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The Research and Application of Spectrum Inversion in Thin Layer

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Abstract: Spectrum inversion is a kind of a priori information and spectral decomposition technique is used to speed up less than tuning thickness of thin layer imaging seismic processing technology. This paper discusses the construction process of objective function in spectrum inversion, and the inversion method is studied. Next, I process actual data of some region of Daqing by spectrum inversion. We can find the resolution of seismic profiles is improved, and the information of high frequency part also has greatly increased.
Keywords: Thin bed, Spectrum inversion, Spectral decomposition.

INTRODUCTION

Spectrum decomposition and spectrum inversion technique are two main methods of thin bed quantitative research in frequency domain. Spectral decomposition technique is within the short-time window through spectral decomposition predict reservoir studies, thin layer and seismic attribute analysis technology. Spectrum inversion is a kind of a priori information and spectral decomposition technique is used to speed up less than tuning thickness of thin layer imaging seismic processing technology. Spectral decomposition has been widely applied in depicting geologic abnormal body thickness change and describes geologic abnormal body transverse discontinuity. Charles I P [1-3] established a through spectrum inversion method to calculate formation thickness, and its application in the synthetic data and real data. Using this approach in the case of without the amplitude correction can determine the formation of the under seismic tuning thickness less than absolute thickness. And they also use this technology to extend and applied to common reflection coefficient sequence, the sequence is composed of a series of pulses. And actual seismic data in the gulf of Mexico in the very good application results have been achieved. Using the spectrum inversion to predict the thickness of the thin layer has certain reference significance in the future. Based on spectrum inversion theory, these papers will spectrum inversion is applied to the practical data of some areas, and good results have been achieved.

THE THEORY OF SPECTRUM INVERSION

Spectrum thin layer inversion technique is a new kind of spectrum inversion under the restriction of technology, the results is helpful to solve the stratigraphic sequence, improved the precision of the prediction of oil and gas in the thin reservoir.

The main method is on the basis of accurate spectral analysis; make full use of the high frequency part of seismic reflection information and reference for the low frequency seismic features as control, using high precision instantaneous spectral decomposition method, the effective realization of high-resolution wave impedance inversion. It was first put forward by Castagna, etc. [4-6], is a kind of spectral decomposition method, using seismic data and the instantaneous frequency spectrum characteristics of constraint, get rid of the influence of seismic wavelet from seismic records, get a high resolution reflection coefficient data volume technology; Spectral decomposition of parity inversion in the reflection coefficient sequence improve resolution under the theory of control, can effectively distinguish the location of the thin layer of reflection coefficient, the polarity and size, spectrum inversion in the preservation of low frequency component of the spectrum at the same time effectively compensate the high frequency component; Can be performed against lower than tuning thickness thin layer, improves the resolution of seismic data.

In the seismic, if it has difference of wave impedance, then will generate reflection coefficient, the ground receives the seismic record is the reflection coefficient and the results of the seismic wavelet convolution. No noise theory model of seismic record is:

$$S(t) = r(t) * W(t) \quad (1)$$

Inside the formula, S(t) stand for the seismic records; R(t) is just as the stratum reflection coefficient; W(t) is for the seismic wavelet.

Reflection coefficient:

$$R = \frac{\rho_2 v_2 - \rho_1 v_1}{\rho_2 v_2 + \rho_1 v_1} \quad (2)$$

R is for the reflection coefficient, ρ and v is for rock density and wave velocity, on behalf of the wave impedance.

A seismic trace reflection coefficient can also be seen as consisting of a series of pulse signal, so the reflection coefficient of seismic trace cans also parity component decomposition. For the avoidances reflection coefficient of a thin layer, can also be expressed as shown in figure1.

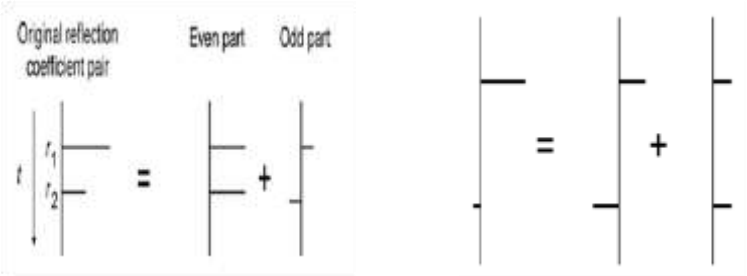

Fig-1: Thin layer reflection coefficient of odd-even decomposition

Thin layer reflection think of seismic resolution limit for Widess model [1], Based on spectrum peak and trap formation is the distance between the thickness of the deterministic function, we can launch a kind uses the constant cycle in the frequency domain values in reflectivity inversion of the new algorithm. Will first pulse in the time domain to say into a numerical sequence type [7], the method of spectral analysis and then use the plural form a kind of numerical algorithm, and in the synthesis of wedge model test.

