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Analysis of seismic stratigraphy of field "X" in determining the play hydrocarbons using wheeler diagrams

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ABSTRAK

Seismic stratigraphy is one of the efforts in interpreting stratigraphy from seismic data. In seismic data, things that can be construed include faults, facies, depositional environments, sequence boundaries, petroleum systems, etc. Studies related to seismic stratigraphy are an essential part of oil and gas exploration activities. These studies can support the analysis of results in early fields with minimal data or fields without good data. The results of stratigraphic analyses on subsequent seismic data are useful as a basis for further exploration activities. A simple method that can be used to interpret seismic data is by using a wheeler diagram. The interpretation results obtained from stratigraphic analysis on seismic data with a width of 5 Km and a depth of 50 ms are ten faults with a descending pattern, and there are five sequence boundaries based on the continuity pattern of seismic data. Based on the results of stratigraphic interpretation on seismic data, the reservoir deposition environment is in the transition area. The petroleum system that can be indicated from the seismic data is that the reservoir is in the off-lap section and also in the basin floor fan, the source rock is below the reservoir zone, the reservoir migration pattern passes through the fault, and the shale at the top of the reservoir layer can be a seal rock and the trapping pattern in the seismic data is generally a stratigraphy trap.

Keywords: depositional environment, facies, petroleum system, sequence boundary, wheeler diagram

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INTRODUCTION

Seismic stratigraphy is one of the efforts in interpreting stratigraphy from Seismic data. The stratigraphic interpretation of seismic data is closely related to the concept of stratigraphic sequences. The idea of sequence stratigraphy is a multi-disciplinary approach. To stratigraphy using data that is then combined in such a way as to reconstruct genetically related facies located between chronostratigraphic planes to produce a stratigraphic A framework capable of predicting facies. In the development of the oil and gas industry, there is a dependence on the analysis of stratigraphic structures on seismic data during exploration in Parts of the basin have very limited or even less well data, so the use of seismic data has been Expanded to be able to identify stratigraphic traps, identify reservoir *source rock*, and determine fluid distribution in the subsurface (Cross & Lessenger, 2003).

This research will focus on the use of the wheeler diagram method to analyze the stratigraphy of seismic data as an initial study in determining the sedimentary depositional environment and basin formation and reservoir potential analysis based on the petroleum system. The Wheeler diagram is used by crossing between periods of deposition in time stratigraphy. Wheeler diagrams can predict depositional environment sequence boundaries and reservoir prospects and determine petroleum systems on seismic data. The stages in performing stratigraphic interpretation on seismic data using a wheeler diagram, namely Sketching lines on seismic data, determining the sequence boundary and the number of sequences from seismic data, determining the age of the sequence from the youngest to the oldest by numbering each line, selecting the upper and lower boundary on seismic data, making time diagrams and chronostratigraphic interpretation of seismic data.

Reflection seismic recordings often have unique characteristics that allow direct application of geological concepts based on the physical stratigraphic appearance of the recordings and also the primary reflection of seismic waves occur due to differences in the acoustic impedance of the rock surface, which is generally a surface layer or plane of *unconformity*. Thus, the seismic reflection recording pattern directly reflects the pattern of rock layering and unconformity. Seismic stratigraphy is the stratigraphic interpretation of seismic data (Van Wagoner, Mitchum, Campion, & Rahmanian , 1990).

Seismic stratigraphy can also be defined as the interpretation of seismic data that has a unique character to a reflection seismic record where it allows for the direct application of geological concepts based on the physical stratigraphy appearance of the seismic record. Seismic stratigraphy cannot be separated from sedimentary basin stratigraphy, which is the long-term response of the depositional field to subsidence. A primary unit of stratigraphy is a depositional sequence that is a coherent package of layers, genetically interconnected and overlain within a basin (Figure 1). In addition to being used on seismic data, the concept of stratigraphic sequences is a method that can also be used for exploration between other data, such as data to obtain the filling of the basin by sediment as a result of the interaction between changes in sea level and sediment supply (Agustin, Novian, Darmawan, & Agung, 2017).

