Deployment Porosity Estimation of Sandstone Reservoir in The Field of Hidrocarbon Exploration Penobscot Canada

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Abstract— Porosity is defined as the percentage of empty spaces for storing fluid contained in rock.. Porosity becomes one of the requirements for determining reservoir which is good or bad. Porosity can be obtained from the seismic data has been acquired and processed previously; to obtain porosity from seismic data it is necessary determine an acoustic impedance value first. Acoustic impedance and porosity can be obtained by using deterministic inversion and neural network. Deterministic inversion operates in minimizing the difference between the acoustic impedance inversion results with the original. Deterministic inversion is part of the model-based inversion. The result of the inversion showed a correlation of 0.8 on a scale of 0-1. This result can be categorized a good inversion. Then acoustic impedance volume converted into volume porosity by using neural network. Neural network method showed a value of 0.2 for the difference between the acoustic impedance volume and volume porosity. The result of deterministic inversion and neural network method were the value of the distribution of porosity in the reservoir sandstone ranges from 13% to 23%

Keywords— Porosity, acoustic impedance, deterministic inversion, seismic

INTRODUCTION

Exploration of oil and gas activity which plays important role to maintain reserves of oil and gas and for preventing derangements of production. Oil and gas are the conversions of organic compounds that have been accumulated over millions of years. These hydrocarbon compounds will be migrated and stored in Perforated rocks called the reservoirs. Requirement of rock that would be a good reservoir is have the ability to accommodate and circulate the fluid contained within. It is expressed as porosity and permeability. Porosity is expressed as the ratio between the volume of empty space with the entire volume (or bulk volume) of material. In a hydrocarbon reservoir, an empty space is a place of accumulation and retention of waters, oils and gasses. Porosity usually expressed as a percentage of the volume of a material, such as an empty volume divided by the volume of the entire material, multiplied by 100[1].

In this research will discuss how the estimated distribution of porosity sandstone reservoirs in the mississauga formation that obtained using the deterministic inversion and neural network. The form of distribution to be estimated is the percentage of porosity which is owned by sandstone reservoirs. Furthermore, the percentage of proceeds will be used to determine the porosity quality of sandstone reservoirs.

METHODS

a. Tools and Materials

This research was conducted from March to August, 2016 which took place in the laboratory of computing, physics department, faculty of Mathematics and Natural Sciences, University of Jember. This research uses software opendtect, with seismic data and well data derived from the seismic survey data from the field Penobscot, Canada that published by opendtect.org under license from CNSOPB. The seismic data being used is the data type 3D seismic post stack time migration and well log data used is data from the L-30 wells which include sonic logs, density logs, Data marker and data checkshot.

b. Data processing

This research was conducted by inserting seismic data, well data and Data marker on opendtect software. Focus of the research is on missisauga formation at depths of 2251.3 meters to 3190.4 meters below sea level. After all necessary data are entered, wavelet extraction process will be performed. then wavelet extraction do convolution with the reflection coefficient for making synthetic seismic tras. Tras synthetic contain information of wells data , and then correlated with the original seismic tras in the process of seismic well tie. Well log data is data that has the depth domain, while the seismic data has the time domain. The process of seismic well tie aided by checkshot the data to get high correlation. In this research, the correlation obtained from the seismic well tie was 0.7 on a scale of 0 to 1. Then picking horizon at the top of the formation of Missisauga at a depth of 2251.3 m and the bottom of Missisauga Formation at a depth of 3190.4 m. After that create initial model by using horizon that has been created and acoustic impedance from well log L-30. Initial models have been produced and then do inversion with deterministic inversion method to determine the acoustic impedance distribution map. To obtain porosity distribution maps of distribution maps the acoustic impedance can be accomplished by using the neural network

RESULTS AND DISCUSSION

a. Initial Model Analysis

The initial model is formed based on the selected horizon and the well data that is used in the inversion process. wells data will provide geological information from every horizon that has been made, afterwards, the geological information by the wells data will be spread over the whole horizon until a predetermined threshold. In this research, distributed geological information is the acoustic impedance values which would then be used to obtain porosity values. Distribution of acoustic impedance value to areas far from the location of the well, will be assisted with the analysis of the vertical and horizontal variogram. the range obtained from the vertical variogram analysis is 31 ms, while the range for the horizontal variogram is 1240.6 m for the distribution based on the direction of inline and 996.7 m for the direction of crossline. Figure 1 represents initial model for deterministic inversion.