SPECTRUM INVERSION APPLICATION EXAMPLE

Step1: By analyzing the raw data of the experimental block section, in figure 2, experimental data quality is good; the fault is more obvious, that early treatment is more reasonable. The basic geological information can be identified easily.

Step2: Choosing the corresponding test body to 500 ms window in time domain extracting wavelet from 0 to 4000ms. The wave frequency to low frequency offset, due to the filtering effect of the earth that filter out the high frequency components. Half wavelength of wavelet is 100 ms. the wavelet which is choose is shown in figure 3

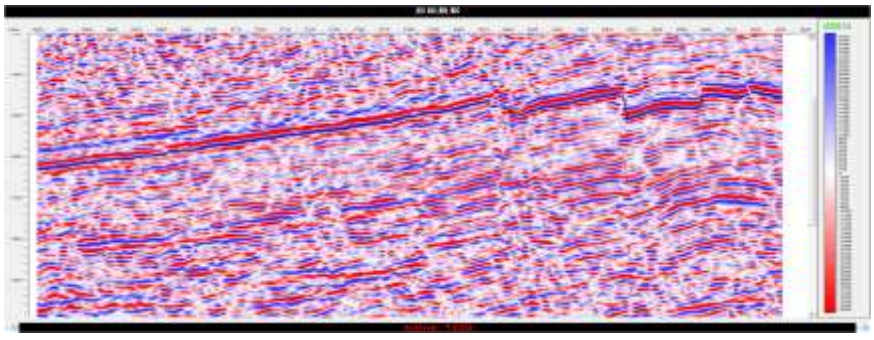

Fig-2: The original data section

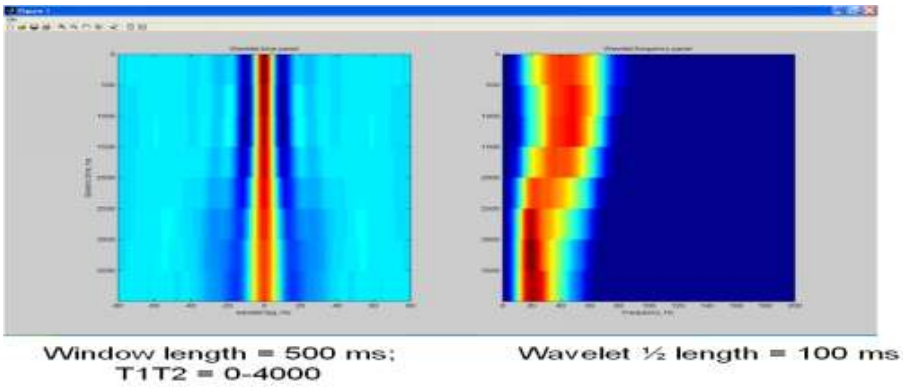

Fig-3: The extracted wavelet

Step 3: With different parameters in the selection of test data, the available parameters including: half wavelength wavele, wave number varies with time, the stability coefficient of noise, etc. The inversion results of test and analysis using the above parameters, to find out the best parameters of the test results, find the best inversion results. Inversion in the whole data volume, get the final result is shown in figure 4.

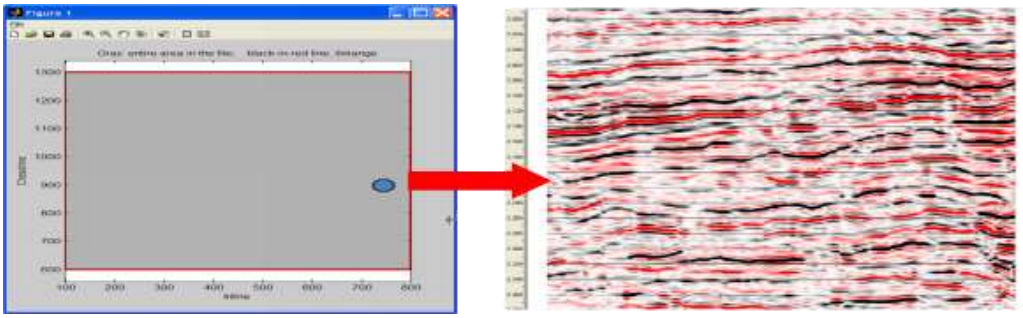

Fig-4: The final result of test

Migration section and the reflection coefficient section profile clearly visible reflection coefficient is higher than that in the relative resolution, it is able to identify the geological structure of the small fault which is difficult to distinguish, etc., the thinner layer identification. Through spectrum analysis spectrum of the reflection coefficient resulting from the inversion profile band broadening obviously, can identify migration section unrecognized by the high frequency signal.

