Available online at:
Al-Fiziya: Journal of Materials Science, Geophysics, Instrumentation and Theoretical Physics
Website: http://journal.uinjkt.ac.id/index.php/al-fiziya
Vol.5 No. I Tahun 2022, 72 - 76

Evaluation Of Coal Distribution For Alternative Energy Using Seismic Spectral Decomposition

Praditiyo Riyadi [1,†], Arkanu Andaru[2]

[1]Physics Study Program, Faculty of Sciences and Technology, State Islamic University Syarif Hidayatullah Jakarta, Ir. H. Djuanda Street No.95, Cempaka Putih, Ciputat, South Tangerang, Banten 15412, Indonesia
[2]School of Computing, College of Engineering and Computer Science, Australian National University, 108 North Road, Acton, ACT 2601, Australia

[†]praditiyo.riyadi@uinjkt.ac.id

Submitted: September 2020; Revised: October 2021; Approved: June 2022; Available Online: Desember 2022

Abstract. Indonesia is the largest coal producer in the world, and Sumatera is one of the contributors to Indonesia's coal production. Coal is generally widely used for industrial fuel or power plants with production directly on the surface. The technology to develop coal into alternative energy sources (Coal Bed Methane (CBM) & Underground Coal Gasification (UCG)) began to develop with various production methods in the earth without having to be exploited directly. To apply this production method, it is necessary to analyze the distribution of coal below the earth's surface. The research area is located in the South Sumatera Basin with coal targets in the Muara Enim Formation. The data consists of 3D seismic data and well data as validation. From the well data, it was identified that there was coal in two zones, with an average thickness in Zone A reaching 6 meters while in Zone B the average thickness reaching 11 meters. The results of the amplitude spectrum analysis from the seismic data, obtained three dominant frequency trends from seismic data, 26 Hz, 42 Hz, and 58 Hz. By using the calculation of ¼ wavelength, the frequency that matches the thickness of the coal is 58 Hz for Zone A and 42 Hz for Zone B coal layer. Seismic amplitudes are then separated based on their frequency using the Spectral Decomposition method, and the distribution of coal is validated with existing well data.

Keywords: *Coal, Alternative Energy, Frequency, Spectral Decomposition, South Sumatera Basin*

DOI: *10.15408/fiziya.v5i1.26670*

INTRODUCTION

Coal that was originally a mining commodity began to be utilized for unconventional energy that can be used in the long term. Coal Bed Methane (CBM) and Underground Coal Gasification (UCG) is a method used to obtain alternative energy from the coal [1]. South Sumatra Basin has is one of the larges potential coals in Indonesia, as for the coal bearing formation in this basin is Muara Enim formation [6]. Muara Enim formation deposited in sallow marine to parallic and non-marine environments [4]. This formation consists of claystone's and shales intercalated by sandstone and coal layer (Figure 1). On other hand, based on analysis of well and seismic data, divided Muara Enim

P-ISSN: 2621-0215, E-ISSN: 2621-489X

formation into two depositional packages: Lower and Upper Muara Enim formation, These two depositional packages consist of three sub-environments, they are tidal mud flat, tidal mixed flat and tidal sand flat environment [12]. Knowing the distribution of coal for unconventional energy targets is an important step, in which the objective is to maximize production in the case of CBM and reduce the level of hazard in the case of UCG method in the target field [13][15]

