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Stratigraphy Sequence Analysis to Determine Rock Correlation Based on Wireline Log Data on DK Field in Kutai Basin East Borneo

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ABSTRACT : Stratigraphy sequence is seen as an accurate geological concept in conducting oil and gas fields' development. One of the outputs of this concept is to provide rock correlation that can be utilized to describe existing rock distribution in the researched area. The objective of this research is to determine the rock correlation in Mahakam Delta area, Kutai Basin, East Borneo, Indonesia. Kutai Basin is the largest tertiary basin in western area of Indonesia that includes Mahakam Delta. Stratigraphy units division was started from the 3rd order (sequence) until the 5th (layer). The initial stage is to identify tract systems, which consist of 3 parts namely Lowstand System Tract (LST), Transgressive System Tract (TST), and Highstand System Tract (HST). The total well data utilized in this research consist of 11 wireline log data, which explains the analysis was conducted only based on wireline log data. We concluded that Mahakam Delta area, especially the researched area, experiences a rapid sedimentation cycle by the fast sea level increase and decrease. This situation is marked by the existence of numerous layers of sand rock and clay rock lithology, along with the discovered number of sequences as much as 4 sequences, from SB-5 to SB-9.

KEYWORDS : Stratigraphy sequence, correlation, mahakam delta.

I. INTRODUCTION

Oil and gas exploration and development is kept on increasing, both aimed to discover new fields or to optimize existing fields and improve their production level, to fulfill the increasing energy requirement level, especially hydrocarbon energy, either on large or middle scale industries, or even on households. Kutai Basin is a center of hydrocarbon and coal production which is formed on tertiary age and also one of the largest basins in Indonesia is located in the Eastern beach area of Borneo and the adjacent area. Kutai Basin contains oil reserves of 2.47 MMBO and 28.1 TCF of gas[1]. The research is focused at Kutai Basin, Mahakam Delta of East Borneo, Indonesia. Kutai Basin is the largest and thickest tertiary basin in the western part of Indonesia. The existing reserve, which is believed to be at 11 billion barrels of oil (bboe), makes Kutai Basin as a significant area on a global scale, and the fourth most productive areas in South East Asia-Australia [2]. Kutai Basin was formed through rift basin process occurred on Middle Eosen to Early Eosen. Borneo Island is the place where micro-continent crash, islands arc, oceanic plate entrapment, and granite intrusion happened, and formed basic rock that becomes the basis of Kutai Basin [3].

The developing structure pattern in Kutai Basin is dominated by a series of folds and faults on NNE-SSW direction, which is parallel with the eastern shoreline. This structural pattern is known as Anticlinorium – Mahakam Foldbelt. This Foldbelt forms a series of asymmetrical anticline, and separated by wider syncline. This structural pattern is dominated the eastern Kutai Basin area up to its shorelines. Meanwhile the structure of Kutai Basin western part is yet to be clearly acknowledged. The west basin experience lifts which causes intervention that eliminates 1500 – 3500 meters of sediments. The Kutai Basin based on the history of its formation can be divided into two parts (Fig. 1), namely: The Kutai Tengah Basin is an area characterized by the presence of Neogeneous sediments, dominated by volcanoclastic, conglomerate, quartz sandstones with the geometry and structure of the sedimentary alluvial-fluvial depositional environment in the western part of the basin [3]. The Lower Kutai Basin is located in the eastern part of the basin or to be precise in the Mahakam Delta area which is currently formed and is dominated by progression delta deposits, fine sediments from outside exposure, and distal flood sediments [4]. This basin has undergone comprehensive sedimentation, structural, and tectonic evolution during the Tertiary producing some extraordinary geological conditions that support oil and gas maturity and trapping mechanisms and have become an attractive hydrocarbon play in exploration. The research area itself is located in the Lower Kutai Basin which consists of a very large and well-known main structure pattern called the Samarinda Anticlinorium [5].
The "DK" field is a hydrocarbon producing field that is still productive, especially to produce gas [6]. The field is located in the Mahakam Delta which is deposited in the Kutai Basin, East Kalimantan. The Kutai Basin is the largest and widest Tertiary Basin in western Indonesia including the Mahakam Delta.

