Correlation of Surface and Subsurface Geological Data Approach to Determine Depositional Facies of Bekasap Formation in Sungai Kuning, Rokan Hulu Riau - Indonesia

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Abstract. Reservoir rocks are exposed in Eastern part of the study area which one of major reservoir of oil and gas field founded in Sungai Kuning, Rokan Hulu, Riau. Surface and subsurface lithological data should be correlated to identify the connectivity because it has an impact and affects the productivity of hydrocarbons. This study focuses on the understanding of depositional facies by correlating surface and subsurface data in Central Sumatra Basin. The methods used was by obtaining surface geological data, micropaleontology and petrography laboratory analysis, characterize depositional facies and geological structure analysis. The subsurface geological data acquired from core and wireline log data of MDL-31Well X Field, such as analysis of lithofacies, electrofacies and depositional facies. So, by the conclusion, there are four facies associations which are Distributary Mouth Bars, Tidal Channel, Upper (fluvial) - Middle Estuarine, and Lower (tidal) Estuarine Channel. From integrated analysis, reservoir lithology on surface and subsurface having similar lithological characteristics and interpreted to be deposited in same depositional environment.

1. Introduction

The study area located in Sungai Kuning, Rokan Hulu, Riau, Indonesia (Figure 1). Reservoir rocks are exposed in several oil fields that located in the eastern and northeastern parts of the study area. From that point, it can be interpreted that the reservoir conditions on subsurface, can be reflected the existence of outcrops which exposed on surface [1,2]. The present-day distribution of sediment and basement rocks can be related to the regional structural geology of Sumatra. The Barisan uplift and Sumatra Fault System (SFS) are controlling the distribution of rock on the mountain front [3].

Aims of this study are to correlate surface and subsurface geological data in determining depositional sequences of reservoir rocks. Also, surface data can be used as an example of rock that can be determined reservoir characteristics, especially in oil fields that have no core data. From characterizing each depositional facies that have unique physical, chemical and biological characteristics that can be distinguished from others. So, it can be used to determine the depositional environment for interpreted correlation of lithology in each layer. Even though the geological condition of the area is quite complicated, where both structural and stratigraphic conditions are affecting entrapment of oil, nevertheless, further geological approach is favorable for further exploration of oil [4].

Sequence stratigraphy is one of method of stratigraphic analysis using by both academic and industry practitioners. The interplay between base level changes and sedimentation controls the fluctuations in water depth, as well as the transgressive and regressive shifts of the shoreline [5]. Before defining boundary on each package of stratigraphy sequence, firstly, depositional facies need to define to get the fluctuating of depositional environment that affected by transgression and regression in study area. Five

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systems tracts are currently in use, as defined by the interplay of base level changes and sedimentation. There are Lowstand systems tract, Transgressive systems tract, Highstand systems tract, Falling stage systems tract, and Regressive systems tract [5].