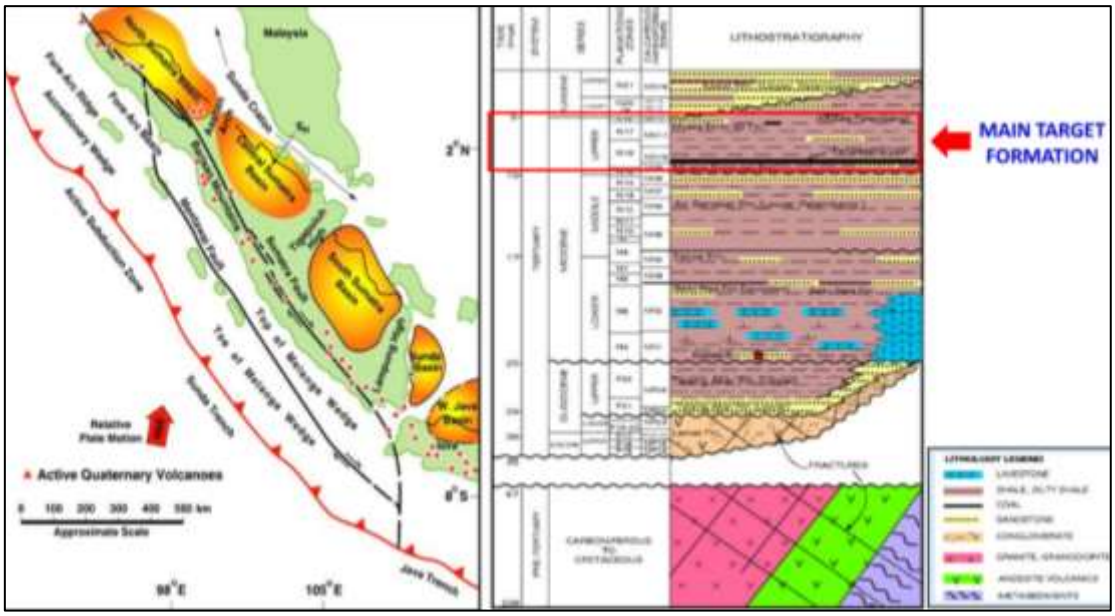

Figure. 1 Regional stratigraphy of south sumatera basin (Heidrik & Aulia, 1993)

Spectral decomposition is a method of signals processing on the seismic data [2][3]. By utilizing frequencies in seismic data, spectral decomposition is useful to distinguish the lithology of the target area vertically and laterally on the seismic data [5]. The lateral coal distribution analysis will provide geologically useful information, thereby increasing success for unconventional energy exploration on the target field [11].

DATA AND METHOD

There are 10 wells that reach the coal target, and the well data is used for the validator. The target consists of two layers of Zone A coal and Zone B coal.