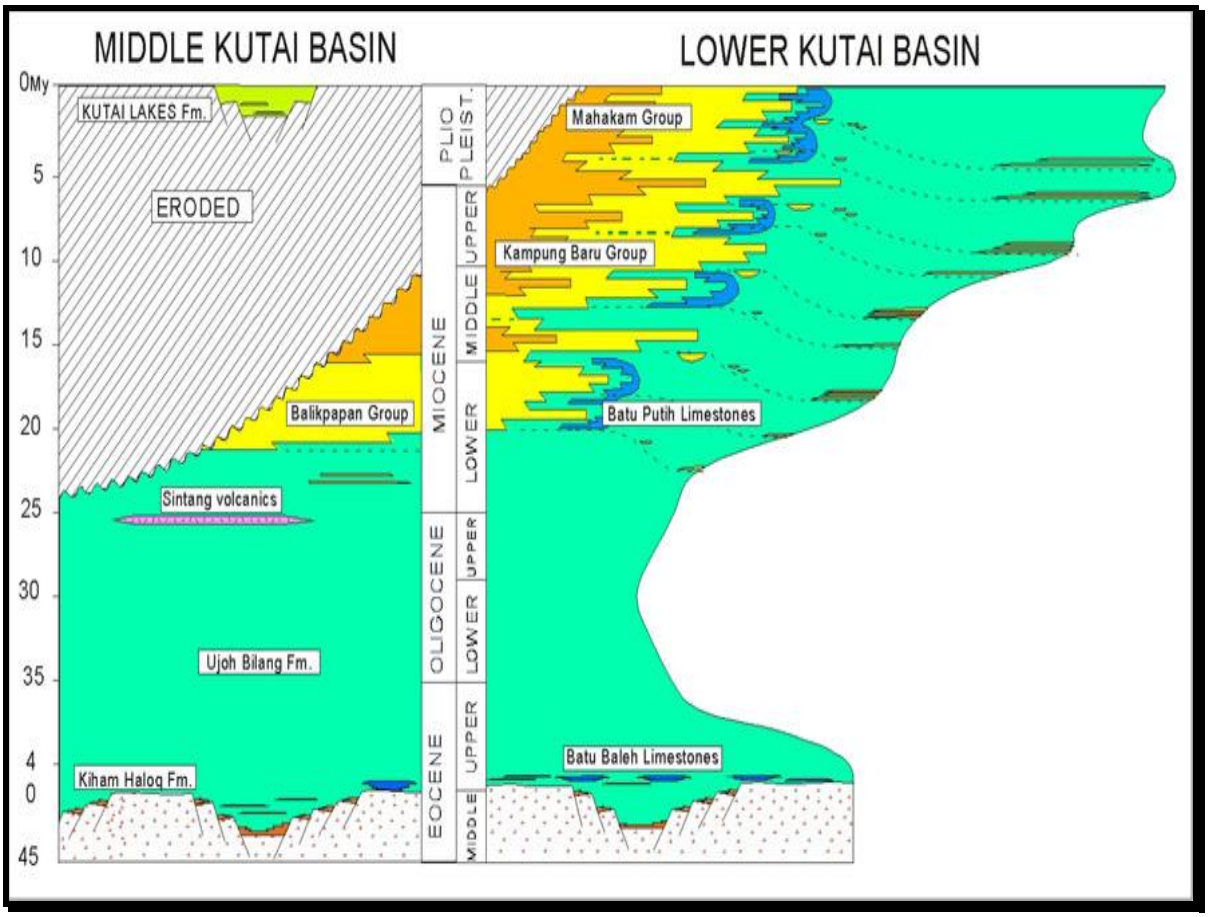

Figure 1. Stratigraphy of the middle and lower kutai basins [3]

II. RESEARCH METHOD

In this study, 11 wells were used in the form of wireline log data (Fig. 2). Determination of the reservoir zone boundaries in the study area was carried out using the stratigraphic sequence method from wireline log well data contained in the study area. The analysis phase begins by analyzing the Gamma Ray log, Resistivity, Density, and Neutron [7]. Then determine the datum (TVDSS) to make a correlation between wells (Figure 3). The division of the stratigraphic units starts from 3rd order (sequence) to 5th order (layer). The initial stage is to identify the tract system; there are 3 types of tract systems, namely Lowstand System Tract (LST), Transgressive System Tract (TST), and Highstand System Tract (HST). Next, determine the boundaries of the chronostratigraphic plane, namely the Sequence Boundary (SB), Maximum Flooding Surface (MFS), Marine Flooding Surface (FS), and Transgressive Surface (TS) [8]. From these results, the lateral and vertical distribution directions of each reservoir can be known. The limitation problem in this research is focused on 3 reservoir layers, from 4 stratigraphic sequences.

