

Application of Spectral Decomposition and RGB Blending for Delineation of "S" Channel At Asri Basin

Aplikasi Dekomposisi Spektral dan RGB Blending untuk Delineasi Channel "S" di Cekungan Asri

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ABSTRACT: Gita member is part of Talang Akar Formation is known as hydrocarbon reservoir at Asri Basin, eastern part of South Sumatra. This formation consists of several depositional systems such as braided channel, meandering channel, fluvial-deltaic, and estuarine system. A channel system was an interesting system developed in the Asri Basin, however, to get the channel distribution in Asri Basin is quite challenging because the thickness of the channels caused its appearance is generally close or under seismic resolution, the existence of coal below our target also affects the impression of "S" sand on seismic data. In this study, spectral decomposition and RGB Blending have been successful to identify "S" sand. RGB Blending map is extracted from 15 Hz as low frequency, 45 Hz as middle frequency, and 75 Hz as high frequency. Our interpretation was applied at RGB Blending map and reveal the "S" sand is classified as a meandering channel depositional system with the main direction of the channel is Northeast – Southwest.

Keywords: spectral decomposition, RGB Blending, Gita reservoir, Asri Basin

ABSTRAK: Anggota Gita merupakan bagian dari Formasi Talang Akar yang dikenal sebagai reservoir hidrokarbon di Cekungan Asri, Sumatra Selatan bagian timur. Formasi ini terdiri dari beberapa sistem pengendapan seperti sistem sungai teranyam, meander, fluvial-delta, dan estuari. Sistem pengendapan sungai purba di Cekungan Asri merupakan sistem yang menarik untuk dieksplorasi namun untuk mendapatkan persebaran sungai tersebut merupakan hal yang menantang dikarenakan tipisnya ketebalan sungai yang mengakibatkan kenampakannya pada data seismik berada disekitar atau bahkan dibawah resolusi seismik, keberadaan lapisan batubara dibawah target turut mempengaruhi kenampakan pasir "S" pada data seismik. Dekomposisi spektral serta RGB Blending yang diaplikasikan pada penelitian ini dapat mengidentifikasi pasir "S". Peta RGB Blending diekstraksi dari beberapa frekuensi, yaitu frekuensi 15 Hz yang diambil sebagai frekuensi rendah, 45 Hz sebagai frekuensi tengah, dan 75 Hz sebagai frekuensi tinggi. Selanjutnya dilakukan interpretasi pada peta hasil RGB Blending dan menunjukkan pasir "S" diklasifikasikan sebagai sungai dengan sistem meander dengan arah utama sedimentasi adalah Timurlaut - Baratdaya.

Kata kunci: dekomposisi spektral, RGB Blending, reservoir Gita, Cekungan Asri

INTRODUCTION

The study area (Figure 1) is located at Asri Basin, it is bordered by the Sunda Shelf in the north, the Biliton Basin and the Karimun Jawa Arc in the east, the Lampung Highland in the west, and in the south by the West Java Basin and the Seribu Platform. This basin has an area of about 3500 km² with a sediment thickness

up to 16,000 feet which was formed in the Paleocene to Pleistocene (Sukanto *et al.*, 1998). The oilfields in the Asri Basin are dominated by structural traps and a combination of stratigraphic traps (Young *et al.*, 1991). Kusuma (2010) states that the reservoir in the Gita member, part of Talang Akar Formation, is consist of

Contributorship:

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Figure 1. Study Area

several compartments that are separated and not related to each other.

Tectonically, the Gita Member Formation was deposited in the Early Miocene post-rift period. In this period, the expansion process had stopped, and there had been a decrease in the basin and regional sea transgression. Neogene Post-rift begin with mean sea level rising, it was marked by deposition of rocks in the marine environment (Sukanto *et al.*, 1998). Gita member has several type depositional systems, such as a braided channel system, meandering channel system, fluvial-deltaic system, and estuarine system (Juniarti, 2018).

The objective of this study is to determine the distribution of “S” sand target (one of the Gita member) reservoir at Asri Basin that shown by stratigraphy column, eastern part of South Sumatra (Figure 2) that could reveal the existence of “S” channel.

A channel system was an interesting system developed in the Asri Basin, however, to get the channel

distribution in Asri Basin is quite challenging because the thickness of the channels caused its appearance is generally close or under seismic resolution so this thin layer sometimes unseeable (Tetyukhina, *et al.*, 2010), the presence of coal under the reservoir also affect the appearance of our target on seismic data. Spectral decomposition is seismic interpretation methods that divulge some concealed geological features, for example, thin layer sediments, channels, or shallow gas.

Spectral decomposition is being used extensively as an excellent tool for mapping channels (Partyka *et al.*, 1999). In Spectral decomposition, the seismic data would be decomposed into several frequency components and the result would be seen as time-frequency seismic sections or maps. The common method of spectral decomposition is Fast Fourier Transform (FFT), Short term Fourier Transform (STFT), Continuous Wavelet Transform (CWT), and Matching Pursuit Decomposition (MPD) each method has different advantages and deficiency. In this study, continuous wavelet transform is used because this method has supple windows and accessible. Later on the result is combined using RGB Blending. These types of the blend are highly effective at visualizing data such as a result of spectral decomposition attributes (Das *et al.*, 2015)

This study used 3D seismic data volume and 1 well data. The spectral decomposition would be applied to seismic data then three different frequencies would be collected and combine using RGB Blending method. Afterwards, the result would be used to determine the distribution of “S” sand. Based on gamma-ray log the target is located at 1,025 meters depth and the thickness is around 15 meters (Figure 3).