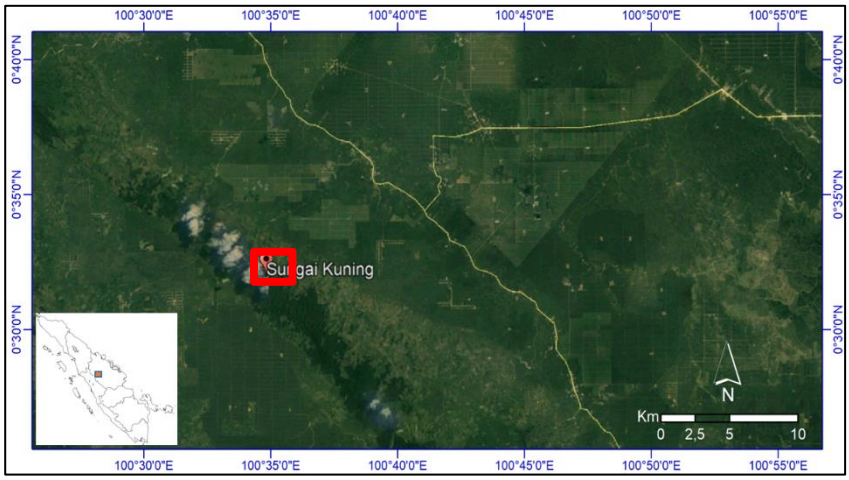

Figure 1. Location map of Study Area

2. Geological Setting

Central Sumatra Basin is one of oil and gas basin in Indonesia. The Central Sumatra Back-arc Basin is one of a series of Tertiary basins linearly arranged along the western and southern margin of the Sunda Craton of southwestern Southeast Asia [6]. From reconstruction of historical geology, the deformation was affected by the tectonic process with several phases [7]. So petroleum system generated in this area resulted from tertiary tectonic phase. The structures formed are the result of tectonic phases that formed in the study area [8].

There are a five-fold subdivision for the Cenozoic rock-stratigraphic units in the Central Sumatra Basin. The five units include (oldest to youngest), the Pematang formation, Sihapas group, and Telisa, Petani, and Minas formations [9]. The study focus on Sihapas Group, which are the main reservoir in Central Sumatra Basin. In determining age and depositional environment, microfossil analysis was performed on calcareous claystone and resulting Sihapas Formation was deposited at Early Miocene [10]. Sihapas Group divided into 4 formations which are Menggala, Bangko, Bekasap dan Duri Formations [6]. Nevertheless, four formation was not present in study location, only Bekasap and Telisa Formation that deposited that present in several spot location. The Telisa Formation deposited unconformably after Formasi Bekasap.

3. Data and Method

Methodology approach for this study are using several steps, firstly, collecting rock sample from field , and then conduct micropaleontology and petrography laboratory analysis [11]. Secondly, from lithostratigraphy aspect, defining stratigraphy of layer that consist in the area and naming the rock into rock unit [12] [13]. Thirdly, laboratory analysis such as grain size analysis or sieve analysis, core analysis, and facies analysis had been carried out to obtain the result. Next is correlating surface data with well core data that located 15 km northeast from Sungai Kuning area. Finally from lithological characteristics of both subsurface and surface data, facies analysis conducted to define depositional sequence on study area.

4. Result and Discussion

4.1 Field Survey Data Analysis

Based on collection data in the mapping field, three types of lithology were found, such as sandstone, sandstone gravel, siltstone (Figure 2). The sandstone description is fine - medium grain with reddish yellow (weathered) and grayish yellow (fresh), open fabric, subrounded to rounded, good sorting, hard, noncalcareous, cross-bedding sedimentary structure with ripple, parallel lamination that destructed by

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bioturbation and nodules, Observation of thin rock incisions consisted of 86% quartz minerals, 10% Feldspar (A and P), 2% rock fragments, 2% opaque matrix and minerals. These rocks are grouped into fine-to-calcareous sandstones lithofacies, which deposited in distributary channel depositional facies.

