The Use of Novel Passive Seismic Method in West Java, Sub Jatibarang Basin

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Abstract. Recently, low-frequency passive seismic is commonly used as an alternative method for detecting the occurrence of hydrocarbons in the reservoir. Compared to active seismic, it has the advantages of providing indication of hydrocarbon occurrences with significantly lower budget and processing time. Low-frequency passive seismic method analyzes the peak signal with a frequency range of 1-5 Hz which indicates the presence of a prospective hydrocarbon reservoir. An extensive survey was carried out at 497 points in the Kandanghaur area, Sub-Jatibarang Basin, an oil and gas field in West Java. Three-component broadband borehole seismometer from Geobit was used to record the microtremor signals. One of the attributes used for analysis is Power Spectral Density (PSD) which will focus on the recorded signal on the vertical component and frequency at around 3 Hz. A calibration test showed promising measurement which reveal a high spectrum of peak amplitude near the production wells. It indicates that the passive seismic could be used a proxy of a good potential reserve indicator. From attribute map, we get a promising area to be develop outside the existing production area. Moreover, a high correlation value is generated between the attributes of passive seismic and hydrocarbon reserves of some proven wells. It highlights that passive attributes can be integrating as additional information to conventional methods such as active seismic data for location new drilling wells and can become another breakthrough of a proven hydrocarbon exploration method.
Keywords: Low-frequency passive seismic, Power Spectral Density

1. Introduction

Hydrocarbons are the main energy source that is widely used by the community. It is used for transportation, power generation or chemical derivative products. However, before it can be processed at the refinery, the hydrocarbons must first be extracted from subsurface at a location that has enormous hydrocarbon reserves. To find these locations, several methods are needed, one of them is seismic exploration. This method uses the principle of reflected waves generated by a source (dynamite, vibroseis) and received by a receiver (geophone). This survey usually takes a long time and expensive. Therefore, in this study, a method that could be an alternative to conventional seismic methods was utilized. Low-frequency passive seismic is a method that records natural waves from the earth in the frequency range of 1-6 Hz. This method has been quite successful in detecting the presence of hydrocarbons [1] and can be an additional analysis if it is integrated with active seismic methods. This method will be applied in the Sub Jatibarang Basin, West Java. The basin is quite proven with several fields that have been producing since the 1900s, starting from the Cisubuh Formation to the Jatibarang Volcanic. The hope is that the results of the analysis can locate new prospective area and determine new well to drill.

2. Data and Methodology

Sub Jatibarang Basin is in the Onshore Northwest Java Basin. This formation consists of Cisubuh, Parigi, Upper Cibulakan, Baturaja, Talangakar and Jatibarang Volcanic Formation deposited from Eocene to Miocene. This research located in Kandanghaur High where the rock is a deposition of thick shale with intra thin sandstone and limestone.

Low-frequency passive seismic is a variation of the commonly used passive seismic method. On this method we focus only for low frequencies spectrum with a range of 1-6 Hz. Measurements were carried out across 7 districts which consist of 497 points. The tool used comes from Geobit with specifications that can record three wave components, vertical (z) and horizontal (x and y) directions. The measurement method is to make a hole as deep as 300 mm and place the tool inside with the purpose of reducing noise on the surface. Measurements were carried out for 1 hour. Before site measurements,

the tools are always calibrated every day at the basecamp so that there are no wrong measurements. After the measurement, the data will be processed and then it will be interpreted where the area has the potential for hydrocarbon accumulation.

Figure 1 shows the flow of this research with the following explanation:

1. Acquisition is done by recording 3 natural wave components
2. Perform a noise filter to prevent misinterpretation at a later stage. The noise that is commonly eliminated is noise in the 4-5 Hz range generated by human activities on the surface [2] and noise in the 10-40 Hz range generated by natural conditions [3]
3. To separate data and noise, an automatic windowing process is used
4. To get the frequency content on the wave, a process called Continuous Wavelet Transform is carried out. This method uses the principle of spectral decomposition in which there are dilatation and translation algorithms
5. There are two passive seismic attributes that will be used for interpretation, namely Power Spectral Density Impedance Z (PSD-IZ) and PSD-3 Hz. These two attributes both analyze the amplitude value of the vertical component wave. The difference is that the PSD-3 Hz attribute only focuses on the amplitude value at a frequency of 3 Hz, while PSD-IZ integral the amplitude values between the frequencies of 1.5 – 4.5 Hz