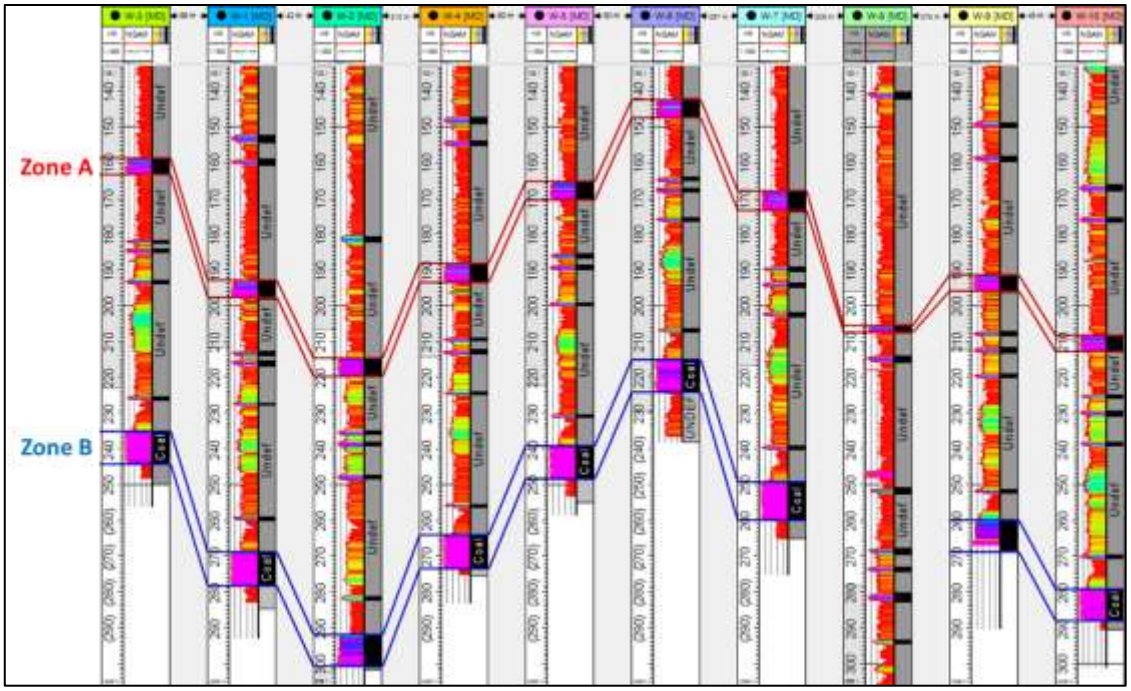

Figure. 2 Coal zone in the well correlation of study area

Coal thickness in Zone A reaches an average thickness of 6 m, whereas in Zone B coal reaches an average thickness of almost 11 m. From the result of correlation of 10 wells directed NW - SE in the study area visible thickness of coal that is consistent from Zone A and Zone B (Figure 2). There are 10 wells that reach the coal target, and the well data is used for the validator. There is also 3D seismic data in this research area, but need to do the data conditioning first in order to reduce the high frequency noise contained in the data [10][14]. The method used for conditioning is the Dip-Steering Median Filter (Figure 3). There are 10 wells that reach the coal target, and the well data is used for the validator.

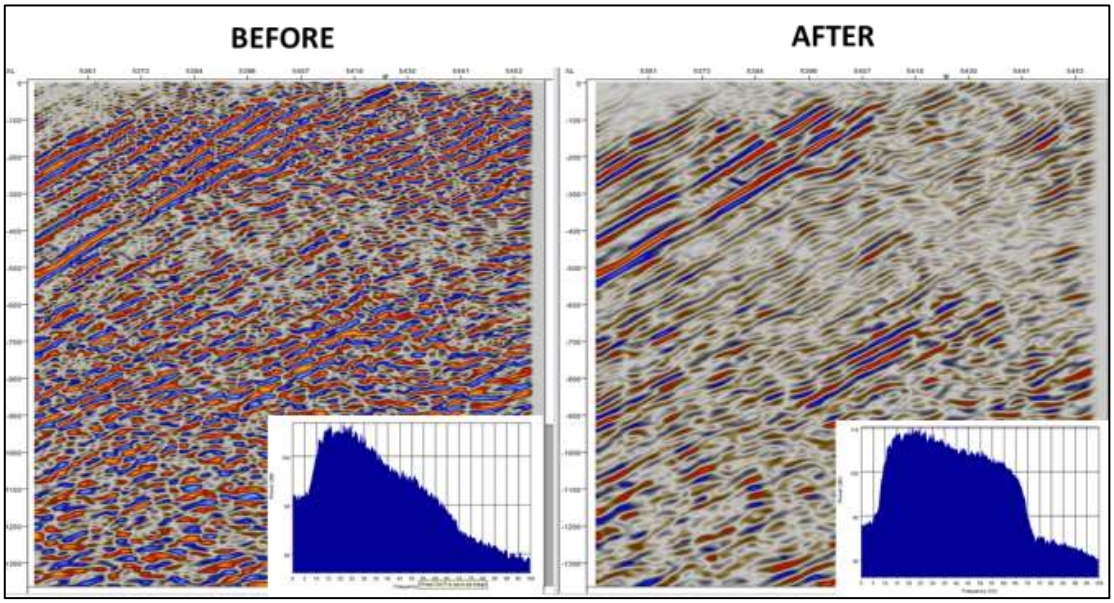

Figure. 3 Seismic 3D on target area before (left) and after (right) conditioning

There are various methods of spectral decomposition such as Short Time Fourier Transform (STFT), Continuous Wavelet Transform (CWT), and Hilbert-Huang Transform (HHT) [7], but in this research will be used continuous Wavelet Transform (CWT) method. The CWT method is principally to find a match of the input signal / wavelet provided with the seismic data, that is by stretch and squeeze (scaling) the input signal and correlate all the time to the seismic data [8][9].