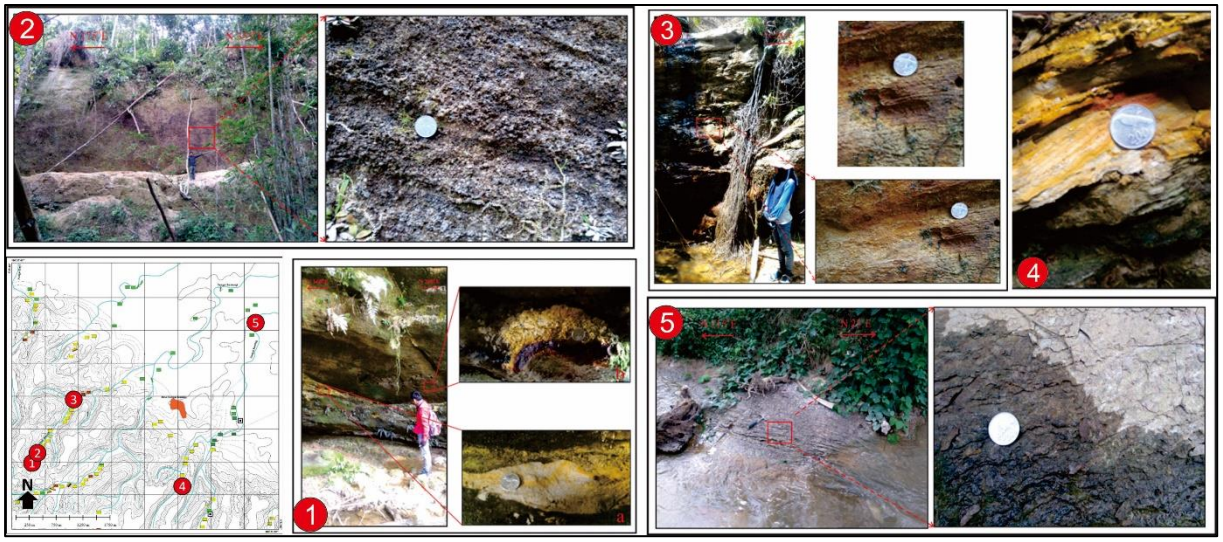

Figure 2. Some outcrops that is founded in the study area

Gravelly sandstone also found with reddish yellow (weathered) and yellow (fresh). Grain size component mostly cobble that has 0.7 cm of average size, matrix filled with fine-medium sandstone, non-calcareous, subrounded, open fabric, poorly sorted, and slightly hard – hard. This lithology deposited erosionally with fine – med sandstone. From observation of thin section gravelly sandstone consist of 50% rock fragments, 20% sand, 28% clay and 2% opaque minerals. The rock fragments, consist of quartz, feldspar and plagioclase mineral with size 2-5 mm, subrounded – rounded, poorly sorted, open fabric also has an embayment structure in quartz. This lithology is characterized into non-calcareous gravelly sandstone lithofacies which interpreted this lithofacies deposited on Upper (fluvial) - Middle Estuarine.

Another lithology was calcareous claystone with weathered color of yellowish ash and fresh gray color, parallel lamination sedimentary structure, nodules and flakes, and hard. Observation of thin sections showed that this rock consisted of 8% quartz mineral, Feldspar and Plagioclase <2%, rock fragments <2%, clay minerals> 75% and opaque minerals <2%. These lithologies are grouped into calcareous claystone lithofacies which interpreted to be deposited in the marine environment.

4.2 Core Analysis

Based on Core log model correlation on well MDL-31, there were four facies association include Distributary mouth bars, Tidal channel, Upper (fluvial) - Middle Estuarine channel, Lower (tidal) Estuarine Channel.

Distributary mouth bars consists of fine – medium bioturbated sandstone, lithofacies - bioturbation, very fine - fine calcareous sandstone, and fine-very fine sandstone with bioturbation flaser. This facies association has the characteristics of coarse up gamma-ray well log pattern and in the well log core found mud drape and flasher, and glauconite minerals with bioturbation index 3-5.

Tidal Channel consist of lithofacies calcareous fine – medium sandstone, fine –medium sandstone noncalcareous, fine calcareous sandstone, and finally fine – medium calcareous sandstone. This facies association having characteristics with bell pattern of well log and from on core are found shale rip up clast which indicates that the area are having tidally infuenced, with bioturbation index 2 – 4.

Upper (fluvial) - Middle Distributary channel, consist several lithostratigraphy which are fine – medium sandstone, fine – medium no calcareous sandstone, and med to coarse noncalcareous, fine – coarse sandstone,fine to med calcareous, with structure sediment wavy lamination. This association has characteristic such as log pattern gamma ray cylindrical, med to coarse sandstone, no calcareous, and wavy sedimentary structure.

Lower (tidal) Estuarine Channel consist of consists of fine - medium carbonates, bioturbated and glauconitic fine sandstones. These facies associations are characterized by rich shell debris and glauconitic a high bioturbation index and glauconite minerals which show a large sea influence.

4.3Depositional Sequence

In the Miocene, it beginning with decreasing sea level that caused the deposition of sandstones in distributary mouth bars and tidal channels. This deposition package was in the Tract Falling Stage System with the sub-alignment limit at the bottom and the subaerial unconformity at the top. Furthermore, sea level rise occurred but the large amount of sediment supply resulted in a progradational regression and deposition. Gravel sandstone is deposited on upper (fluvial) to middle distributary channel which is a package of Lowstand System Tract are deposited in Delta Tide dominated environment. Deposition bounded by subaerial unconformity at the bottom and maximum regressive surface or often known as Transgressive Surface.