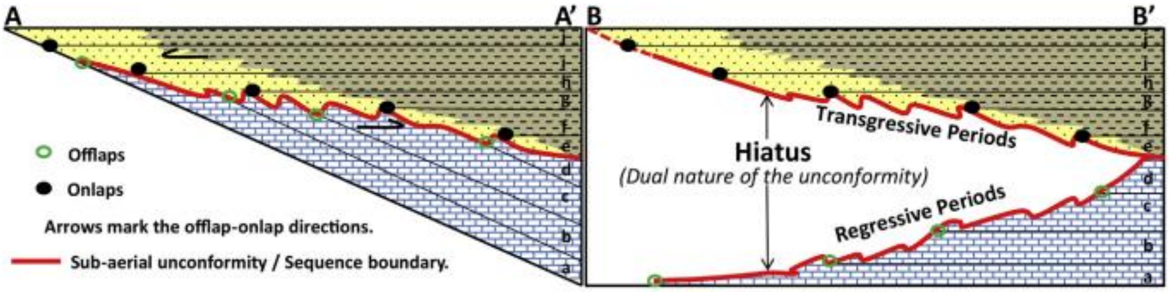

Figure 1. The basic concept of deposition. (a) Generalized stratigraphic section of a depositional sequence; (b) Chronostratigraphic section (Wheeler diagram) of a stratigraphic sequence (Qayyum, Betzler, & Catuneanu, 2017).

RESEARCH METHODS

The methodology for interpreting the creation of the Wheeler Chart (Chronostatigraphy Chart) consists of the following:

Fault Interpretation

Interpreting faults or structures in seismic data is the initial stage in conducting seismic stratigraphic analysis. The interpretation of these faults will be useful in helping to analyze petroleum systems from seismic data.

Creating a chronostratigraphic Diagram Stages create a chronostratigraphic diagram requires the following steps: a) sketching lines on seismic data, b) Determining the sequencing boundary and the number of sequences in the seismic data, c) Determining the age of the sequence from the youngest to the most by numbering each line, d) Determining upper and lower boundaries on seismic data, e) Creating time diagrams, f) Calibration of wheeler diagram, g) Chronostratigraphic interpretation based on seismic data

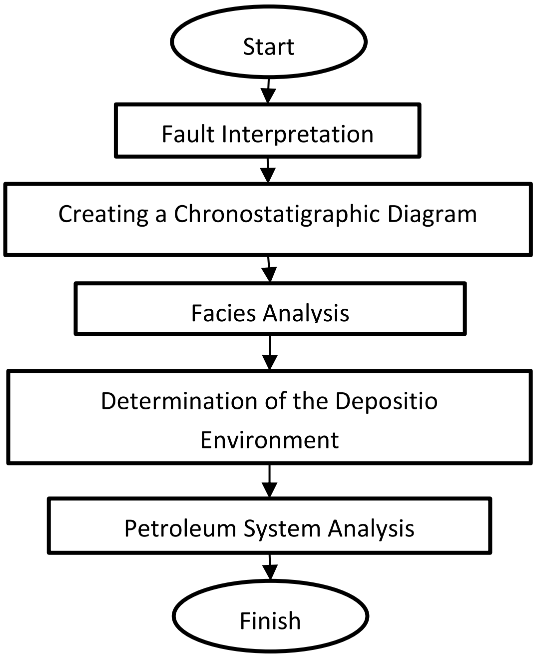

Figure 2. Research Flowchart

Create a Chronostostatic Diagram

Step 1, facies analysis, is used in the geological interpretation of reflection parameters, including configuration, continuity, amplitude, frequency, and interval velocity. Step 2, petroleum system analysis, consists of determining the source rock, reservoir, seal rock, migration direction, or other petroleum system components.