METHODS

Prior to perform Spectral Decomposition and RGB Blending, the sand target was determined using several log data from well W-1 such as gamma-ray, density, neutron porosity, and resistivity. Gamma-ray log was used to construe a variety of different clastic depositional systems based on the principles of Kendall (2003). Gamma-ray log was employed to identify clastic reservoir units and from resistivity log, we could

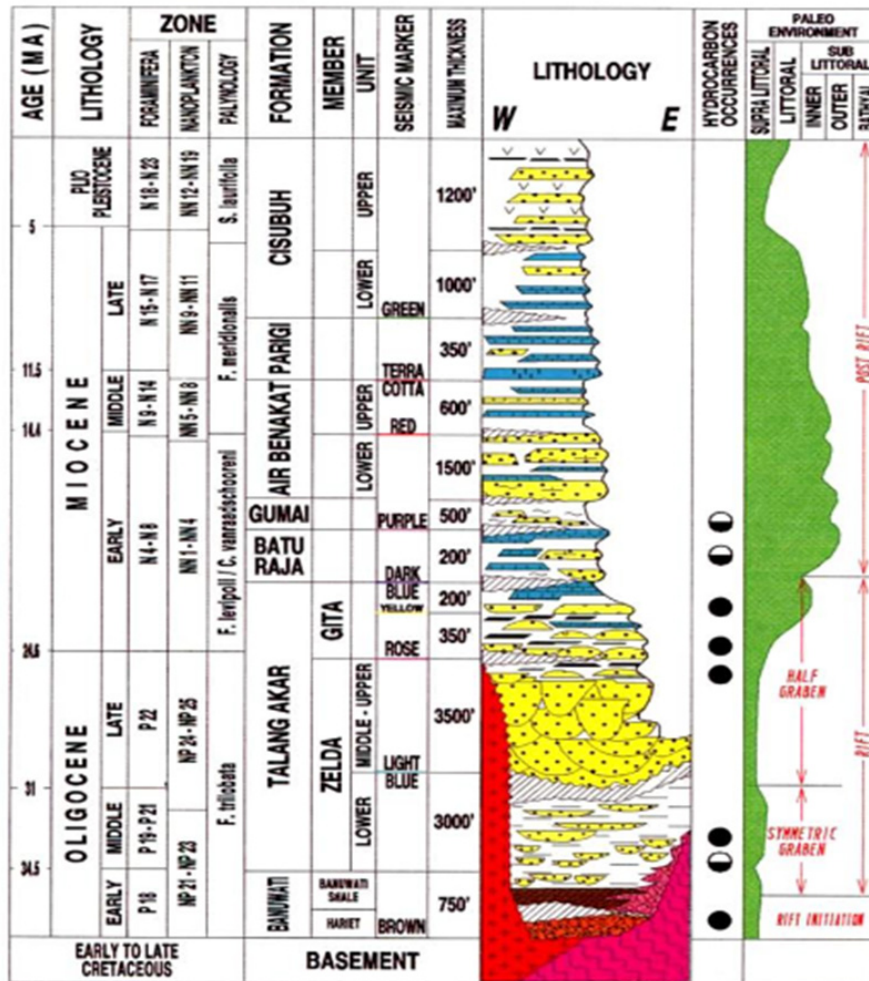


Figure 2. Asri basin stratigraphy (Sukanto *et al.*, 1998)

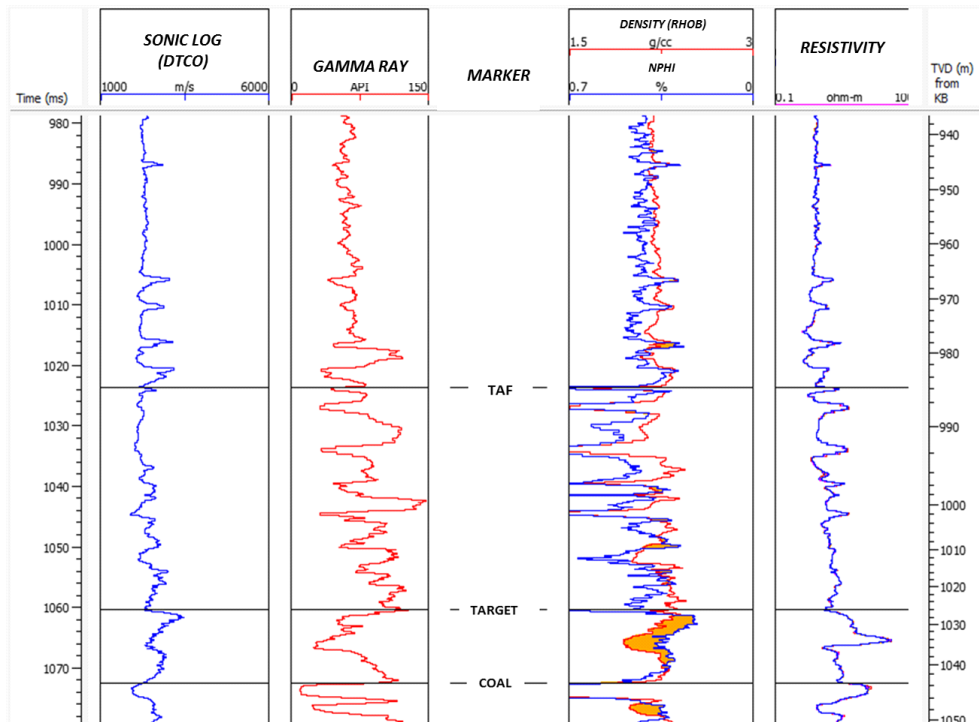


Figure 3. DTCO, gamma-ray, density, resistivity, and marker log at well W-1 data

differentiate between the hydrocarbon and non-hydrocarbon bearing zones (low Gamma-ray and high resistivity). DTCO or sonic log and density log (RHOB) were used to create seismic synthetic that would be used for well-seismic tie.