Stratigraphic sequences are considered as an appropriate geological concept in developing oil and gas fields, one of the results that can be obtained by applying this concept is the correlation between rocks which can later be used to describe the distribution of rock distribution in the study area. Sequences are layers that are genetically linked and bounded by areas of nonconformity or further inconsistencies [9]. A sequence is deposited during one sea level cycle, that is, the speed at which the sea level falls is greatest until the velocity of the decline in sea level is the next greatest. The concept of sequence stratigraphy is an appropriate geological concept in developing hydrocarbon fields, especially in analyzing the depositional environment.

Several steps are carried out in correlation, namely the first step carried out is determining the stratigraphic fields which are considered to be able to describe the time limits of deposition. These fields are used as markers which are considered to have the same deposition time. The marker that can represent these conditions is the maximum flooding surface, this is done because the maximum flooding surface is considered a depositional phase which describes a spread area of sediment. The maximum flooding surface can be interpreted based on

the appearance of a log curve that shows the maximum log gamma ray value. By interpreting log patterns as such, correlation can be made.

Figure 2. Map of the position of wells in the "DK" field

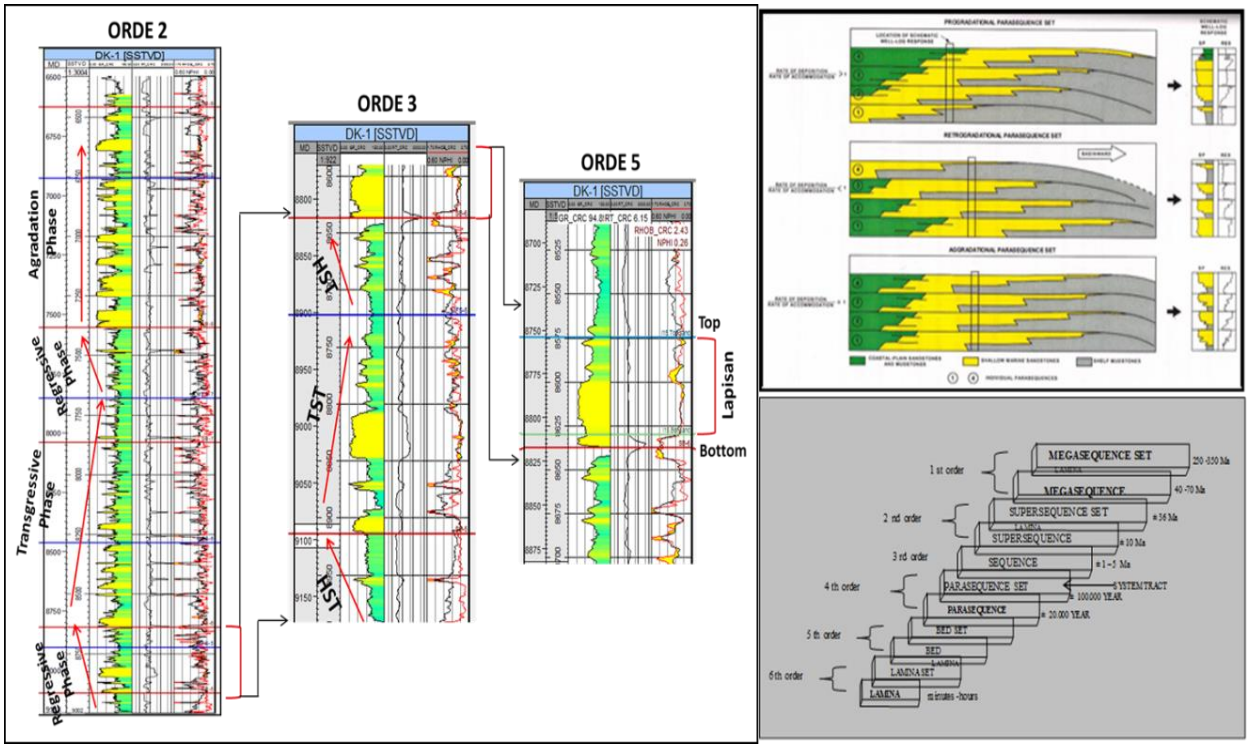

Figure 3. The basis for determining the track system and stratigraphic sequence boundaries