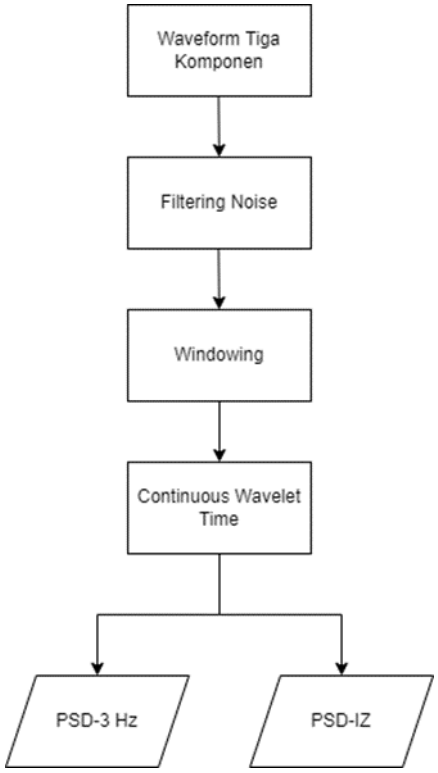


Figure 1. Low-Frequency Passive Seismic Processing Workflow

3. Results and Discussion

Figure 2 shows the measurement results near the KHT-07 well. Also displayed in bottom left is the result of the spectral attribute for the vertical component. The amplitude value of PSD-IZ is 85 and PSD-3 Hz is 141. This value is quite high, which means that there is potential for hydrocarbons near the well.

To validate the seismic passive attribute used to see the potential for hydrocarbons, a cross plot is carried out between the two attributes. Figure 3 (left) shows the horizontal axis is the reserve value of each well while the vertical axis is the PSD-3 Hz amplitude value measured in these wells. The correlation value is about 0.75. The same thing is also done in Figure 3 (right) which shows the correlation between the reserve value and the PSD-IZ attribute. The correlation value obtained is 0.87. A value close to 1

indicates a good correlation between the two. It can also be interpreted, the greater the attribute amplitude value, the greater the hydrocarbons reserves.

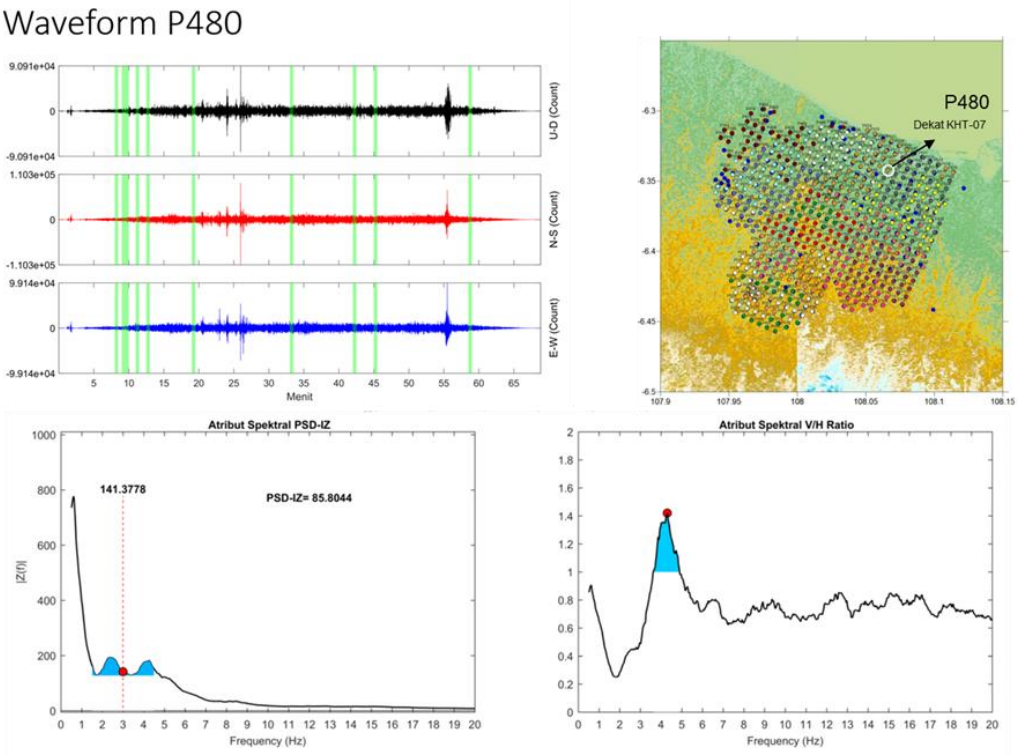


Figure 2. Waveform and attribute spectrum of PSD-3 Hz and PSD-IZ on P480 measurement

