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The Diagenesis Study Attributed to Depositional Environment in Determining Potential Porosity in Talang Akar Formation, South Sumatera Basin

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Abstract— *The Southern Sumatera Basin is a productive hydrocarbon basin and makes it very interesting to study. The basin is infilled with carbonate and siliciclastic Talang Akar sedimentary rocks as a main potential reservoir in the area. This paper focuses on studying the diagenetic process linkage with the facies sedimentation to identify the characteristic porosity of the siliciclastic Talang Akar Formation. The research used well data consisting of log data of 3 wells and a thin section of selection well section, further it applied the concept of sequential stratigraphy to develop a depositional environment accurately. The result of the study shows that the siliciclastic Talang Akar reservoir consists of argillaceous sandstone and calcareous sandstone, both of them deposited in the delta front which is highly affected by fluctuation in sea level (eustacy). The main target porosity in the study area is the vuggy secondary porosity that occurs intensively in the calcareous sandstone. Whereas matrix recrystallized to illite and also sericite are widespread in a certain depth of the argilliceous sandstone and it must be potential to microporosity. There is a significant relationship between the abundance of vuggy secondary porosity in calcareous sandstone with Sequence Boundary (SB) as reflected in 1090 m and 1100 depth.*

Keywords— *Diagenetic, South Sumatera Basin, Porosity, Sequence Stratigraphy*

I. Introduction

The South Sumatera Basin is a backarc basin, located on the southern part of Sumatera Island and bounded by the Central Sumatera Basin in the north and Sunda Basin in the south. It is a productive hydrocarbon basin that ranked 2nd in total production in Indonesia. The primary reservoirs lie within the siliciclastic Talang Akar and Gumai Formations, carbonates of Baturaja, and a smaller amount in the fractured basement(1). These sediments are a product of Tertiary megacycle transgression-regression that infills the basin and is associated with the petroleum system in the south Sumatra basin. The object of this research is the Lower Talang Akar Formation (TAF), composed of siliciclastic sandstone interbedded with shale and coal (Fig.1). The sediments of the Talang Akar Formation were deposited in various depositional settings, from fluvial to deltaic, and changed gradually to marginally deep marine along the transgression phase (2). How facies sedimentation and diagenetic process control the porosity of the siliciclastic reservoir and the enhanced possibility of a good reservoir will be discussed in this paper. The research has been derived from well log interpretation accompanied by petrographic analysis of selected rock-cutting samples from interested wells. Before going further into the discussion, hence are the overview of the geological setting and sedimentation history of the research area.

Geological Setting and Sedimentation History

South Sumatera has undergone three major tectonic events (3) which consist of:

- Extension during late Paleocene to early Miocene forming north-trending grabens that were filled with Eocene to early Miocene deposits (40-29 Ma)
- Relative quiescence with late normal faulting from early Miocene to early Pliocene (29-5 Ma); and
- Basement-involved compression, basin inversion, and reversal of normal faults in the Pliocene to Recent forming the anticlines (5 MaRecent) that form major traps in the area.

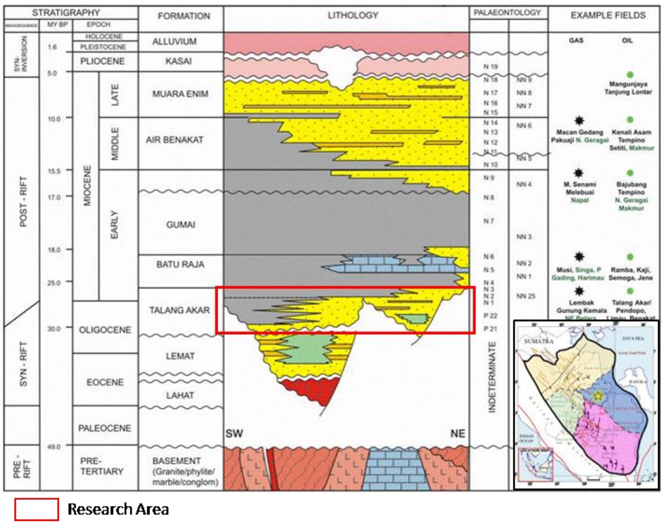

Fig. 1. The petroleum system and object of research area in South Sumatera Basin (6).