RESULTS AND DISCUSSIONS

From the results of depositional coal in the target area is Muara Enim formation on Zone A and Zone B coal. Based on correlation log depositional environment the target area is lacustrine. Based on seismic and well data, trend coal structure of Zone A and Zone B is homocline structure. Amplitude spectrum analysis on the seismic data used in the target area of research, obtained of three different frequencies on the coal targets area (Figure 4). These three frequencies are generated from three maximum amplitudes in the target area (Zone A and Zone B). Using tuning thickness analysis of ¼ wavelength, the distance of the seismic scope in the vertical limit is 5.46 m at 58 Hz frequency, 9.87 m at 42 Hz frequency and 15.52 m at 26 Hz frequency. So that the value of seismic resolution that is close to the thickness of coal in Zone A which has an average thickness of 6 meters is 58 Hz, and in Zone B with an average thickness of 11 meters is 42 Hz. Spectral decomposition seismic attributes were distributed using a frequency of 58 Hz for Zone A and 42 Hz for Zone B coal zone. Strong amplitude of the Spectral Decomposition Attribute results with a high value is the correlation of the sought coal thickness. It is clear that the distribution of coal in Zone A and Zone B is validated by well data (Figure 3). The result of the Spectral decomposition attribute indicates coal Zone A and Zone B direction SE-NW, which is the main direction of coal distribution.

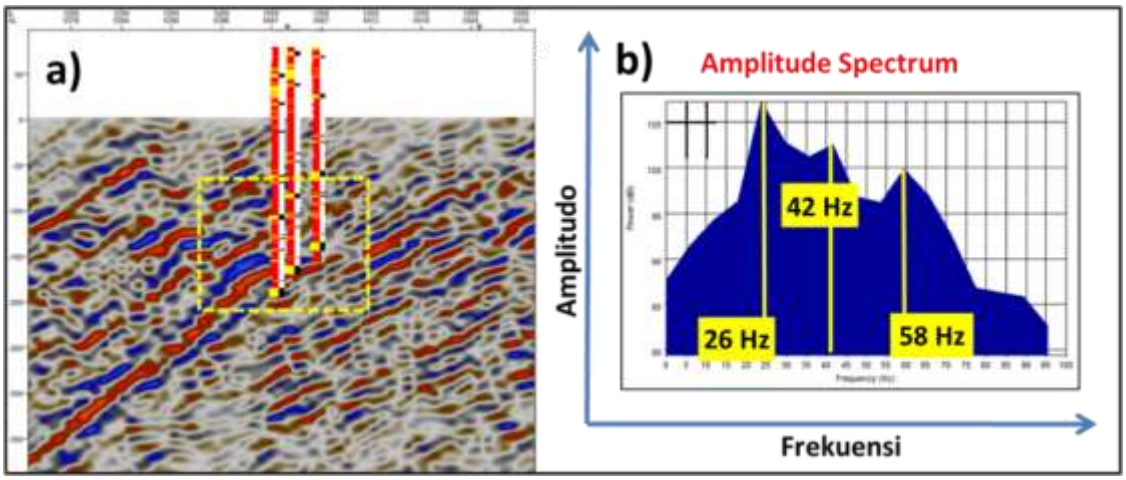

Figure. 4 (a) Area of interest in seismic (b) Seismic amplitude spectrum analysis

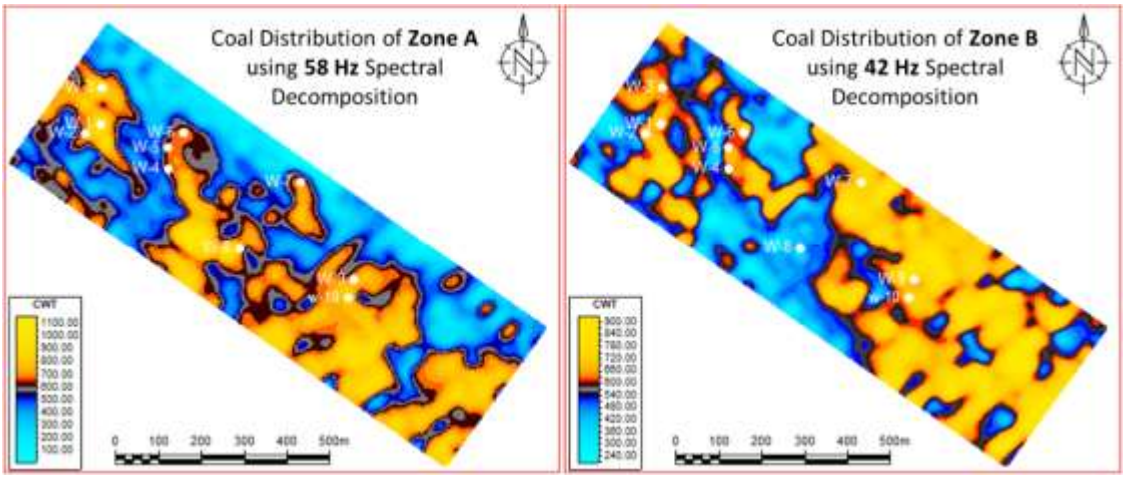

Figure. 5 Coal distribution (yellow to red) from spectral decomposition attributes at 58 Hz frequency in the Zone A (left) and 42 Hz frequency in Zone B (right)