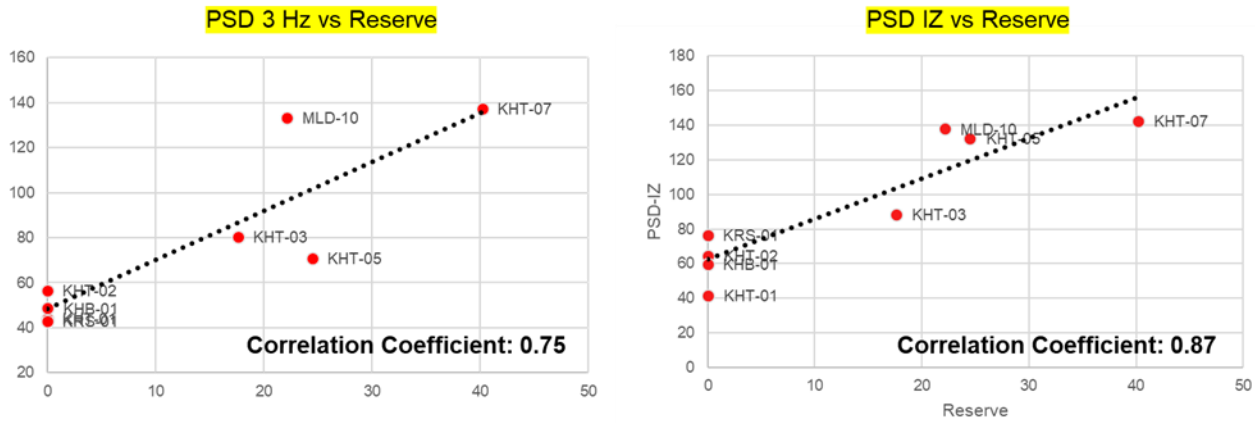


Figure 3. Cross plot between PSD-3 Hz and reserve (left) PSD-IZ and reserve (right) show high correlation coefficient

Figure 4 (above) shows the PSD-3 Hz attribute map in the Kandanghaur study area. A high value is indicated by a red color. The potential area is near the KHT-07 well which show bright area. The PSD-IZ values range from 120 to 180. A consistent picture is also seen in Figure 4 (bottom) which shows the PSD-3 Hz attribute map where the high value is near the KHT-07 well.

Meanwhile, we also carried out an evaluation involving sonic logs in the wells of the study area to predict the depth that produced anomalies in the previous attribute. We called this method as Fingerprint Amplitude which showed in Figure 5. Roughly speaking, the reservoir that gives the anomaly response comes from the Upper Cibulakan formation. Based on the evaluation, there are several reservoir layers in the formation that have the potential to be further developed. This is in line with the conditions in the field based on the results of production in the layers of the Upper Cibulakan formation.