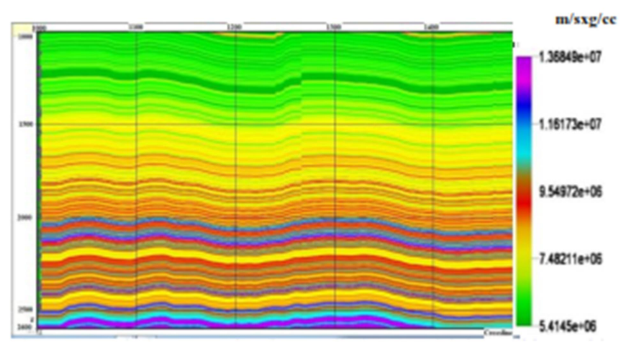

Figure 1. Vertical cross-section for a preliminary model that will be used in the inversion process

b. Deterministic Inversion Analysist

Deterministic inversion generate cross-sectional model of the acoustic impedance and capable of distinguishing the acoustic impedance zones based on the color and scale of acoustic impedance value. Zones with the lowest

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impedance shown by the green color with a value of 5414500 $\frac{m}{s} x \frac{g}{cc}$ which dominates the upper part of the formation of Missisauga, while zones with highest impedance shown by the purple color with a value of 13684900 $\frac{m}{s} x \frac{g}{cc}$ which dominates the lower part of the formation of Missisauga. Value of the of acoustic impedance inversion results show that formation of Mississauga consists of sandstone. This result matched as mentioned by Nasmy[2] that the sandstone layer has an acoustic impedance value above 3810 $\frac{m}{s} x \frac{g}{cc}$. Inversion process on seismic data need quality control to find out that the obtained model able to be used to map out the porosity of the reservoir sandstones. The results of inversion can be controlled through the correlation of crossplot between acoustic impedance of the deterministic inversion with acoustic impedance of the well data L-30. Correspondence between acoustic impedance inversion results with acoustic impedance of wells L-30 is shown by the correlation results of crossplot by 0.8 on scale of 0 to 1. This correlation is quite good. acoustic impedance distribution maps created by applying the inversion results on the horizon. That horizon is upper part horizon of the formation Missisauga, because low acoustic impedance that indicates high porosity dominate upper part of the formation Missisauga. Based on the acoustic impedance map in Figure 3, it can be seen formation of Missisauga' have a zone of high acoustic impedance and low acoustic impedance. Zone of high acoustic impedance scattered on Southeast, East, Northeast and North zone of formation of Missisauga with a range of values 10000900 $\frac{m}{s} x \frac{g}{cc}$ to 11303100 $\frac{m}{s} x \frac{g}{cc}$ and zone of low acoustic impedance spread in the Northwest, West, Southwest and South zones with a range of values 6094120 $\frac{m}{s} x \frac{g}{cc}$ up to 8698620 $\frac{m}{s} x \frac{g}{cc}$. Because the value of acoustic impedance for sandstone reservoirs is more than 3810 $\frac{m}{s} x \frac{g}{cc}$, it can be considered a reservoir sandstone scattered throughout the formation of Missisauga.