The thin-bed tuning effects occur when reflections from the top and down layer have constructive interference and the seismic data only show wavelength and if the layer thickness less then this value will not be detected (Okiongbo & Ombu, 2017). The wavelength itself depend on a frequency where high-frequency seismic data will reflect thin layer. On

Gaussian, Morlet, and Mexican Hat wavelet, it depends on the desired resultants vertical resolution. This paper used Gaussian wavelet because although the resolution of the Mexican Hat and Gaussian appears to be similar, the Gaussian wavelet resolution of the channel features is slightly superior to that of the Mexican hat wavelet (Kenneth Samuel & Righteous, 2019). The data is analyzed by the amplitude spectrum of seismic data (Figure 4). Afterwards, these frequencies will be chosen and applied to the RGB Blending method, from the amplitude spectrum could be seen three dominant frequencies 15 Hz, 45 Hz, and 75 Hz. The frequencies

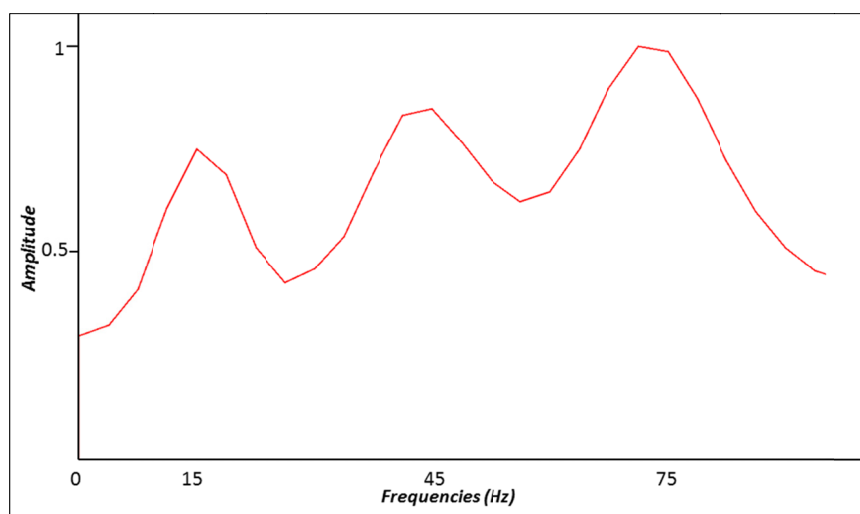


Figure 4. Amplitude spectrum of seismic data

seismic data, channels are generally close or under seismic resolution (Tetyukhina *et al.*, 2010) so this thin layer sometimes unseeable, the presence of coal under the reservoir also affect the appearance of our target on seismic data.

Continuous Wavelet Transform (CWT) transforms the signal from a time domain into a signal in the time and frequency domain, which in this case is formed into translational and scale domains. The translation is a form of transformation of the time domain related to the location of the window function, where the window moved along the incoming signal. A scale is a form of transformation from frequency, where the scale value is inversely proportional to the frequency value. CWT uses a variable window length it has the character of multi-resolution analysis, and can represent seismic data in both time domain and frequency domains. In the low frequency part, it has high frequency resolution and low time resolution, while in the high frequency part it has high time resolution and low frequency resolution (Jahan and Castagna, 2017). There are several types of wavelet that commonly used in CWT analysis such as

that have been chosen are important because different frequencies enable to analyze results and show different geological features. For example higher frequencies reveal features of more detailed character, whereas lower frequencies those which are more coarse (Kenneth Samuel & Righteous, 2019).

Color is commonly and effectively used to encode information in the most application of scientific visualization (Das, *et al.*, 2015). Red, green, and blue are called primary components of RGB model and each of the components can have an arbitrary intensity from fully off to fully on, RGB also produces secondary colors formed by the additive blending (Cao, *et al.*, 2015). The use of frequency decomposition color blending has become commonplace in the analysis of stratigraphic formations from 3D seismic data (McArdle and Ackers, 2012). This paper used Red-Green-Blue (RGB) color blending to see the distribution of "S" sand. The time-frequency data that we obtained from spectral decomposition then being applied as RGB Blending using 15 Hz as Red, 45 Hz as Green, and 75 Hz as Blue (Figure 5).

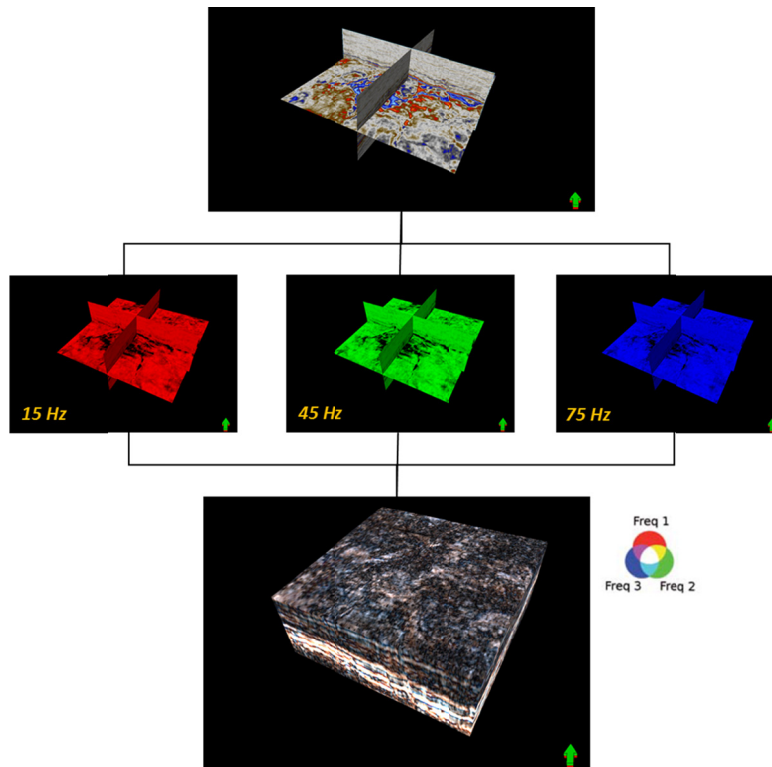


Figure 5. RGB Blending workflow

RESULTS

Reservoir target zone, “S” sand, is shown by a low gamma-ray log, then the appearance of cross over pattern between density (RHOB) - neutron porosity (NPHI), and high value of resistivity also indicate the target contains hydrocarbon, occurred at well W-1 has 15 meters thickness and 1,025 meters depth. Prior to interpreting the top horizon of “S” sand, well-seismic tie performed between seismic data and well W-1, resulting that “S” sand is located at 1,056 ms (Figure 6). The time structure of “S” sand is shown in Figure 7

where the area with orange to red color (1,500 - 1,600 ms) has a higher elevation than blue to purple area (2,300 – 2,500 ms).