CONCLUSIONS

Spectral decomposition method is very useful to see the distribution of coal in the target zone of Zone A and Zone B with a coal thickness around 6 to 11 m and the frequency of seismic data obtained to achieve the target zone thickness is 58 Hz for Zone A and 42 Hz for Zone B coal zone. Strong amplitude of the Spectral Decomposition Attribute results indicated by a high value is the distribution of coal which is validated by well data penetrating in the coal zone. There is a prospect area for new drilling on the Zone A and zone B coal zone in the South East of study area. This area of research is suitable for unconventional target energy methods such as CBM and UCG, due to the continuous expanse of coal extending towards the NW-SE.

REFERENCES

[1] APEC Secretariat, 2013, APEC Energy Demand and Outlook 5th Edition, Asia Pacific Energy Research Centre, Institute of Energy Economics, Japan.
[2] Castagna, John, and S. S, Comparison of spectral decomposition methods. First Break, 2006: p. 75-79.
[3] Chopra, S. and K.J. Marfurt, Spectral decomposition and spectral balancing of seismic data. The Leading Edge, 2016. 35(2): p. 176-179.
[4] Kurniawan, Erlangga., et al., 2020, Estimasi Sumberdaya Underground Coal Gasification (Ucg), Daerah Banjarsari, Tanjung Enim, Sumatera Selatan, Prosiding TPT XXIX PERHAPI 2020.
[5] Lapins, Sacha., et al., 2020, An examination of the continuous wavelet transform for volcano-seismic spectral analysis, Journal of Volcanology and Geothermal Research.
[6] Muksin, N., et al., Regional Depositional environment model of Muara Enim Formation and its significant implication for CBM prospectivity in South Sumatra Basin, Indonesia. American Association of Petroleum Geologists, Search and Discovery Article, 2012. 80272.
[7] Ostrander, W. J. (1984); Plane-wave reflection coefficients for gas sands at nonnormal angles of incidence. Geophysics; 49 (10): 1637–1648.
[8] Russell, B. H. (1988). Introduction to seismic inversion methods (Vol. 2). Tulsa: Society of Exploration Geophysicists.

[9] Saputro, R. A., Suprajitno Munadi, and Humbang Purba, 2012, Spectral Filtering For Removing Coal Bright Spot Effect In Seismic Interpretation, Scientific Contributions Oil & Gas, Vol. 35. No. 3: 109 - 114
[10] Sheriff, R. E., & Geldart, L. P. (1995). Exploration seismology. Cambridge university press.
[11] Sinha, S.K., et al. Time-frequency attribute of seismic data using continuous wavelet transform. SEG Annual Meeting. 2003. Society of Exploration Geophysicists.
[12] Sitompul N., et al., 1992, Effects of Sea Level Drops During Late Early Miocene to The Reservoirs in South Palembang Sub Basin, South Sumatra, Indonesia, Proceedings of the Indonesian Petroleum Association, 21st, 309-324.
[13] Sugiyono, A., Permana, A.D., Boedoyo, M.S dan Adiarso, 2013, Outlook energi Indonesia 2013, Pusat Teknologi Pengembangan Sumberdaya Energi, Badan Pengkajian dan Penerapan Teknologi.
[14] Yilmaz, Ozdogan. (2001). Seismic Data Analysis: Processing, Inversion, and Interpretation of Seismic Data (Volume 1). Society of Exploration Geophysics. Volume 1.
[15] Zheng, Wenbo., et al., 2020, Study on the Coalbed Methane Development under High In Situ Stress, Large Buried Depth, and Low Permeability Reservoir in the Libi Block, Qinshui Basin, China, Advances in Civil Engineering, 10.1155/2020/6663496.