SPECTRAL FILTERING FOR REMOVING COAL BRIGHT SPOT EFFECT IN SEISMIC INTERPRETATION

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First Registered on August 29th 2012; Received after Corection on December 3rd 2012
Publication Approval on : December 31st 2012

ABSTRAK

Pada data seismik keberdaan reservoir gas dan batubara keduanya dapat memberikan efek *bright spot*. Oleh karena itu, diperlukan suatu methode baru untuk membedakan respon *bright spot* akibat adanya reservoir gas atau batubara. *Spectral filtering* merupakan metode yang dapat digunakan untuk mengatasi masalah tersebut. Metode ini pada dasarnya dikembangkan dari metode dekomposisi spektral yang telah lama digunakan dalam analisa data seismik. Dalam paper ini *spectral filtering* telah sukses diaplikasikan pada data real seismik 3D di cekungan Natuna.

Kata kunci: *Bright spot,* dekomposisi spektral

ABSTRACT

Gas sand and coal bed both give bright appearence in seismic section. For the purpose of gas exploration one has to differentiate between gas response and coal respone. A spectral filtering technique is introduced in this paper to solve this problem. This technique is the development of the spectral decomposition method which constitutes the leading edge in seismic data analysis. Testing using the real seismic data has been carried out using the seimic data from West natuna basin.

Keywords: Bright spot, Spectral Decompositions

I. INTRODUCTION

The high world demand for oil and gas is a challenge for Oil and Gas Companies. Various exploration activities have been carried out such as Re-study of G & G of the existing oil and gas fields up to the expansion of exploration activities into the deep sea reservoir. As we know, the deep sea exploration is an activity that requires significant investment and has a high risk, therefore innovation in geoscience is expected to greatly contribute to the improvement the success ratio in finding oil and gas.

The first use of information from the amplitude anomalies on seismic data as hydrocarbon indicators was introduced in the early 1970s. This discovery triggered interest among geophysicist for how to connect the seismic amplitude with rock physical properties and fluid type. In general, the presence of gas or light oil in sandstone (soft) can significantly increase the compressibility, the velocity will be decreased so that the amplitude will move towards to negative (bright spot) but if the sandstone is relatively hard (compared to the cap-rock) the sandstone with water saturated will also show a bright spot anomaly.

The ambiguity of the bright spots response also appears on the some other of geology event such as:

- Volcanic intrusions and volcanic ash layer
- Highly cemented sands, often calcite cement in thin pinch-out zones
- Low porosity heterolithic sands
- Over pressured sand and shale
- Coal beds
- Top Salt diapers

In addition the bright spot on seismic data can be caused by the existence of coal beds. It also causes dimming effect on the underlying reflectors. This is because the coal bed is a zone that has a high attenuation property so that very little energy is transmitted. As a result, the reflectors below the coal beds can not be seen clearly.

Seismic inversion, complex trace attribute, and Q-inversion are several methods that utilize the seismic amplitude for the hydrocarbon identification and reservoir characterization. Therefore it is required a special technique in order to separate hydrocarbon and coal beds response.

This paper described deals with a technique called as spectral filtering which can be used to distinguish whether the bright spot anomaly due to the coal or hydrocarbons (gas). Spectral filtering is a technique based on spectral decomposition method where the seismic data will be extracted into a single frequency which can be used to describe the subsurface geological feature at that level.

II. SPECTRAL DECOMPOSITION: TUNING FREQUENCY

Spectral decomposition is a novel seismic technique that was originally pioneered through research at BP and Amoco in the 1990's. Spectral decomposition is an imaging innovation that provides interpreters with high-resolution reservoir detail for imaging and mapping temporal bed thickness and geological discontinuities within 3D seismic surveys by breaking down the seismic signal into its frequency component.

A fully processed seismic survey contains all of the frequencies that are capable of being recorded by the geophones/hydrophones used for that particular survey (this is known as its "dynamic range"). After the seismic source has been "shot," the energy propagates downward into the subsurface and at each geologic boundary (e.g., an unconformity, bed boundaries, etc.), the seismic energy is reflected, refracted, and/or absorbed.

As the wavefront continues to propagate into the underlying sediments, it attenuates, causing the frequency content to decrease with depth, i.e., higher frequencies are better preserved at the top of the section. Due to this attenuation, the higher frequencies deeper in the seismic survey are "drowned" by the more dominant, lower frequencies. The purpose of spectral decomposition is to see the seismic response at different, discrete frequency intervals, as higher frequencies image thinner beds, while lower frequencies image thicker beds.