Sedimentation in the South Sumatera Basin began with the Eocene continental sediment deposition, derived from local erosion of some paleo highs (4). In the late Oligocene, as rifting phase weakened, transgression as a result of the eustatic gain occurred (5) and was followed by sedimentation of the Talang Akar Formation in several rifted grabens. The Talang Akar Formation (TAF) is composed of various lithology units reflecting various depositional settings of the infilling basin. The fluviatile to deltaic interbedded sandstone, shales, and coals are composed of the lower part of the TAF. In the early Miocene, transgression continued and deposited fluvial-more deltaic and marginally-deep marine siliciclastic sediment.

II. METHODOLOGY

This research carried out integrated wellog data with petrographic analysis from selected depths. There were 3 wells data sets, consisting of wireline logs, mudlogging, and 12 samples of siliciclastic rock-cuts from lower part of Talang Akar Formation (TAF). The sequence stratigraphic has been conducted to correlate sedimentary facies and sea level change interpretation; the petrophysical was carried out to obtain rock properties such as: shale content, porosity and water saturation; and the petrographic analysis provides valuable information of rock-composition, microstructures and pore system in rock reservoirs. All these methods conduct to provide an overview in determining the potential porosity by linking petrography with petrophysics-facies sedimentation based on a case study from the South Sumatera Basin.

III. DISCUSSION AND RESULT

Sequence Stratigraphy

Sequence Stratigraphy can provide information about rock relationships within a similar time interval (chronostratigraphic framework) of repetitive genetic strata bounded by the surface of erosion or unconformity. This surface of significant erosional is a product of sea level fall then known as Sequence Boundary (SB).On the contrary, a surface that exhibits evidence of abrupt sea level rise is known as Flooding Sequence (FS). Cycles of falling and rising sea levels through geologic time will accommodate the sediment supply and deposition, hence it would provide valuable information in targeting potential reservoirs.

Based on sequence stratigraphic analysis of the research area, there were 4 markers identified in the Talang Akar Formation (TAF) section. They were 2 sequence boundaries (SB) and 2 flooding surfaces (FS). Figure 2 is representative of sequence stratigraphy correlation from 5 wellog data in the area. Whereas Fig.3 shows system tract analysis and electrofacies of the DVS-3 whose rock cutting will be discussed more in the petrography section.

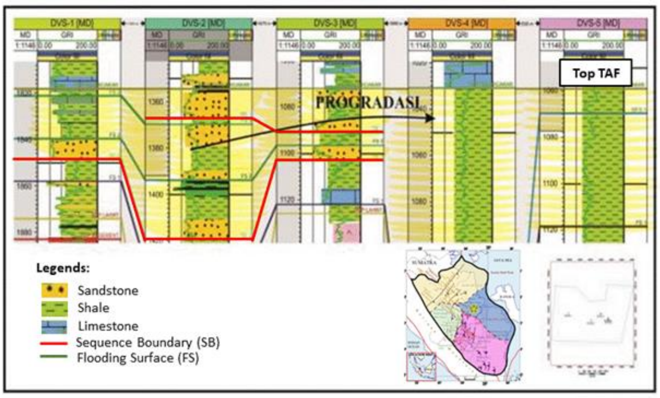

Fig. 2. The sequence stratigraphy correlation of 5 wells in the research are.

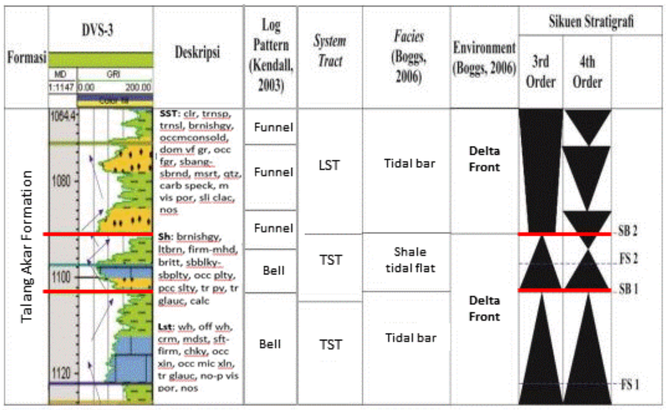

Fig. 3. System tract analysis of well 3 in the research area.

Petrography

Based on the petrographic analysis, there were two types of siliciclastic identified in TAF in the research area. They were argilliceous sandstone and calcareous sandstone. Analysis was conducted on 12 samples carried out from several sandstone intervals in DVS-3 well. Figure 5 show distribution samples of various depth and their relation with sequence stratigraphy sets and porosity of petrographic analysis.