III. RESULTS AND DISCUSSION

The focus of the research area consists of 3 reservoir layers located at SB-5 to SB-9. In general, the research area consists of 12 sequences, and the focus of the discussion is only 4 sequences, in detail the sequence from bottom to top is at the bottom starting in sequence 1 (SB-5 - MFS-5 - SB-6), then sequence 2 (SB-6 - MFS-6 - SB-7), sequence 3 (SB-7- MFS-7-SB-8) and the very top is sequence 4 (SB-8- MFS-8 - SB-9) (Fig. 4 & 5). SB-

5 - MFS-5 - SB-6 is a candidate for the limit sequence-1 in the study area. In this sequence-1, there are 2 track systems, namely the Transgressive system track starting from the SB-5 to MFS-5, characterized by the upward finning pattern and the Highstand system track starting from MFS-5 to SB-6, characterized by an upward coarsening pattern. The dominant log pattern is in the form of a funnel and a bell [10].SB-6 - MFS-6 - SB-7 is a candidate from the boundary-2 sequence of the study area. In this sequence-2 there are 2 track systems, namely the transgressive system track starting from SB-6 to MFS-6, characterized by an upward finning pattern, sandstone layers I-15 and I-20 are present in this sequence interval, characterized by a log funnel pattern. The highstand system track starts from the MFS-6 to the SB-7, which is characterized by an upward coarsening pattern. The dominant log pattern is in the form of a funnel and a bell.

SB-7 - MFS-7 - SB-8 is a candidate from the 3 sequence boundary of the research area. In this 3 sequence there are 2 track systems, namely the Transgressive system track starting from SB-7 to MFS-7, characterized by upward and highstand finning patterns system tracks starting from the MFS-7 to the SB-8, are characterized by an upward coarsening pattern. In this sequence the log patterns that look dominant are funnel and blocky, in some places the log pattern shows a bell pattern. SB-8 - MFS-8 - SB-9 is a candidate for the 4-sequence boundary of the study area. In this 4-sequence there are 2 track systems, namely the Transgressive system track starting from SB-8 to MFS-8, characterized by an upward finning pattern, the G-4 sandstone layer is present in this sequence interval, characterized by a Cylindrical log pattern. The highstand system track starts from the MFS-8 to the SB-9, which is characterized by an upward coarsening pattern. In this sequence the log pattern that looks dominant is cylindrical but in some places the log pattern shows a bell pattern. The SB-8 plane is thought to be the contact area of misalignment erosion.