Based on the spectral decomposition results, it is seen the three spectral decomposition results reveal channels and fault better than the seismic data default (Figure 8). Spectral decomposition results shows different image at the 1,056 ms time slice, there is channel that are seen better at low (15 Hz) frequency (Figure 9), and another channel better seen at medium (45 Hz) (Figure 10), or high (75 Hz) frequency (Figure 11). The result of spectral decomposition is diverse

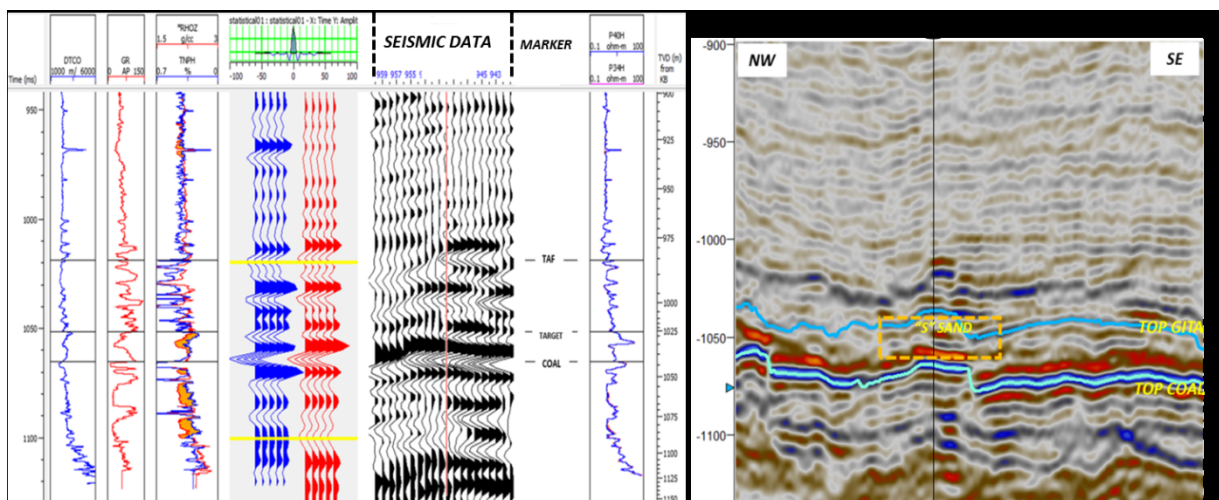


Figure 6. Well seismic tie window and the location of “S” sand at seismic section