Furthermore, the sea level continues to rise caused transgression and the depositional environment changes from the tide dominated delta into the tide-dominated estuarine. This condition resulting deposition of sandstone in the Lower Estuarine Channel continued by deposition of claystone and gradually become marine environment. Calcareous sandstone and claystone are in the Transgressive System Tract depositional package which constrains by maximum flooding surface on top.

Finally, the compression phase that caused Bukit Barisan uplifting and exposed the older rocks. So, this resulting changes in the depositional environment from the sea to the fluvial system along with the regression phase that occurs due to the compression force that happen in the study area.

5. Conclusion

Lithology correlation from surface and subsurface data showed that there are 4 facies associations, distributary mouth bars, tidal channel, upper (fluvial) - middle distributary channel deposited in Tide dominated delta. Furthermore was conformably deposition of Lower estuarine channel as the changes of regression phase into transgression, which changing the depositional condition from delta to Tide Dominated Estuarine. Deposition packages formed in the study area are the falling stage system tract (FSST), Lowstand System Tract (LST), Transgressive System Tract (TST) and Highstand System Tract. The compression phase occurred at late Miocene that resulting Bukit Barisan mountains and exposed basement rock.

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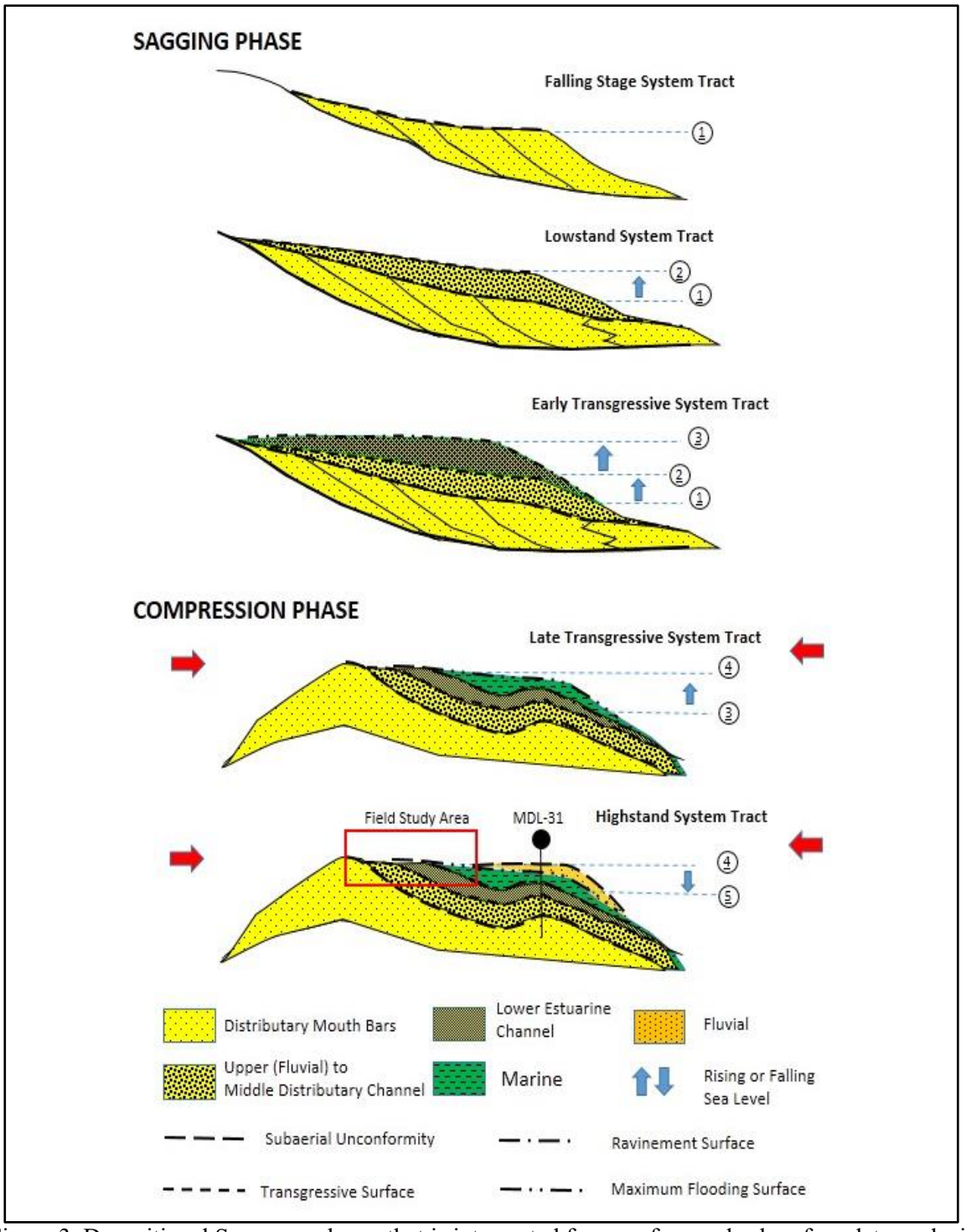

