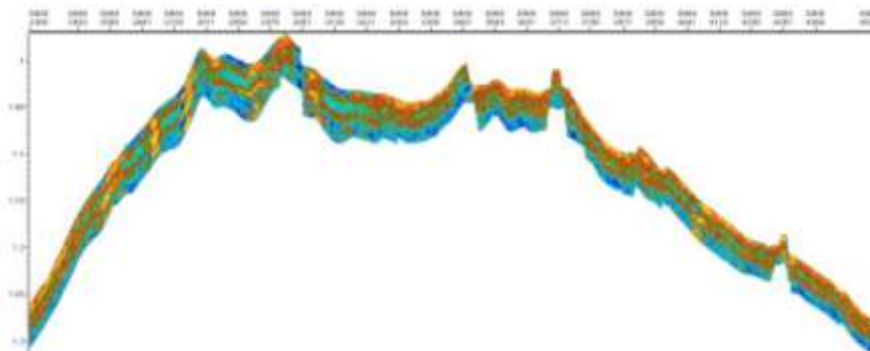


Fig-2: impedance inversion profile of the original wave in the test area

Inversion of well seismic joint reconstruction

The main idea of reconstruction is to use seismic inversion to transform seismic profiles into the pseudo wave impedance profile for reservoir prediction; the inversion results can reflect the information of amplitude, frequency, phase and other characteristics of seismic data, to ensure the authenticity of sandstone

prediction [3-6]. Therefore, the final choice on wave impedance inversion as the background, adopting the idea of well seismic combination, carrying out the of stochastic inversion and relying on the reconstructed curve, the final inversion results can improve the ability to recognize small layers vertically (Figure 3).

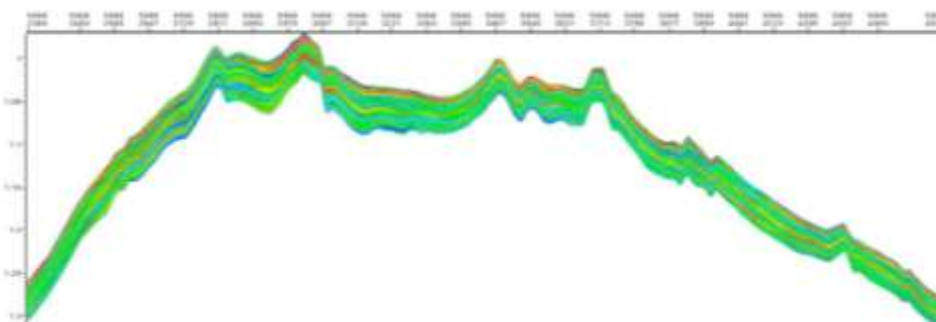


Fig-3: impedance inversion profile with frequency compensation

SEISMIC INVERSION IMPLEMENTATION PROCESS

Seismic inversion is mainly composed of the following process to achieve [7]:

- (1) Seismic data preparation
- (2) Accurate calibration of horizons
- (3) Wavelet extraction
- (4) Geological statistics

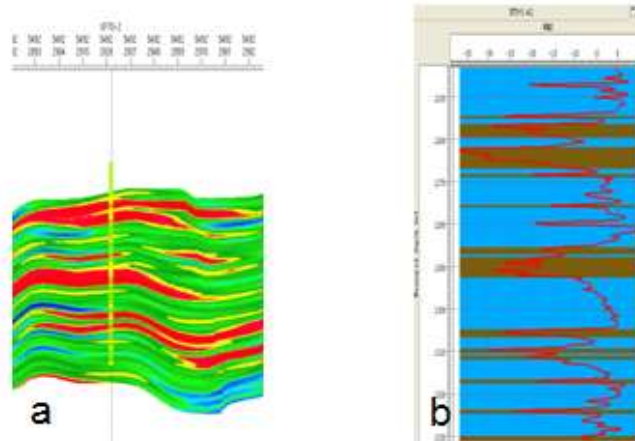
SEISMIC INVERSION RESULTS EVALUATION

Through the contrast experiment and inversion method of comprehensive analysis to determine the final inversion methods and processes, in this paper, the final inversion results are analyzed and evaluated in terms of the vertical resolution and the coincidence rate of the wells.

Longitudinal resolution

The vertical resolution is an important index to decide the inversion accuracy, it determines whether the

fine description of sand body distribution of each layer [8-10].The resolution of the inversion results is good or bad, there are two ways to measure. The first method is based on the good agreement with the well (Fig. 4), which can be distinguished by 3m or more in the longitudinal direction, according to the reconstructed seismic inversion. Through inversion section and lithology comparison, it is concluded that when the reservoir is too thin, the two sets of sandstone can only be retrieved by a set of sandstone combination. Another way to analyze the resolution is to see that the inversion section is in agreement with the sedimentary facies. Figure for inversion slice of sand body development zone and is usually associated with distribution of river morphology similar, in a certain extent, the inversion results can guide the micro facies of the river, and the near source area is usually the sandstone development zone, the sand body is thicker [11].



(a) XF72-2 well inversion profile (b) XF72-2 sand and mudstone interpretation
Fig-4: Vertical resolution effect analysis (a- inversion section and b- lithology comparison)

Comparison of inversion sections and sedimentary facies

The inversion results can reflect the natural and true nature of the geological body, and the inversion results have good lateral resolution [12]. At the same

time, it also reflects the distribution law and shape of sandstone (Fig. 5), it has good correlation with sedimentary microfacies (Fig. 6), and therefore, it can be used to guide the division of sedimentary facies and the subsequent wells deployment.