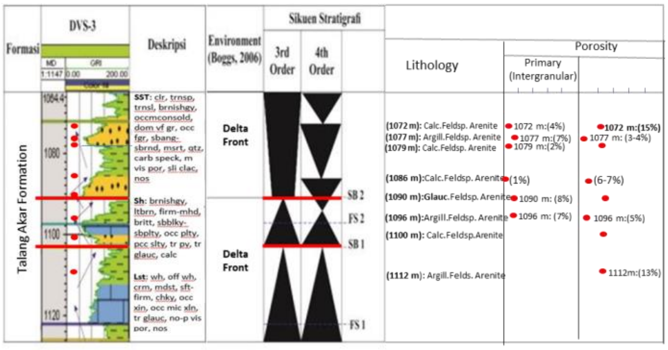

Fig. 4. Relationship between sequence stratigraphiy sets and porosity (primary and secondary) resulting from petrographic analysis.

The calcareous sandstone identified as calcareous feldspathic arenite (Pettijohn, 1975), grain supported, shows medium grain (0.3 - 0.6 mm), well to medium sorted, grain consists of dominant feldspar accompanied by quartz, lithic, glauconite and minor micaceous grain (Fig.5) Grains occurred in subrounded - subangular, some of the grains show an anhedral shape with dark clay coating the grain. Sandstone is cemented intensively by calcite, slightly glauconite, and also pyrite with framboidal structure as an indicator of reduction deposition environment (Fig.5). Matrix occurred in small proportion with a percentage, not more than 10%. The calcareous sandstone is characterized by its intensive calcite cemented grains, indicating tight rock. But in several depths (1072 m, 1090 m, 1100 m), they show abundant vuggy porosity at about 15%-17%, resulted from diagenetic process as dissolution (Fig.5).

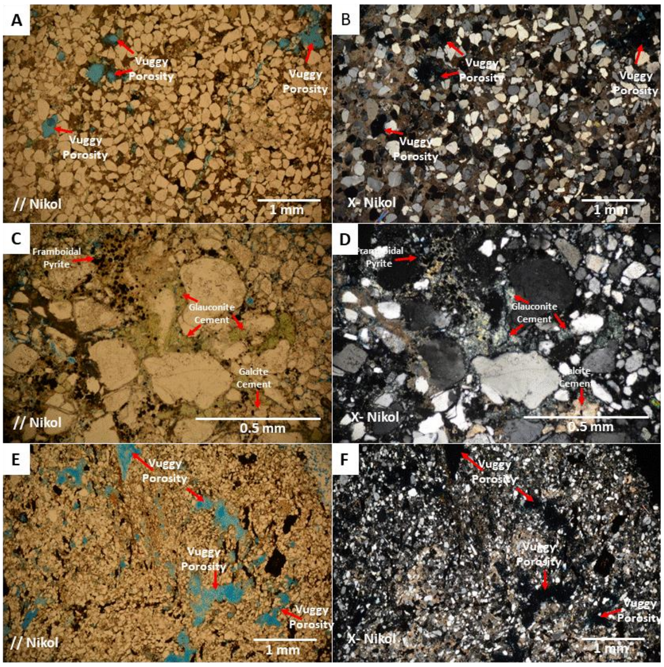

Fig. 5 (A), (B). Calcareous Sandstone of 1090 m depth, show grain supported which has intensively cemented by calcite, grains consist of dominant feldspar in medium size. (C), (D). Calcareous Sandstone of 1086 m depth, shows abundant light brown calcite cemented grains, and greenish glauconite cement is also present with framboidal pyrite indicating a reduction depositional system. (E), (F), The fine-grained calcareous sandstone, intensively dissolve to vuggy porosity.

The argillaceous sandstone identified as feldspathic wacke (Pettijohn, 1975), matrix-supported, shows medium-fine grain (0.1 - 0.3 mm), medium sorted with open fabric, grains consist of dominant feldspar accompanied by quartz, lithic and minor micaceous grain (Fig.6). Matrix occurs abundantly and consists of clay materials that have been intensively recrystallized into illite. The argillaceous sandstone shows intergranular primary porosity in 7-8%, meanwhile, the vuggy secondary porosity occurred slightly in 3-4%. Figure 6 shows the matrix-supported argillaceous sandstone, tightly textured as a matrix intensively recrystallized into illite.