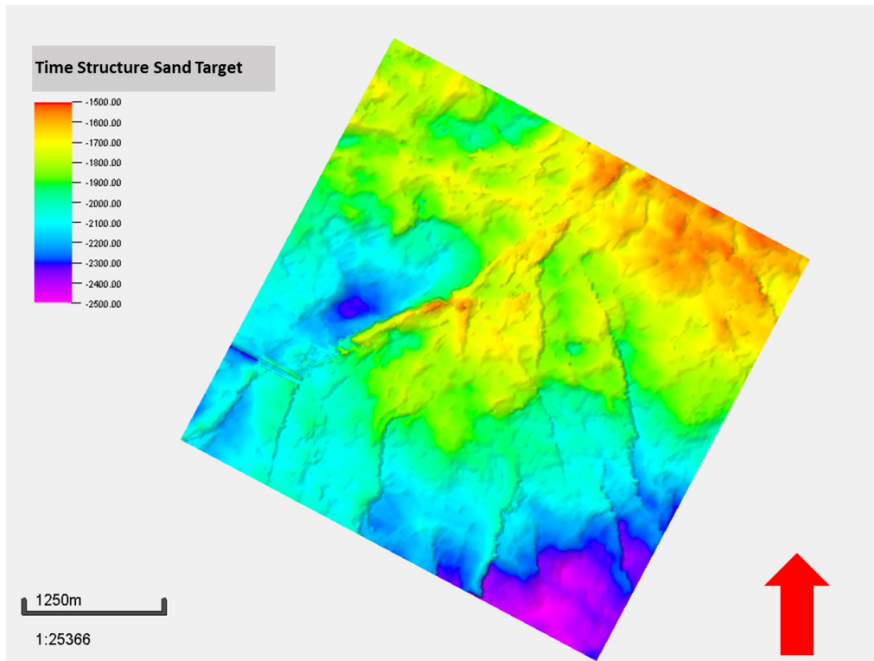


Figure 7. Time structure of "S" sand

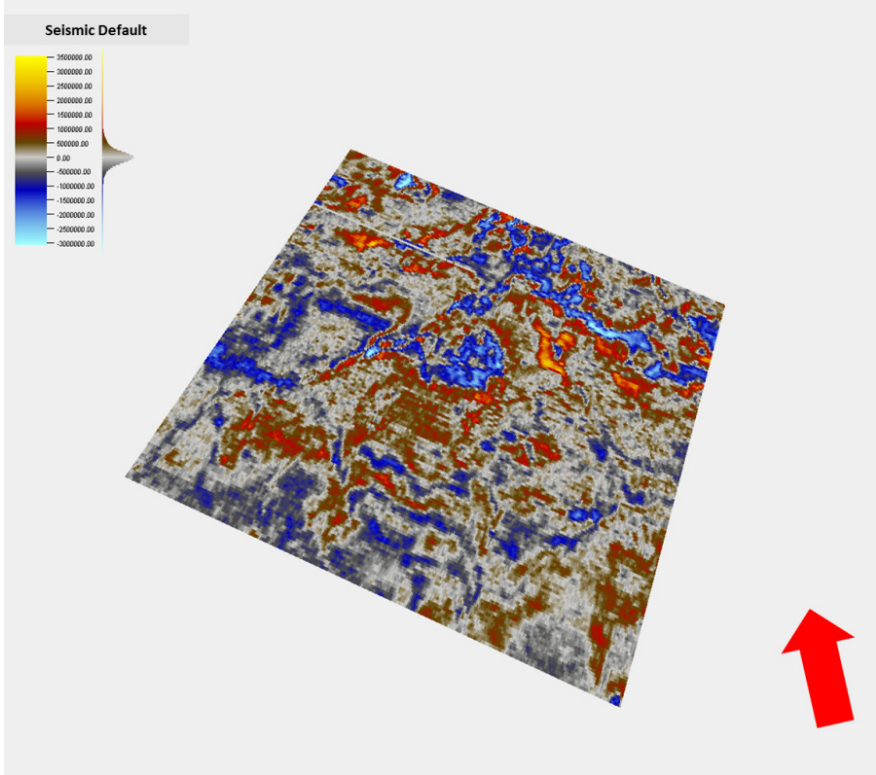


Figure 8. Seismic default at 1,056 ms

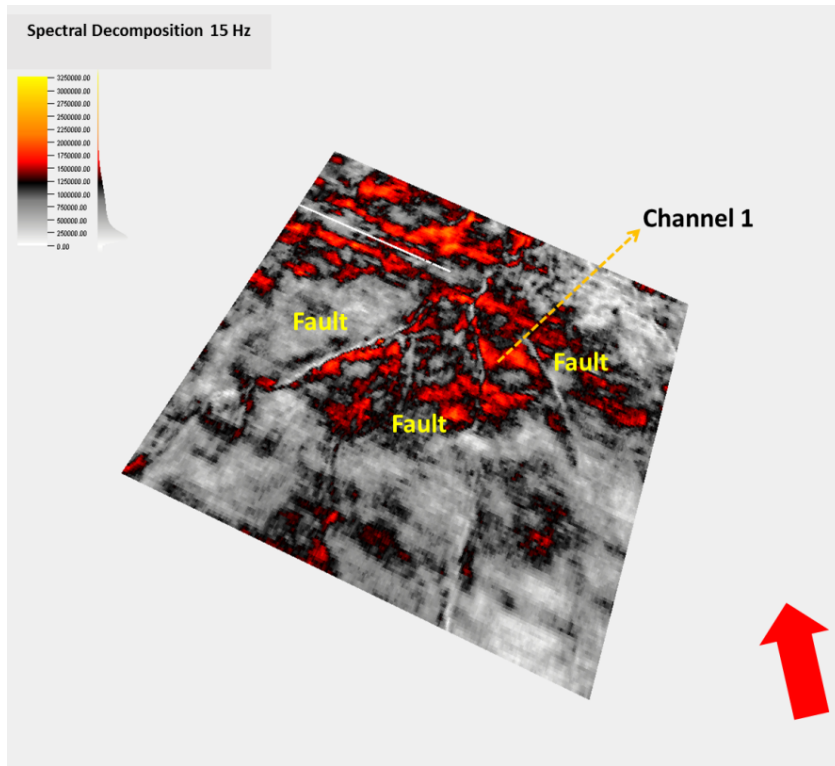


Figure 9. Spectral Decomposition (15 Hz) result at 1,056 ms

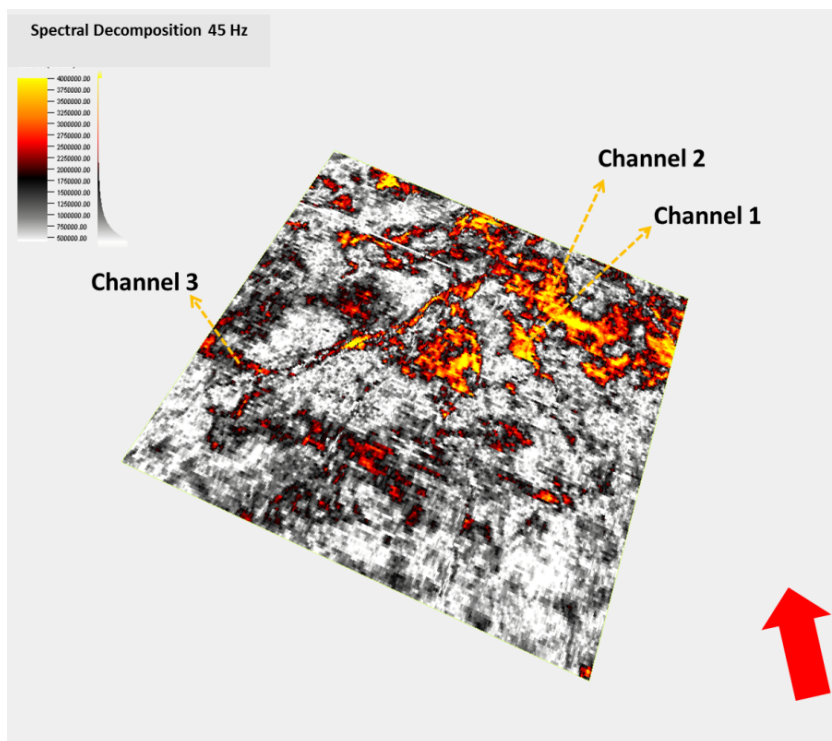


Figure 10. Spectral Decomposition (45 Hz) result at 1,056 ms

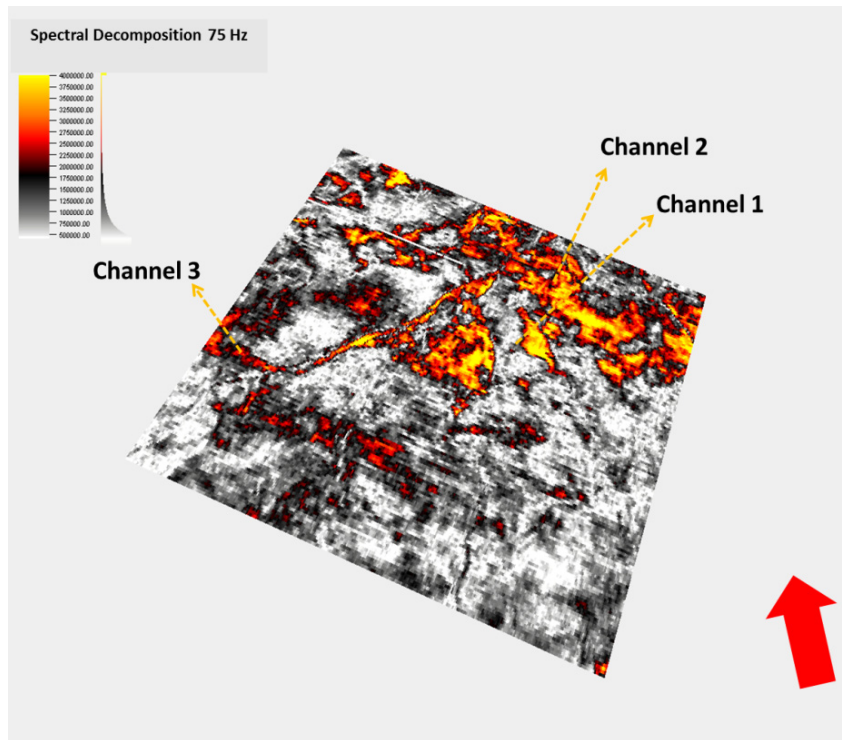


Figure 11. Spectral Decomposition (75 Hz) result at 1,056 ms

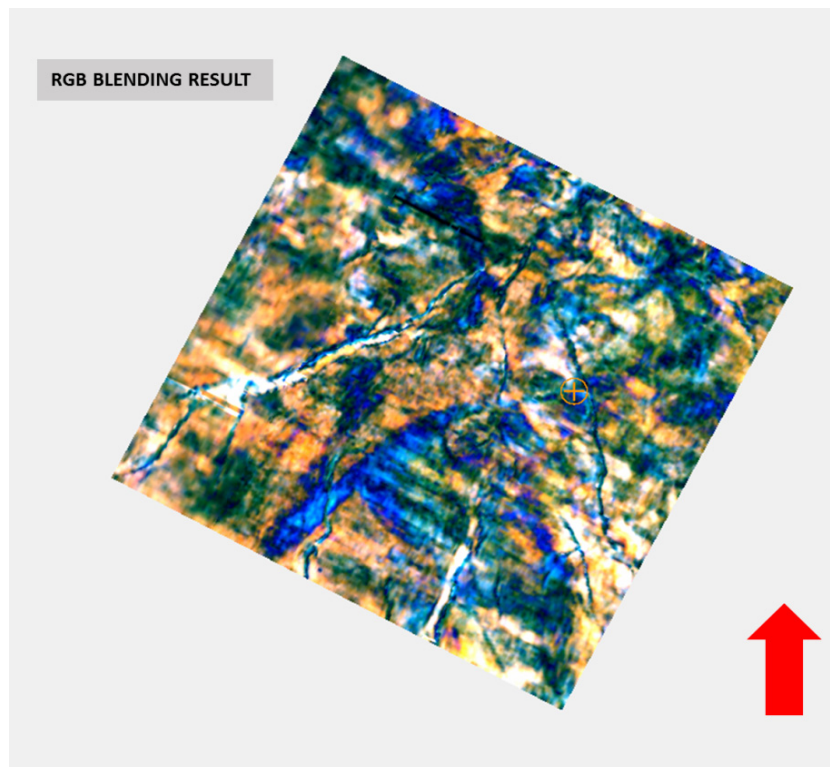


Figure 12. RGB Blending result at horizon "S" sand

caused by time-slicing method lead the appearance of several different channels.

Then the three different frequencies data would be merged and sliced on the "S" sand horizon. The result of slicing top horizon "S" sand from RGB Blending unveils the channel feature more clearly, the distribution of channel be indicated with blue color.

DISCUSSION

Gita member is composed of transgressive mudstones, shales, and coals and subordinate distributary and estuarine channel sandstones (Sukanto *et al.*, 1998). Among four sandstones depositional facies system sedimentation that exist on Gita member, based on gamma-ray log of W-1 it appears as fining upward pattern (Figure 13) it indicates our target,

(channel "S") is classified as a meandering channel system. It is also shown by brown dashed line on seismic section which through the channel "S" (Figure 14). Based on sequence-stratigraphic concepts, these meandering channels may be interpreted as having formed during sea-level rise after the preceding sea-level fall (Shanley and McCabe, 1994).

