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Effectiveness Analysis of 90 Degree Phase Rotation Technology in Thin Reservoir Prediction

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1 Introduction

Seismic waveform reflects the basic information of seismic data which mainly includes seismic amplitude, phase, frequency etc. Zero-phase wavelet has high signal-to-noise ratio, high resolution and the characteristic of symmetry. But in the case of thin layer, the zero-phase reflection waves from top and bottom will interfere with each other and its symmetry is disappeared. The peak (trough) will no longer correspond to the interface. In recent years, some scholars proposed 90 degree phase rotation technology. It is considered that the main lobe of the reflection wave will correspond to the center of thin layer and the symmetry of reflection wave will be restored as well by rotating the wavelet with 90 degrees. However some scholars believe that doing a 90 degree phase rotation to the seismic data will distort seismic wavelet, and the seismic amplitude will no longer have relationship with lithology. This paper designed forward models based on the actual parameters and verified the Effectiveness of 90 degree phase rotation technology in the identification of thin layer.

2 Theory of 90 degree phase rotation

90 degree phase rotation is one of the two key technologies of seismic sedimentology. To single interface (thick layer), the reflection wave from zero phase wavelet is interfacial symmetric. To double interface (thin layer), 90 degree phase wavelet has the character of symmetry to interface. That is to say, by doing 90 degree phase to wavelet, the seismic response of the main lobe (maximum amplitude) moved to intermediate point of thin layer. The main seismic phase axis corresponding to reservoir and makes it easier to distinguish sand and shale in thin layer. So, under the condition of thin layer, 90 degree wavelet can get a better result.

3 90 Degree Phase Rotation Technical Feasibility Analysis

To verify the advantage of 90 degree phase Rotation technology in identification of thin reservoir layer, this paper established forward models using actual geological parameters of studied area and extracted seismic attribute from the seismic forward section.

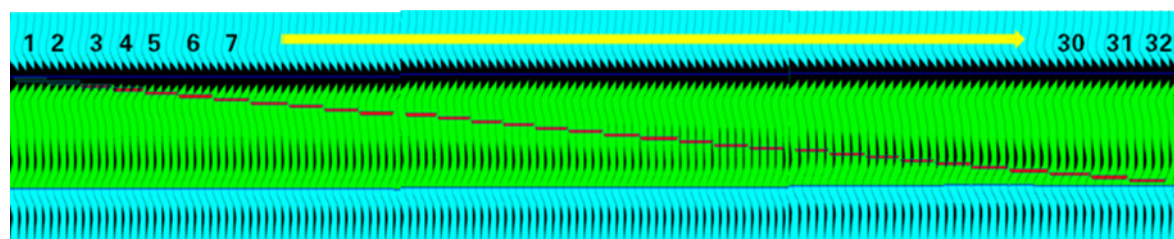
3.1 Forward model

The forward model is 1000 meters long with 100 traces in total and is composed of three layers whose thickness is 30 meters, 67 meters and 30 meters respectively. The upper and lower medium is mudstone with the velocity of 2700m/s and 3000m/s. The intermediate medium is the muddy silt with the velocity of 3400m/s. Among the middle layer 32 sandstones whose thickness is 2 meters and velocity is 3700m/s dislocated from the top (Fig.1).

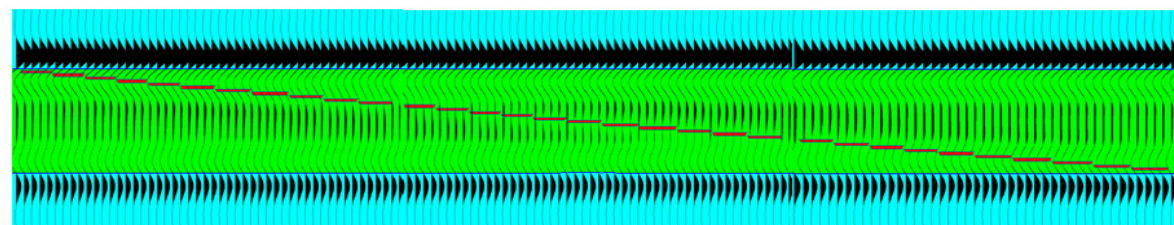
3.2 forward modeling and results analysis