The concept behind spectral decomposition is that the seismic reflection from a thin bed has a characteristic expression in the frequency domain that is indicative of its thickness in time. For example, a simple homogeneous thin bed contains a predictable

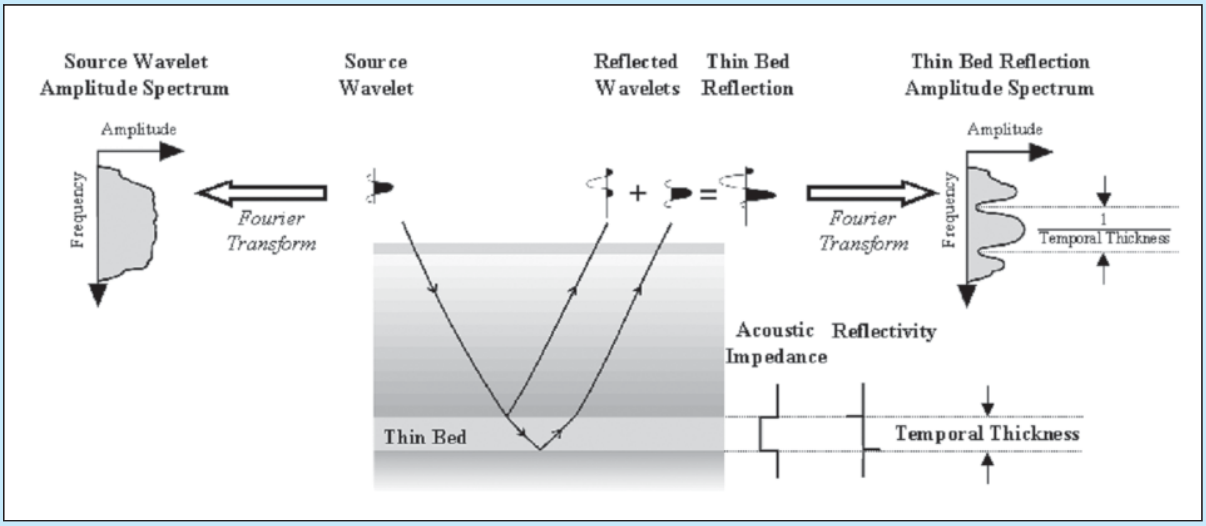

Figure 1
Spectral decomposition is used to identify thin beds through analysis of the frequency spectrum in a short window around the time of the bed (Partyka *et al.,* 1999).

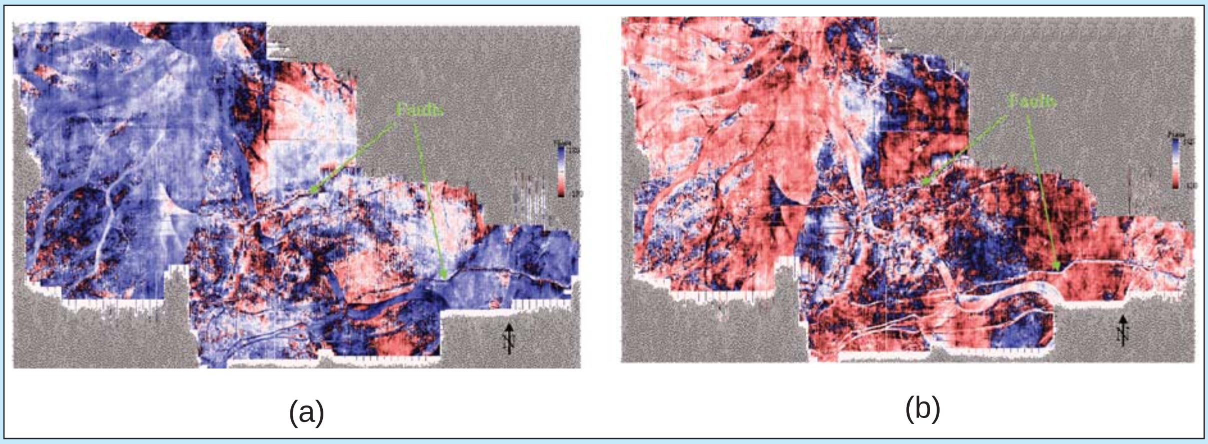

Figure 2
Tuning frequency, a: High Frequency signal (45 Hz) detect narrow channel, b: Low frequency Signal (16 Hz) detect width channel (Partyka, *et. al*., 1999)