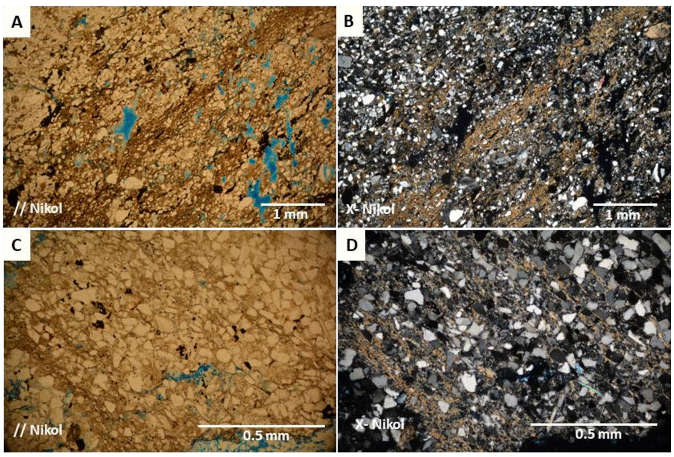

Fig. 6 (A), (B). Argillaceous Sandstone of 1077 m depth, show matrix supported which has intensively recrystallized to light yellowish illite. (C), (D). Argillaceous Sandstone of 1096 m depth, shows abundant illite. The secondary porosity present in small precentage.

Based on petrographic observation, it is clear that argillaceous sandstone preserves primary porosity better than calcareous sandstone, the calcareous sandstone has been cemented intensively cemented by calcite making the sandstone texture tight. However, there was evidence of diagenetic i.e. dissolution, which develop a vuggy porosity as a secondary porosity. Dissolution with a large percentage at several depths was related to the Sequence Boundary (SB) in the sequence stratigraphic set. The vuggy secondary porosity then becomes the main target for potential porosity in reservoirs in the South Sumatra basin. Fig. shows primary porosity at around 2-4% in argillaceous sandstone compared to vuggy secondary porosity (15-17%) that occurs in calcareous sandstone

IV. Conclusion

- There were two types of reservoirs identified in the research area, argilliceous sandstone, and calcareous sandstone. The argilliceous sandstone is characterized by the abundance occurrence of clay matrix, which is further grouped into feldspathic wacke (Pettijohn, 1975). Whereas the calcareous sandstone is characterized by intensive calcite cemented grains, which are further grouped to calcareous feldspathic arenite (Pettijohn, 1975).
- Clay matrix in the argilliceous sandstone is highly recrystallized to illite, making it potential for microporosity, but vuggy dissolution porosity that intensively develops in calcareous sandstone makes it more potential as the main target porosity.
- There was a relationship between the presence of intensive vuggy secondary porosity with the Sequence Boundary (SB) in the siliciclastic reservoirs in the study area.

References

[1] Suseno, P. H., Zakaria, Mujahindin, Nizar, and Subroto, E. A. “Contribution of Lahat Formation as hydrocarbon source rock in South Palembang area, South Sumatera, Indonesia” in *Proceedings Indonesian Petroleum Association 21st Annual Convention*, pp. 325- 337, 1992

[2] Togi Y. Sitinjak, Ricky A. Tampubolon, Ardian Pratama1, “A New Insight of Talang Akar Formation in the Ridho Field, North Palembang Sub-basin, Indonesia” Berita Sedimentologi, number 45, pp.19-52, 2020.

[3] Suhendan, A. R., 1984. Middle Neogene depositional environments in Rambutan area, South Sumatra. Proceedings of Indonesian Petroleum Association, Thirteenth Annual Convention, May, 1984, p. 63- 73, 1984

[4] Cole, J. M., and Crittenden, S., “Early Tertiary basin formation and the development of lacustrine and quasi-lacustrine/marine source rocks on the Sunda Shelf of SE Asia” in: Fraser, A. J., Matthews, S. J., and Murphy, R. W., eds., *Petroleum Geology of Southeast Asia: Geological Society Special Publication* No. 126, pp. 147-183, 1997

[5] Barber, A.J., Crow, M.J., and Milsom, J.S. “Sumatera: Geology, Resources and Tectonic Evolution” Geological Soeciety, London, Memoirs, 2005

[6] Ginger, D., K. Fielding. “The Petroleum Systems and Future Potential of the South Sumatra Basin”. in *IPA05-G-039*, 2005.