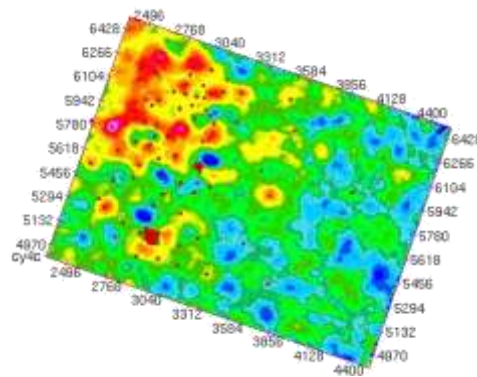


Fig-5: Inversion sections of G36_9 layers in Gao-3 groups

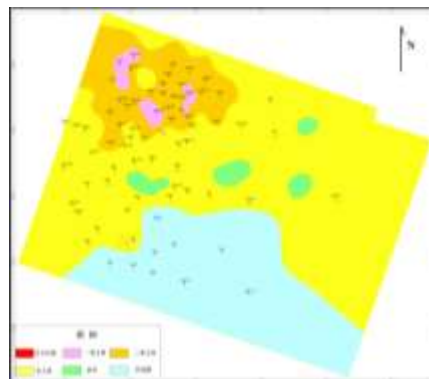


Fig-6: Sedimentary facies of G36_9 in Gao-3 groups

Accuracy analysis of sandstone thickness prediction
1. Judgment of threshold of sandstone and mudstone

According to the reservoir sensitivity analysis, the thicknesses of sandstone is extracted in the inversion result data, according to statistical analysis of the histogram of pseudo wave impedance curve, determine the threshold value of sand and mudstone in this area is

$-8.9 \times 10^6 \text{ kg/m}^3 \cdot \text{m/s}$ (Figure 7), below this value is sandstone. According to the threshold value, the thickness of sandstone and prediction map of sandstone thickness are extracted from 6 main sedimentary units, finally get the region's 7 sandstone thickness prediction maps. Through the sandstone thickness distribution map, it reflects that the northwest of the whole area is well developed, southern is the worst. The overall

presentation of the northern has the characters that northern part is thick, southern part is thin, consistent

with the sedimentary facies [13].

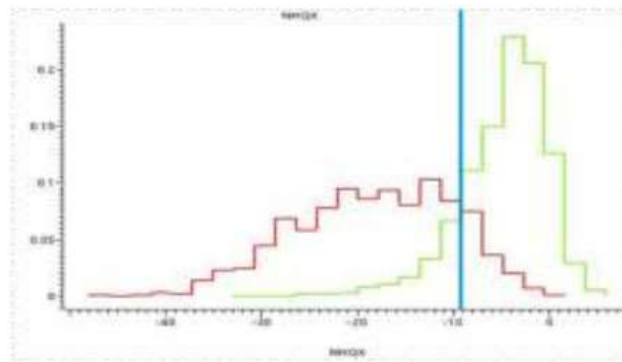


Fig-7: Threshold value of sand and mudstone in the Gao-3 groups

2. Analysis of plane combination

The sand body prediction seismic inversion of the single well minimum error <1%, the maximum error is 14.05%, the average error is 6.59%, The main error is

below 5%, the G320 error is small, the error of G312-14 is larger than 5%, and the error is more, which meets the requirement of the inversion (Fig. 8).

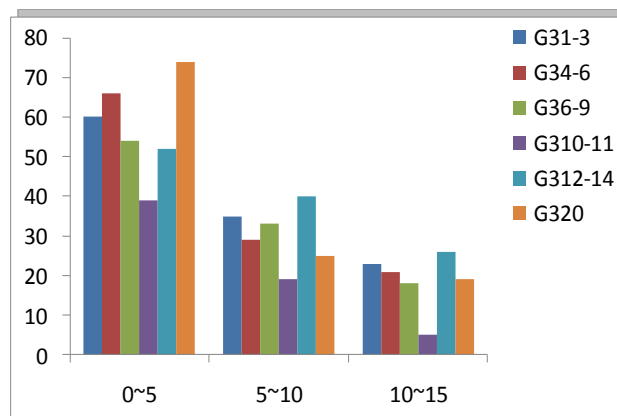


Fig-8: Error statistics

CONCLUSION

(1) Through the comparison of the Inver Trace Plus inversion method and the well seismic joint reconstruction method, finally through wave impedance inversion with well seismic combination as the background, Based on the idea of well seismic combination, the co simulation of stochastic inversion is carried out, and the curve is reconstructed and the ability of longitudinal identification is improved.

(2) Gao-3 group has many layers of sand; there are large differences between layers, and the plane continuity is poor, the plane is not uniform and so on, it fully reflects the unique features of large continental shallow lacustrine delta front deposition.

(3) The direction of sandstone thickness is consistent with the sedimentary facies. The direction of sand body is the direction of the sand body, thick sandstone lenticular distribution is surrounded by a thin layer of sand or sand dam, it belongs to the far edge of the outer edge of the sedimentary sand dam, the thin sandstone area is dominated by the front sheet sand, the development of sand body region for the deposition of mud and shallow lake. The distribution direction of

sand body is controlled by fault, the fault is usually filled with mudstone, the sandstone is very small, but the two sets of faults are thick, especially in the northwest region.

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