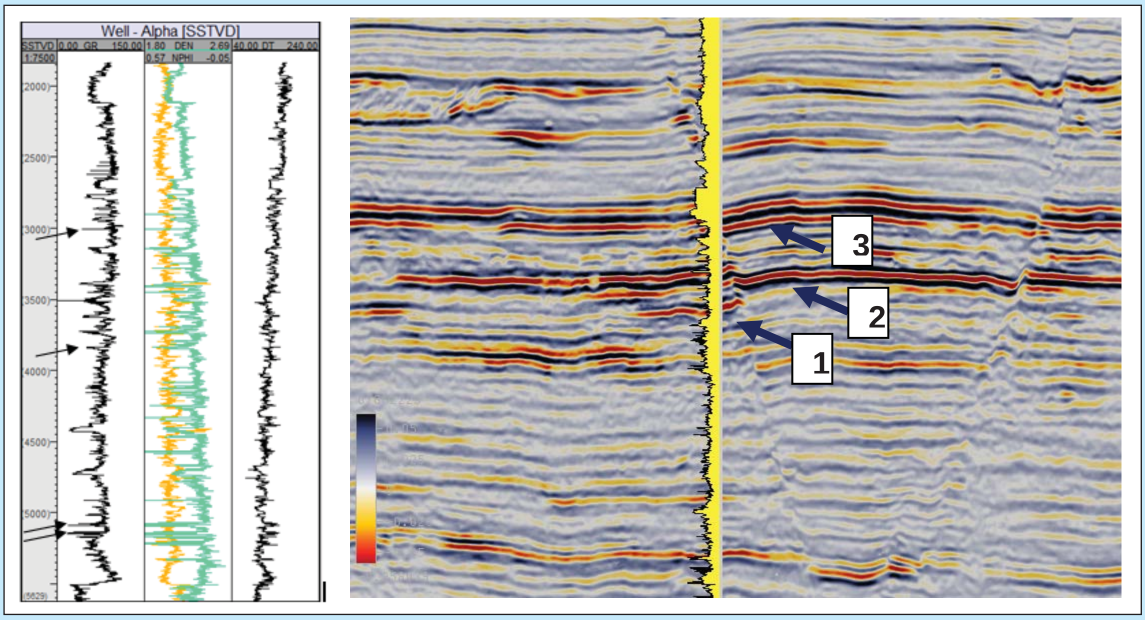

Figure 3
Seimic section and Well log completly dominated by noumerous coal beds

and periodic sequence of notches into the amplitude spectrum of the composite reflection (see Figure 1). However, typically a seismic wavelet contains the information from multiple subsurface layers and not just one simple thin bed. The combined seismic response from these multiple subsurface layers usually results in a complex tuned reflection which has a unique frequency domain expression; in order to resolve these thin beds, spectral decomposition can be used.

As stated before, spectral decomposition can be used to break down the seismic data into its frequency component (see Figure 2)

III. APPLICATION

The Technic of Spectral filtering which base on Spectral decomposition discussed above has been applied to the 3D seismic data in the West Natuna basin. For the shake of secrecy the exact location of the field not be presented here.

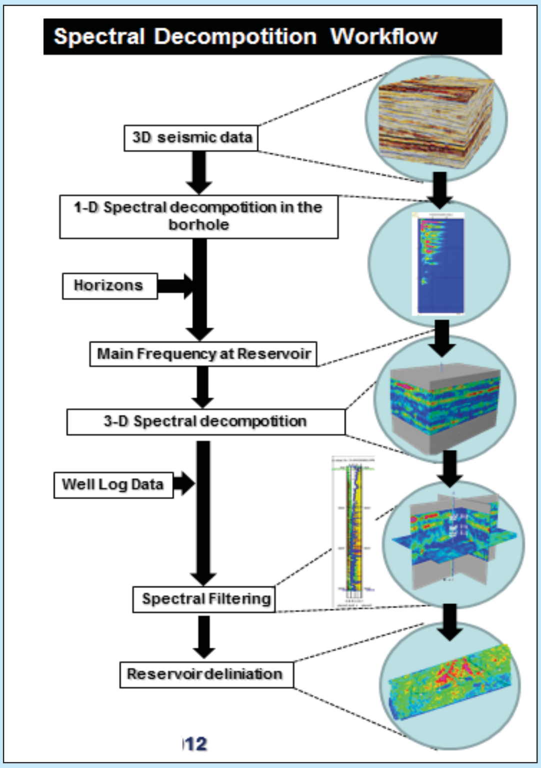

Figure 4
General workflow of spectral decomposition for reservoir identification

Coals are integral part of the West Natuna geology and dominant from older group to the younger group. This is shown in Figure 3 where numerous thin coal beds dominate the stratigraphy (black arrow).