RESULTS AND DISCUSSION

The research was conducted using secondary data using seismic data with a width of 5km and a depth of 50 ms, and the data is offshore data characterized by the absence of seismic reflectors at the top of the data. In addition, this seismic data uses SEG reversed polarity, where the data shows a peak in high acoustic impedance changes and uses zero phase because the layer boundary is at the wave's height. The results of structural interpretation on seismic data show the presence of 10 faults with a descending fault pattern, and this is possible due to the extension force that moves away from each other, as seen in Figure 3, which is a line sketch on seismic data and numbering based on the age of deposition**.**

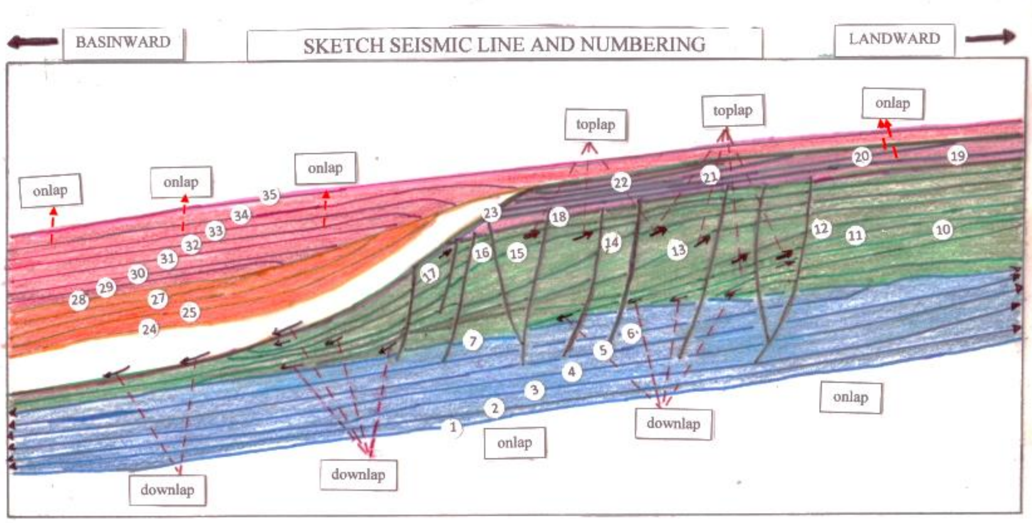

Figure 3. Line sketch of seismic data and numbering by age of deposition

Based on the seismic data, a stratigraphic sequence analysis was conducted. The interpretation of stratigraphic sequences refers to depositional sequences (Lubis & Ramli, 2021). A sequence is a package of rocks genetically aligned and bounded by misalignment to form a sequence *boundary*. *Sequence boundary* in seismic data is divided into five *sequence boundaries* based on the pattern of seismic data continuity. The age of the *sequence boundary* starts from the oldest to the youngest, shown with blue, green, purple, orange, and pink lines. The first sequence boundary has a parallel *(even)* reflection. The reflection of parallel (even) seismic data indicates a constant rate of deposition and uniform receding. Progradation is shown in the second sequence boundary, where progradation can be formed due to lateral progressive growth on a tilted depositional plane. Then, for the third *sequence boundary*, retrogradation can be indicated. Furthermore, in the fourth *boundary sequence*, a rapid decrease in sea level occurs so that a *basin floor fan* is formed, *which is* then covered by more sedimentary deposits young to the present time, the base of the clinoform indicating deep water with a sigmoidal fill pattern indicating a pattern of deposition on a slope influenced by the direction of the sea. So, it can be suggested that this environment is a transitional depositional.

The following interpretation obtained the upper and lower boundaries of the sequence, where, in general, this seismic data has an upper boundary in the form of a top lap indicating the boundary of the sea surface, then in this seismic data has a lower boundary in the form of a down lap, which shows the bottom of the clinoform indicating depth water with a filling pattern in the form of a sigmoid indicating the pattern of deposition on the slope influenced by the direction of the sea. So, it can be indicated that this environment is a transitional depositional environment.