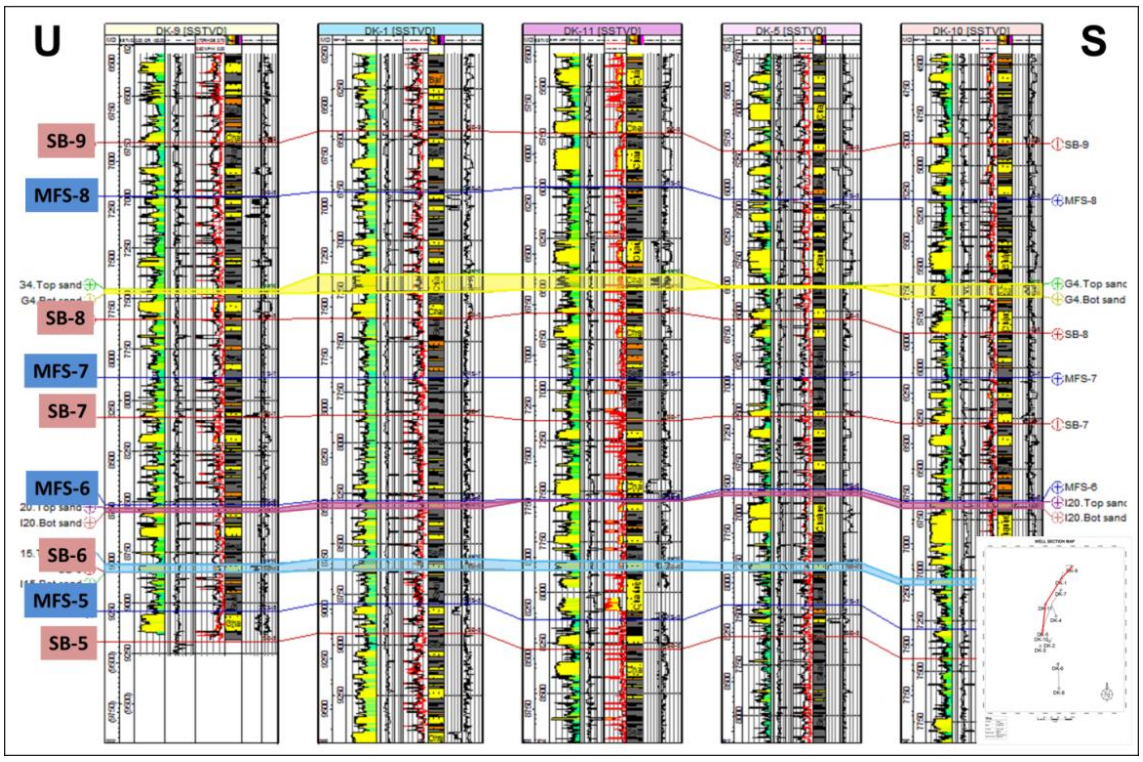

Figure 4. Flattening stratigraphic correlations in MFS-7 wells DK-9, DK-1, DK-11, DK-5, DK-10

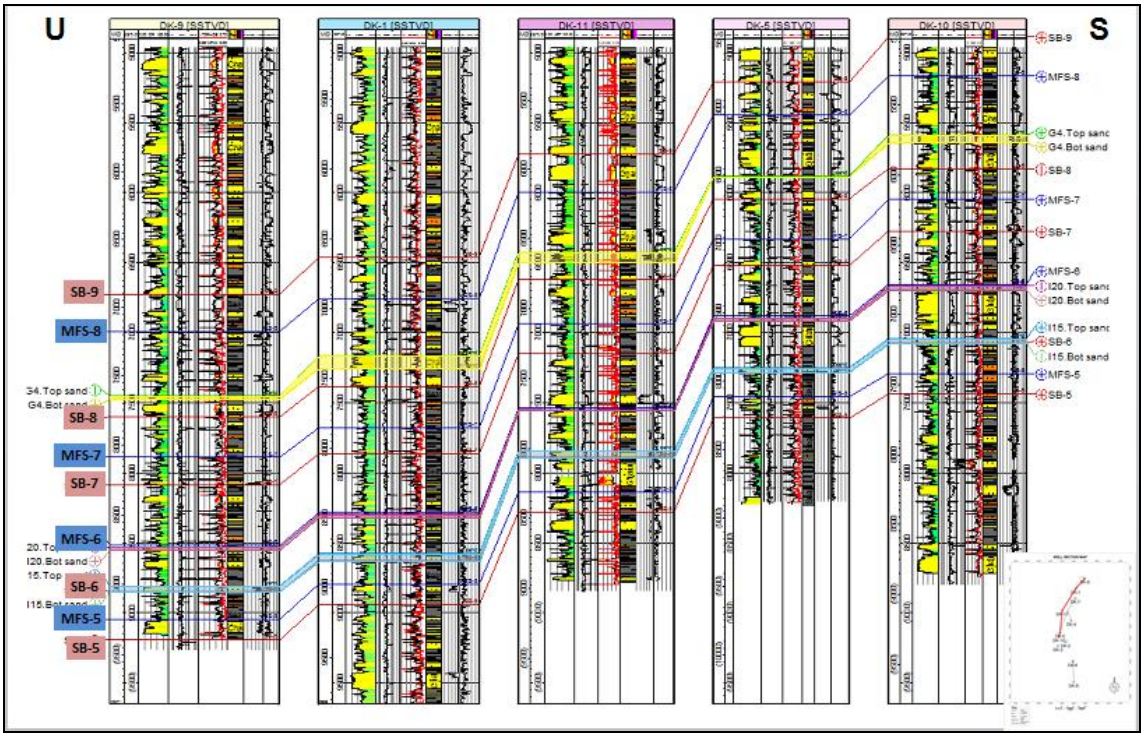

Figure 5 structural correlations of wells DK-9, DK-1, DK-11, DK-5, DK-10

IV. CONCLUSION

It can be concluded that the Mahakam Delta, especially the research area, has a very fast sedimentation cycle, the rise and fall of sea level is quite fast, this is indicated by the many alternations of sandstone and claystone lithology, besides that it is also supported by the number of sequences in the study area, namely 4 sequences starting from SB-5 to SB-9.

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