Moreover, on Figure 4b shows that the seismic section also contains numerous bright spot anomaly layers (Blue arrow), number 1 and 3 are top of Hydrocarbon Sand reservoir which interpreted form well log data and number 2 is coal beds level. Unfortunately, coals produce strong negative impedance response so that it can be make mistake in amplitude interpretation.

IV. RESULT AND DISCUSSION

In this paper, to reduce the ambiguity of bright spot anomaly we applied spectral decomposition method. The main goal of this method is to predict the specific frequency both of coal and hydrocarbon in the well. With this information we can start designing the filter.

Figure 5 show the general workflow for reservoir identification which consists of Seismic data conditioning, 1-D spectral decomposition, 3D/2D spectral decomposition spectral filtering and

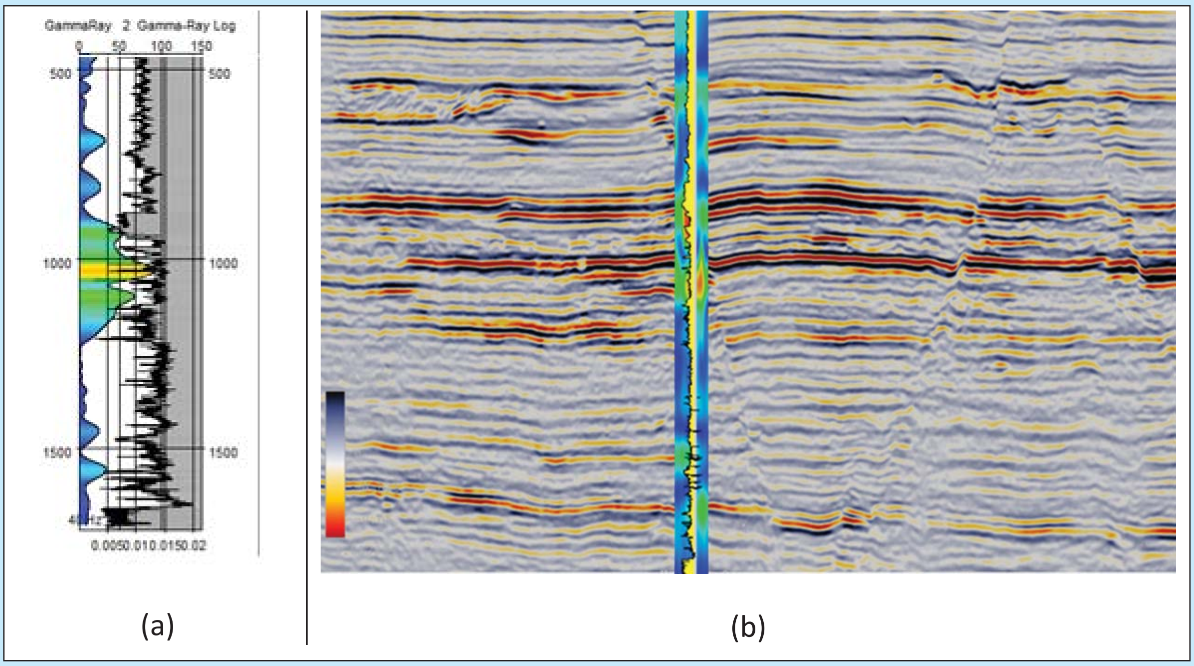

Figure 5
(a) Correlation Log bettwen Gamma Log and Spectral Decomposition at 55 Hz which associeted with Coal beds (b). Spectral Decomposition with low frequency content (19 Hz) which associeted with HC sand