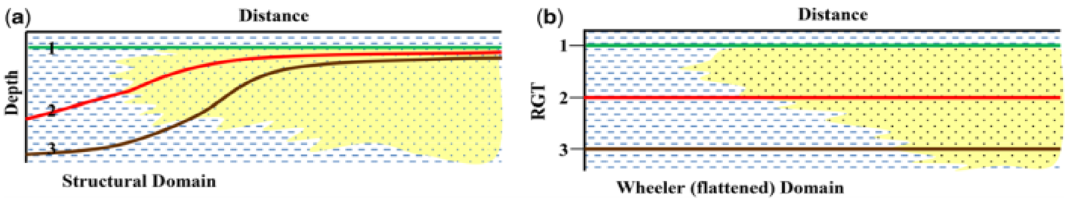

Figure 4. (4a) Showing actual surface layering where the X-axis is the structural domain and the Y-axis is the depth; (4b) Showing surface layering formed using a wheeler diagram where the X-axis is the wheeler domain made horizontal and the Y-axis is the relative geological time value (Wheeler, Harry E, & E Maurice Beesley, 1948).

Interpretation of seismic data using a wheeler diagram in principle, the wheeler diagram has a concept that can be illustrated in Figure 4, where in Figure 4a, there is a surface layer with the Y-axis as the depth domain and the X-axis as the structure domain then an analysis is also carried out in 4b where the Y-axis is the relative geological time domain and the X-axis is the wheeler domain which causes the surface layer to be flat (Qayyum, De Groot, Hemstra, & Catuneanu, 2015).

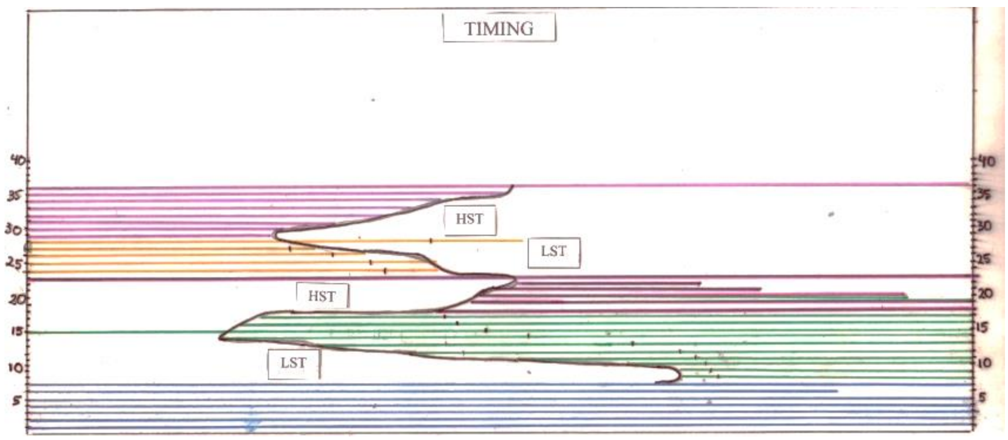

Figure 5. Time Diagram

In this case (Figure 5), if the graph on the wheeler diagram tends to the left, it can indicate a decrease in sea level or a large sedimentation rate. Conversely, suppose the chart on the wheeler diagram tends to the right. In that case, it can be indicated that there is a rise in sea level based on the system tract, the graph that moves to the left is the Lowstand Systems Tract (LST), and the chart that moves towards the right is the sea level *Highstand System Tract* (HST). (Wheeler, Harry & E Maurice Beesley 1948). After interpreting seismic data using the wheeler diagram, we can determine the distribution of facies contained in the wheeler diagram. The transition zone consists of coastal plain mudstone in the landward direction, sandstone in the offlap direction, and mudstone on the slope, mudstone in the seismic data above can be indicated from the pattern of mudstone, which is low reflection. So overall, we can predict the facies pattern of the seismic data as follows (Figure 6).

The petroleum system that can be indicated from the seismic data depicted in Figure 7 is that the reservoir is in the off-lap section and also in the basin floor fan, then the source rock can be indicated to come from the layer below the reservoir zone, the migration pattern can be indicated to have a primary migration pattern and also secondary migration which is indicated to pass through the fault. Shale at the top of the reservoir layer can be indicated as seal rock. Then, the trapping pattern on the seismic data is generally a stratigraphy trap.