Zero phase Ricker wavelet and 90 degree phase Ricker wavelet whose main frequency are 40Hz are chosen to sub forward (Fig.1). The amplitude attributes are attracted along the top of sand body from the two phase wavelet forward section. And the attribute values are analyzed (Fig.2). Fig.2(a) shows the amplitude attributes from the zero phase wavelet forward section along the top of No. 7 sand body. Fig.2(a) shows that, the attribute value abstracting along the top of No.7 sand body is significantly less than that along the top of No.3 sand body. That means the seismic attributes reflected the information of No.3 sand body even it was extracted along No.7 sand. The attribute from zero phase seismic section can't identify the thin layer correctly. Fig.2(b) is the result of amplitude attributes from 90 degree phase forward section along the top of No. 7 sand body. It shows that the amplitude attribute is corresponding to the No.7 sand body and reflects its own information in a maximum. At this

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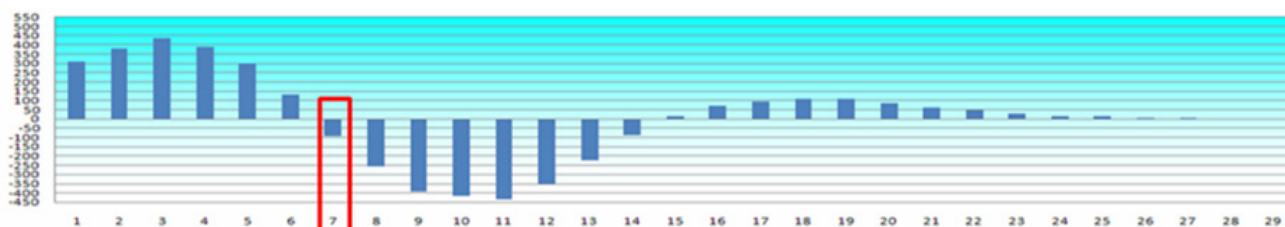


(a) The forward model and its simulation section(zero phase wavelet)

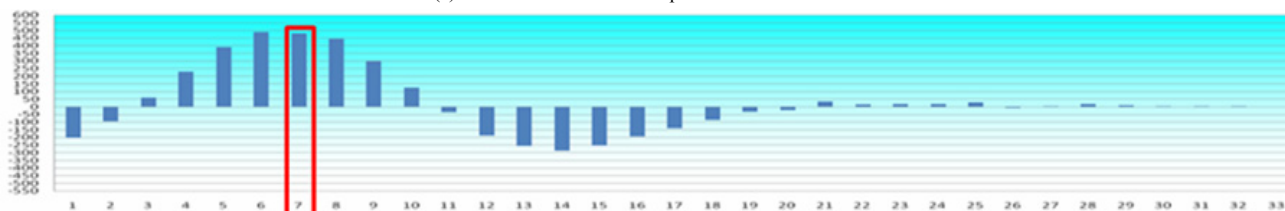


(b) The forward model and its simulation section(90 degree phase wavelet)

Fig.1 forward simulation section



(a) Attribute value from zero phase simulation section



(b) Attribute value from 90 degree phase simulation section

Fig.2 Attribute value attracted along the top of No.7 sand body

time, the seismic reflection has the correct corresponding relationship with the lithology, which is advantageous to identify thin sand layer.

Above all, simulation analysis shows that 90 degree phase rotation technology has better effect in thin layer. Moreover, as shown in Fig.2, whether zero phase wavelet or 90 degree phase wavelet, the interference between the sand bodies is there. That is to say, 90 degrees phase conversion technology can't improve the resolution of seismic exploration.

4 Applications

Putaoehua reservoir in Gaotaizi oil develops delta sedimentary system. The sand body is small and 2-3m in thickness.

The conventional zero phase seismic data can't correspond to the actual lithology. So the phase of seismic wavelet is converted to 90 degree. After that, the high

value of resistivity curve corresponds to the wave crest of seismic event axis. That means the main energy of seismic reflection reflect the lithology(sand). Then the amplitude slice along target layer was extracted. By contrast the slice from zero phase data volume and 90 degree phase data volume, the latter has better effect on identification thin layer.

5 Conclusions and Suggestions

In summary, 90 degree phase rotation technology can effectively improve the recognition ability of seismic attributes to thin sand body. For the prediction to thin reservoir, making 90 degree phase rotation to seismic data is suggested. Meanwhile, when using the 90 degree phase rotation technology, the following issues also should be paid attention:

(1) 90 degree phase rotation is making phase rotation to seismic data and can't improve the resolution of seismic

data;

(2) Because of the difference of seismic data in each region, some seismic data may be zero phase or mixed phase. The applicability of 90 degree phase rotation technology should be considered before use it.

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