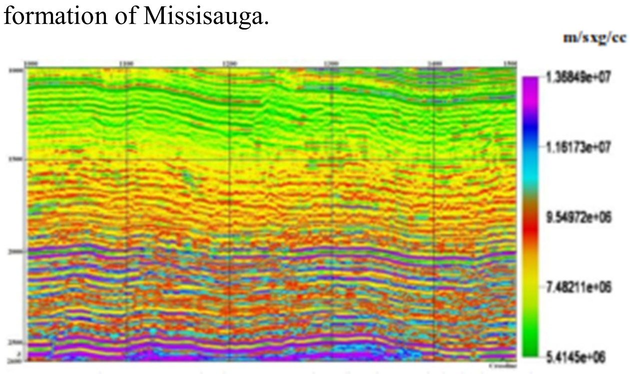

Figure 2. Vertical cross-section for deterministic inversion

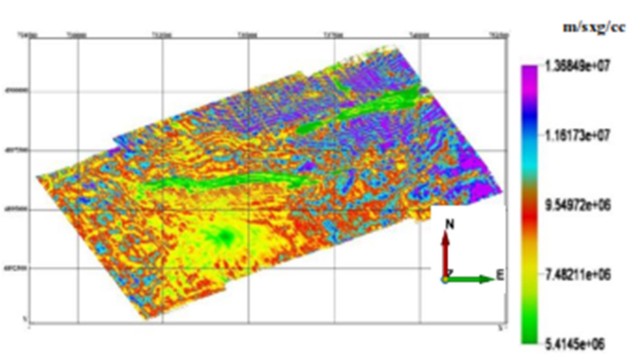

Figure 3. Acoustic impedance map for Formation of Missisauga

c. Neural Network Analysist

Porosity distribution maps could be obtained by applying the method of neural network in the selected horizon. This research use a supervised neural network to determine the relationship between the volume of the acoustic impedance inversion results obtained from the porosity.Total error obtained from the neural network is 0.2. The range of error from the neural network is 0 for no error and 1 for a maximum error[2]. Final map obtained is maps the distribution of acoustic impedance and porosity maps, both maps showed similar results. Both show that smaller the acoustic impedance, the porosity will be even greater, while the greater the acoustic impedance shows that the smaller the porosity.Based on these maps can be obtained information on the Southeast, East, Northeast and North dominated by the high acoustic impedance which means it has a low porosity with a range of porosity values of 13% to 18%. In the Northeast there is a porosity value of 23%.This area can be used as a reference for developing new wells. In the area of Northwest, West, Southwest to South dominated by high porosity, with a range of values between 19% to 23%.The area near wells L-30 also has a high porosity value with the value of 23%. The percentage of of porosity is obtained by multiplying the scale of porosity, which is shown in Figure 4 to 100%. According Koesoemadinata[4], porosity values by 23% is excellent, and 13% is enough. Areas with excellent porosity can also be said to have a good quality reservoir.

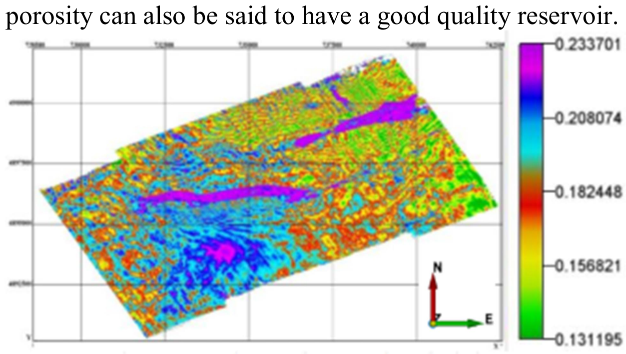

Figure 4. Porosity map for Formation of Missisauga.

CONCLUSION

Based on the results of the deterministic inversion method and the neural network can be concluded that the distribution of sandstone porosity reservoirs in the formation of Missisauga have quality of the porosity with range of values from 13% to 23%. The distribution of porosity in formation of Missisuga divided into two zones, the first zone that dominated by low porosity at scale of 13% to 18% located at Southeast, East, Northeast, North and the second zone that dominated by high porosity at scale of 19% to 23% located at Northwestern, Western, Southwestern and Southern. Generally, the results of porosity with the range of values between 13% to 23% can be classified as a zone of hydrocarbon prospects

ACKNOWLEDGMENT

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