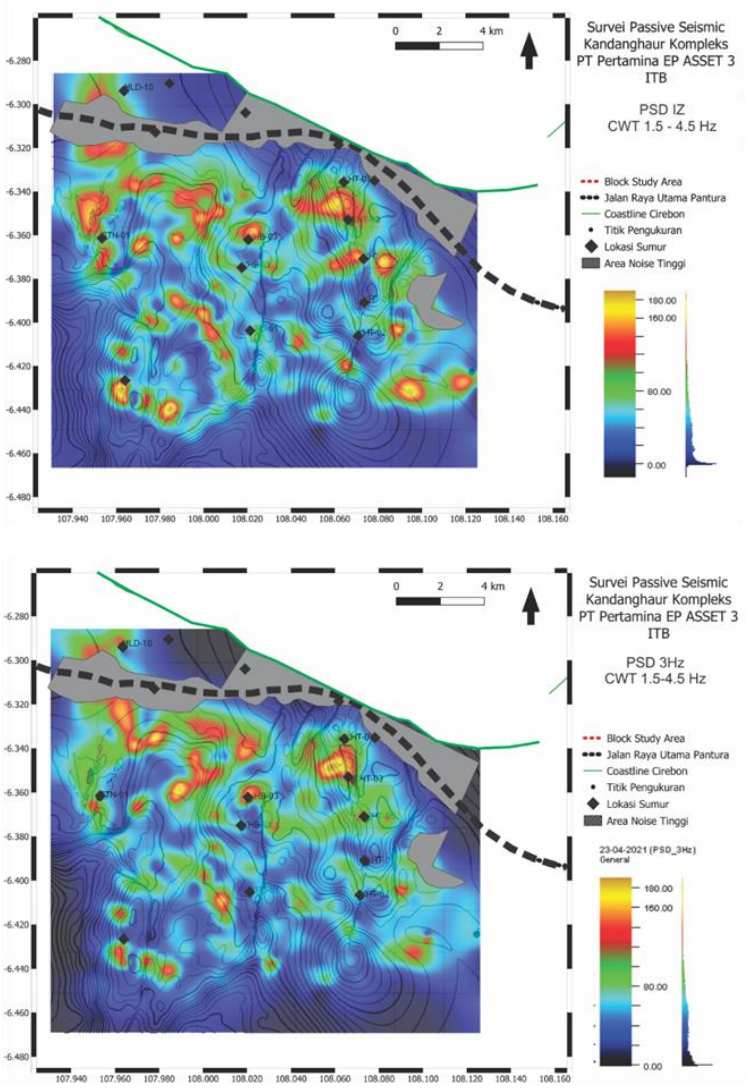
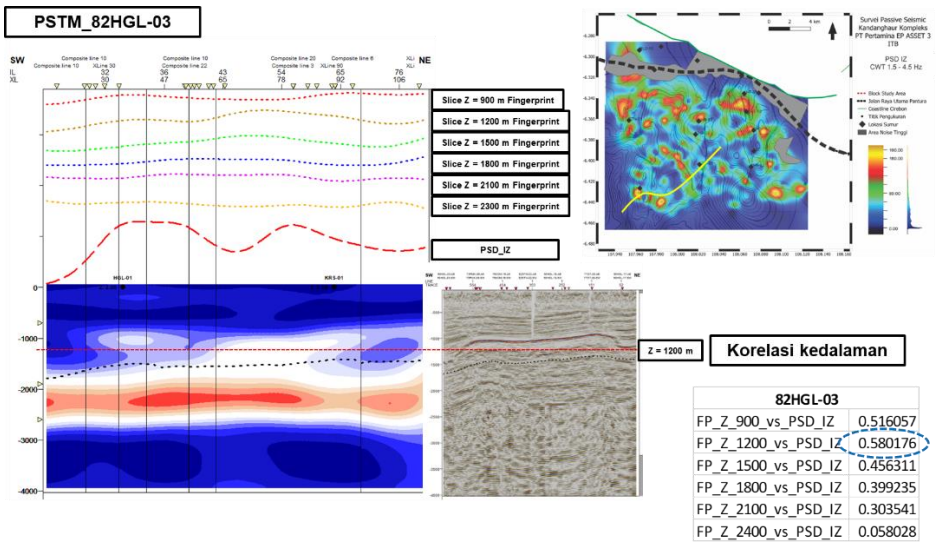


Figure 4. PSD-IZ attribute map (top) and PSD-3 Hz attribute map (bottom), which show good potential area indicated by the red color



82HGL-03	
FP_Z_900_vs_PSD_IZ	0.516057
FP_Z_1200_vs_PSD_IZ	0.580176
FP_Z_1500_vs_PSD_IZ	0.456311
FP_Z_1800_vs_PSD_IZ	0.399235
FP_Z_2100_vs_PSD_IZ	0.303541
FP_Z_2400_vs_PSD_IZ	0.058028

Figure 5. Fingerprint Amplitude – Depth Profile from one of the sections in area of study

4. Conclusions

This study shows an interesting zone based on the resulting passive seismic attributes located near the KHT-07 well. High value of amplitude can be indicated there are hydrocarbon potential in that area. This is also confirmed by the sufficient reserve value in the well by using previously geomodelling volumetric calculation. Furthermore, this method can be integrated with seismic data that has been analyzed to determine further development wells.

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