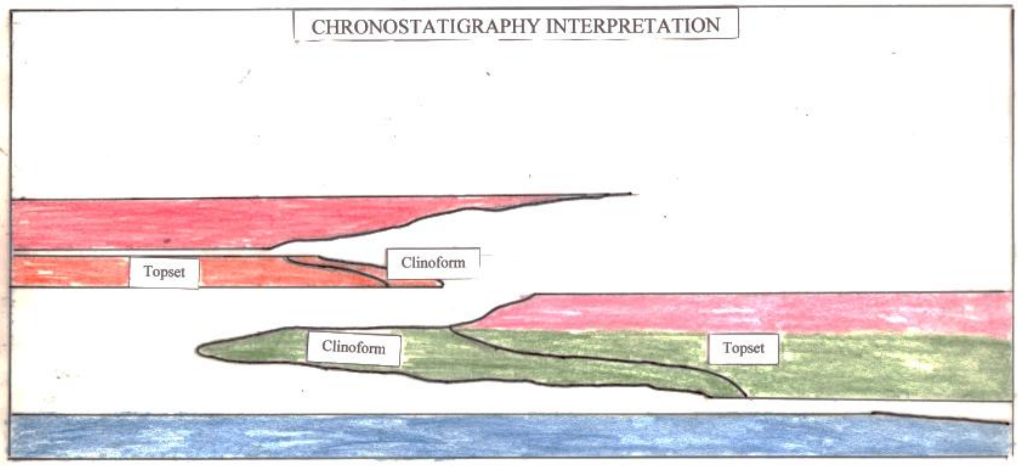

Figure 6. Chronostatic Interpretation

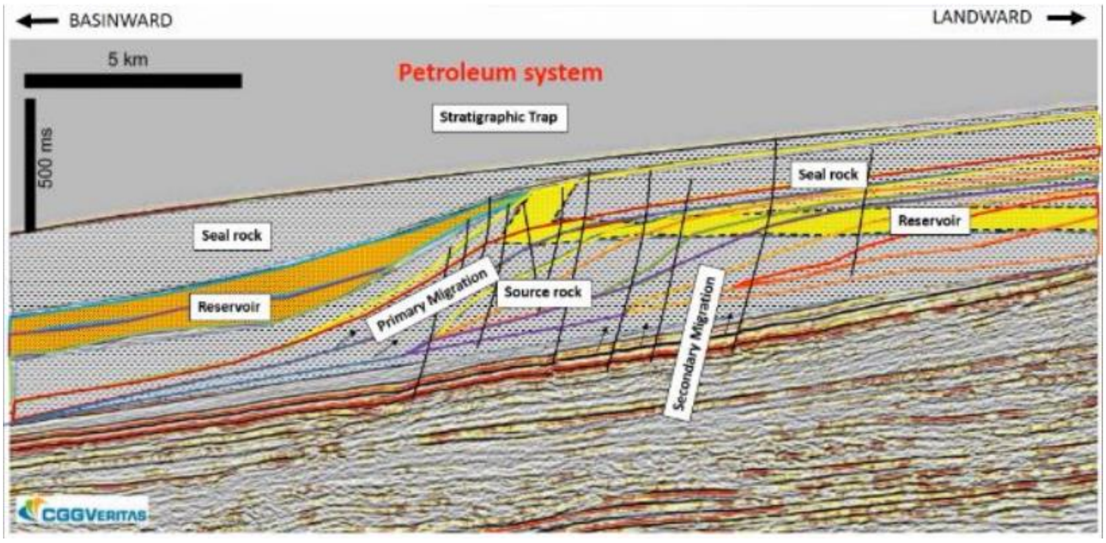

Figure 7. *Petroleum system* data seismik

CONCLUSION

The petroleum system that can be indicated from the seismic data depicted in Figure 7 is that the reservoir is in the off-lap section and also in the basin floor fan, then the source rock can be indicated to come from the layer below the reservoir zone, the migration pattern can be indicated to have a primary migration pattern and also secondary migration which is indicated to pass through the fault. Shale at the top of the reservoir layer can be indicated as seal rock. Then, the trapping pattern on the seismic data is generally a stratigraphy trap.

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