Spectral decomposition analysis is an important reservoir imaging tool that helps in delineating subtle geological features such as channels (Kenneth Samuel & Righteous, 2019). From the spectral decomposition result at top horizon "S" sand (Figure 16), the channel distribution pattern is seen better than at seismic default (Figure 15). Based on this result it's still couldn't depict the distribution of "S" sand clearly, it is caused the frequency is influenced by the thickness of the channel

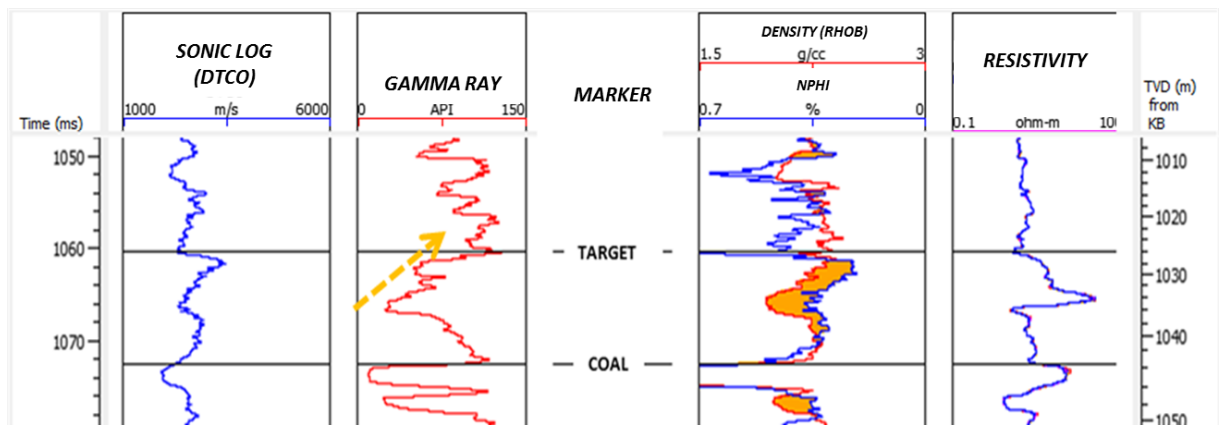


Figure 13. Fining upward pattern at W-1 gamma-ray log data

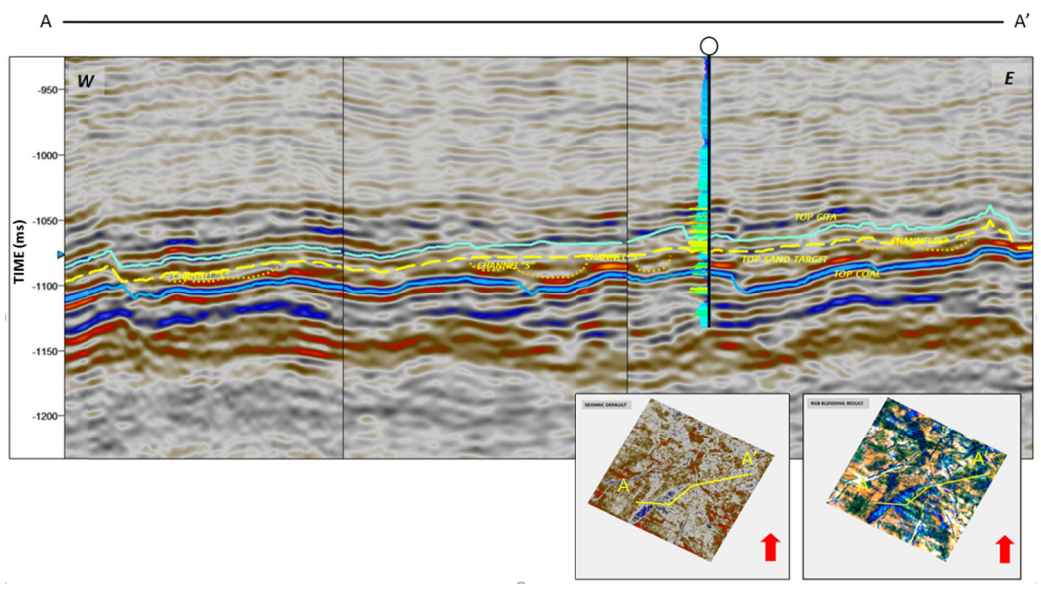


Figure 14. Profile line (yellow line at base map) at seismic default which through the channel "S"