Figure 3. Depositional Sequence phases that is interpreted from surface and subsurface data analysis

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7. Referensi

[1] Choanji T 2017 Slope Analysis Based On SRTM Digital Elevation Model Data: Study Case On Rokan IV Koto Area And Surrounding *J. Dyn.* **1** 71–5
[2] Choanji T 2016 Slope Analysis Based On SRTM Digital Elevation Model Data: Study Case On

Rokan IV Koto Area And Surrounding *J. Dyn.* **1** 71–5
[3] Clarke M C ., Kartawa W, A. Djunuddin E, Suganda E and Bagdja M 1982 Geological Map of The Pekanbaru Quadrane, Sumatra
[4] Mertosono S 1975 Geology of Pungut and Tandun Oil Fields - Central Sumatra *Indones. Pet. Assoc. Proc. 4th Annu. Conv. Jakarta, 1975* **I** 165–80
[5] Catuneanu O 2002 Sequence stratigraphy of clastic systems : concepts , merits , and pitfalls **35** 1–43
[6] Eubank R T and Makki A C 1981 STRUCTURAL GEOLOGY OF THE CENTRAL SUMATRA BACK-ARC BASIN *IPA*
[7] Choanji T, Rita N, Yuskar Y and Pradana A 2018 Analog Study of Fluid Flow on Deformation Band at Petani Formation , Riau , Indonesia *IJCAET & ISAMPE 2017* vol 01034 pp 1–6
[8] Yuskar Y, Putra D B E, Suryadi A, Choanji T and Cahyaningsih C 2017 Structural Geology Analysis In A Disaster-Prone Of Slope Failure, Merangin Village, Kuok District, Kampar Regency, Riau Province *J. Geosci. Eng. Environ. Technol.* **2** 249–54
[9] Mertosono S and Nayoan G A S 1974 The Tertiary Basinal Area of Central Sumatra *Indones. Pet. Assoc. Proc. 3rd Annu. Conv.* 63–76
[10] Yuskar Y, Putra D B E, Choanji T, Faiez Z and Habibi M 2017 SANDSTONE RESERVOIR CHARACTERISTIC BASED ON SURFICIAL GEOLOGICAL DATA OF SIHAPAS FORMATION IN BUKIT SULIGI AREA, SOUTHWEST CENTRAL SUMATRA BASIN *ICoSET* (Pekanbaru) pp 112–7
[11] Yuskar Y 2013 Interpretasi Fasies Pengendapan Formasi Tondo, Pulau Buton, Sulawesi Tenggara Berdasarkan Data Pemetaan Geologi dan Potensinya Sebagai Batuan Reservoir Minyakbumi *J. Earth Energy Eng.* **3** 45–54
[12] Yuskar Y 2014 Structural Geology and Tectonostratigraphy Model of Gonda Area and Surroundings, Buton regency, South East Sulawesi Province. *J. RAT* **3**
[13] Yuskar Y, Putra D B E and Revanda M 2018 Quarternary Sediment Characteristics of Floodplain area: Study Case at Kampar River, Rumbio Area and Surroundings, Riau Province *J. Geosci. Eng. Environ. Technol.* **3** 63–8