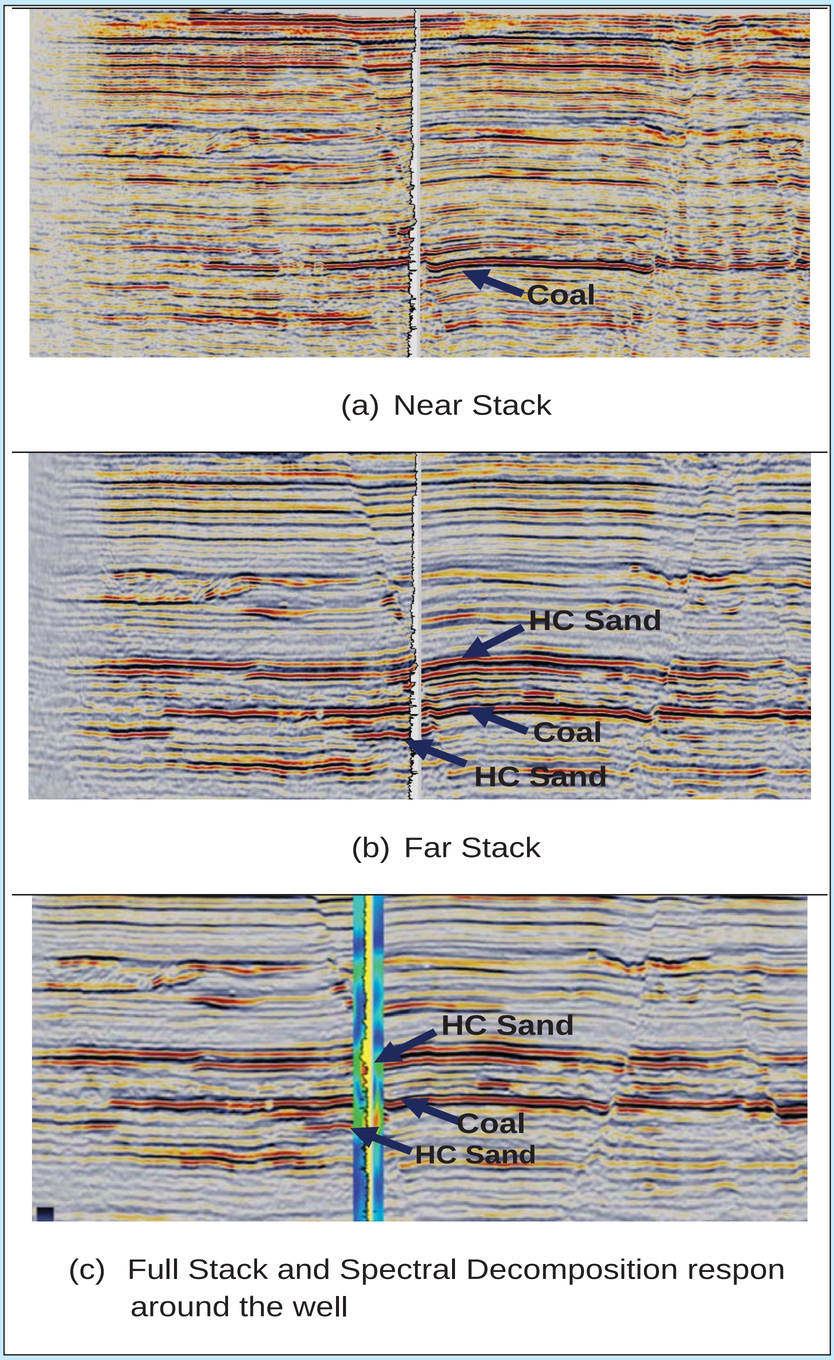

Figure 6
AVO anomaly in seismic data

Reservoir delineation. However, this is not intended to solve reservoir delineation.

From the Figure above (Figure 5) it is clear that spectral decomposition is powerful tool to predict gas sand and also to reduce the ambiguity in bright spot anomaly. For the purpose of comparing of the result of spectral decomposition in predicting coal and HC sand, we also analyze the AVO anomaly on the seismic data (see Figure 6.)

Comparing the near and far offset section in Figure 6 a and b, we immediately see that the reflection of HC sand changes significantly with offset meanwhile the reflection from Coal is not affected by increasing offset.

V. CONCLUSION

Spectral decomposition is a powerful tool to filter or reduce the ambiguity in distinguishing bright spot anomaly whether it is coal or hydrocarbon sand. However if these coal beds are too close to the pay beds they might still contaminate the reservoir response.

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