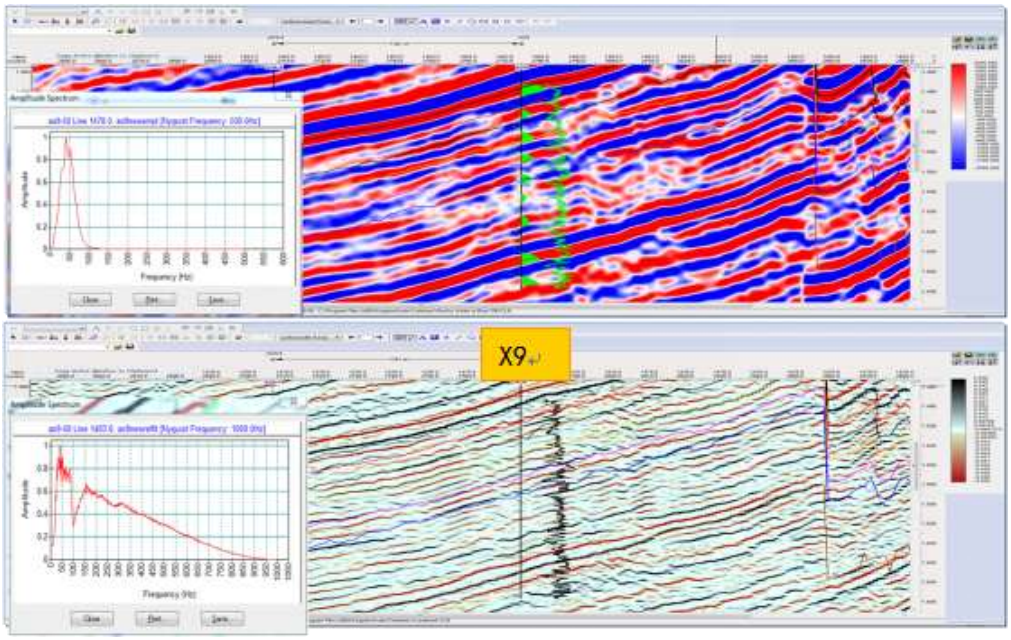

Fig-5: Reflection coefficient profile and migration section

Spectrum inversion results well contrast. By figure 4 to 12, the inversion results of synthetic seismic records and real basic perfectly well logging curve, has high reliability and may apply. Verify the accuracy of spectral inversion by well logging curve, and the spectrum with adjacent seismic trace inversion results of synthetic seismic records of the continuity of seismic synthetic record also can judge spectrum inversion result is good.

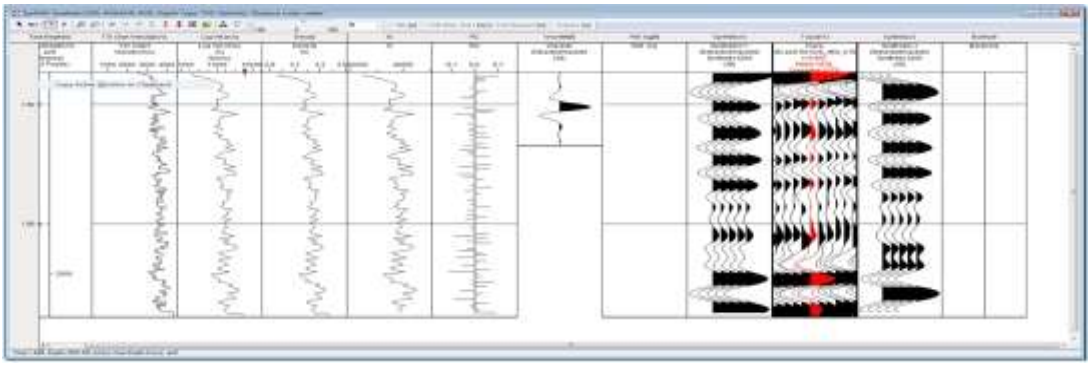

Fig-6: X9 synthetic records contrast with well loging records

Based on the above experimental area the spectrum inversion data analysis, we can see that, spectrum inversion result resolution is improved obviously, positioning more accurate reflection interface. Spectrum inversion data of conventional effective frequency band to keep the original data of relative amplitude and frequency. Data of the data is to use high frequency spectrum constant periodic high-frequency effective signals obtained by combining frequency division high-frequency recovery; the recognition of thin layer tracking has very good guidance significance.

CONCLUSIONS

Spectrum inversion is a kind of fine identification of thin layer and reflection coefficient inversion method, without the noise and the condition of known seismic wavelet, This method can identify the thickness less than tuning thickness of thin layer, and can accurately portrays the stratigraphic boundary, spectral inversion objective function has better convergence and restraint ability, By adjusting the size and location of the reflection coefficient, the objective function under the constraint of the reflection coefficient can be obtained. In practice can be due to the effect of tuning of the formation and blurs the thin layer of information retrieval. , in turn, improves the resolution of seismic data, provide a more abundant seismic stratigraphic information.

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