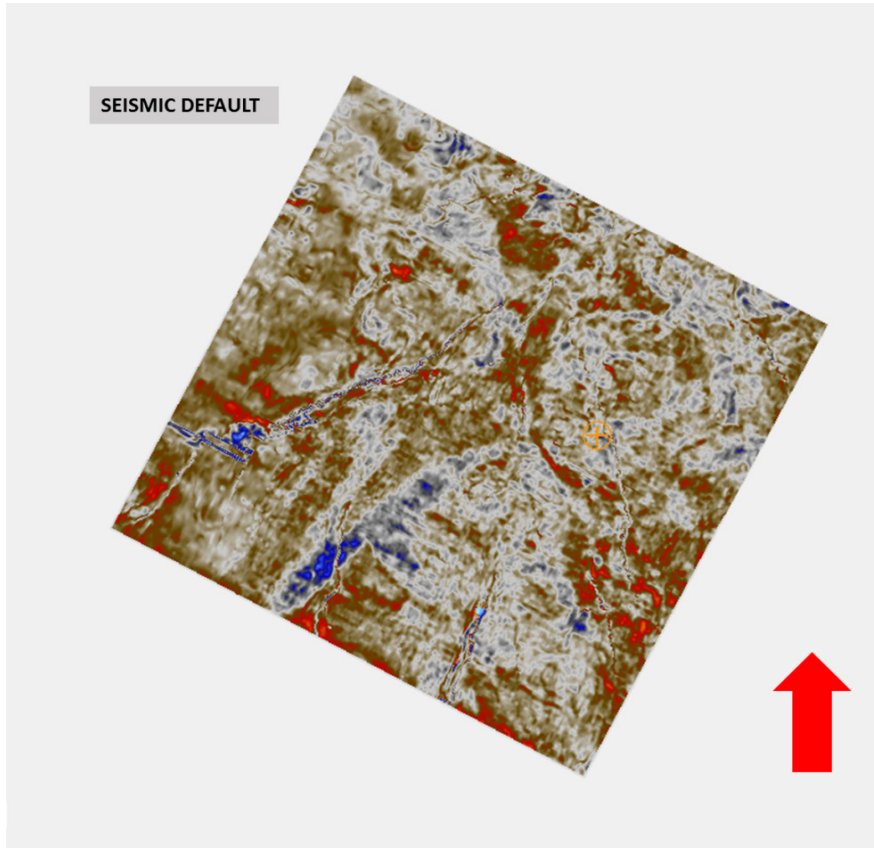


Figure 15. Seismic default at Top Horizon "S" sand

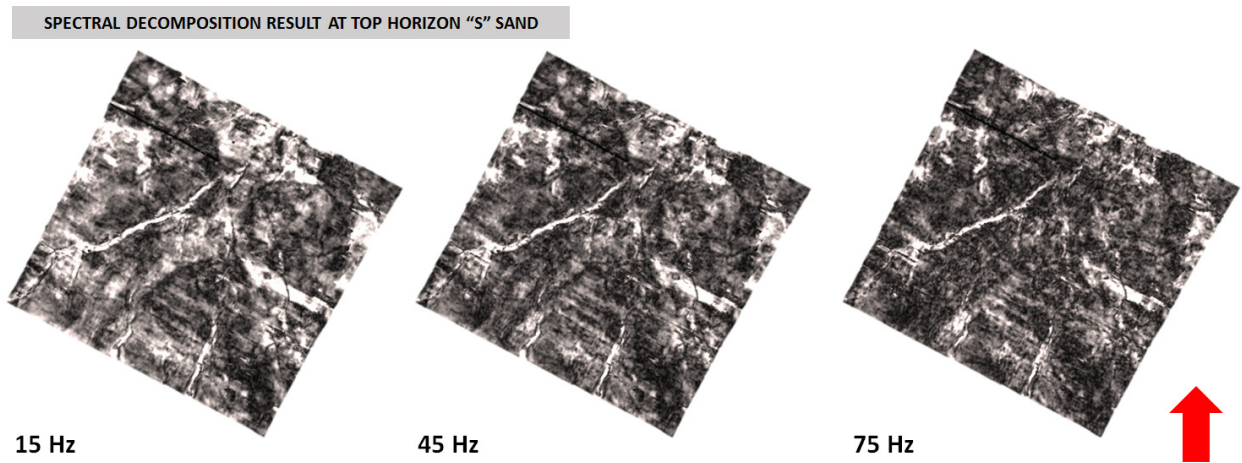


Figure 16. Spectral Decomposition result at Top Horizon "S" sand

which the higher the frequency used bring the higher resolution of the target.

The better result is shown by the RGB Blending which can give the distribution of “S” sand images more visible. The result is appear better because it has combined the information from low, medium and high frequency. From RGB Blending result, the channel “S” distribution is shown in blue color and marked by orange dashed line with the main channel direction of sedimentation is Northeast – Southwest.

resolution. Based on the dominant frequency, 15 Hz, 45 Hz, and 75 Hz frequencies were chosen.

Spectral decomposition and RGB Blending are enabled to reveal the distribution of channel “S” which from gamma-ray log (finning-upward pattern) and RGB Blending horizon slice indicates target is classified as a meandering channel system.

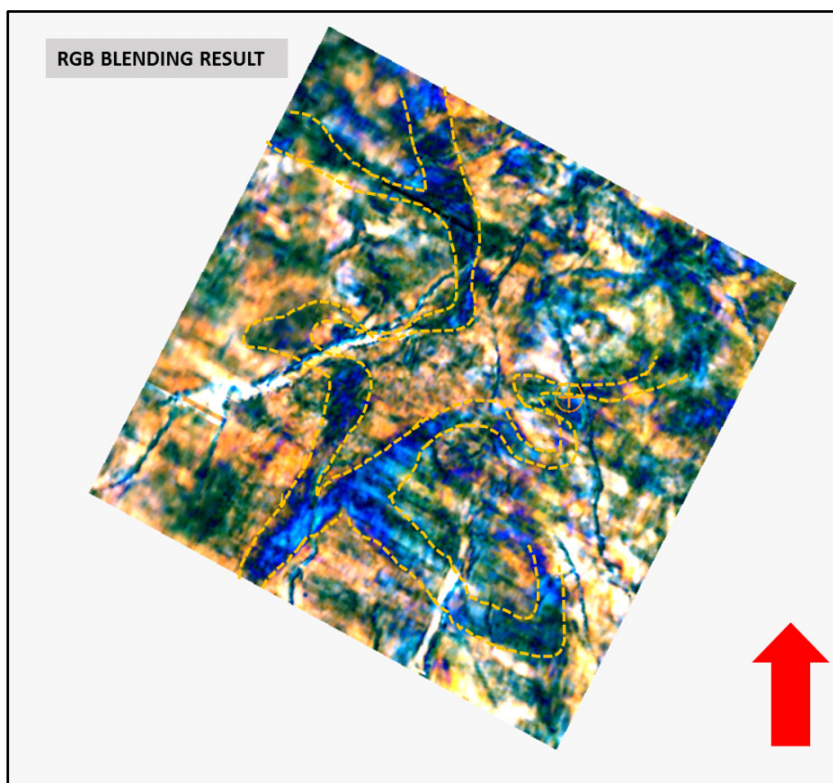


Figure 17. RGB Blending result at Top Horizon “S” the channel distribution shown by orange dashed line

CONCLUSION

The delineation of geological features such as channels has always been a challenge, especially for thin channels which are nearly invisible in default seismic data. Delineating these features are important to get more information about reservoir, in order to define depositional system and to delineate the distribution of our sand target reservoir and it’s useful for advanced purpose particularly in distributing other rock properties such as porosity and water saturation.

Spectral decomposition analysis and RGB Blending were carried out to delineate these thin sand reservoirs and reveal the channel features in better

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