

Strike-Slip Fault Deformation and Its Control in Hydrocarbon Trapping in Ketaling Area, Jambi Subbasin, Indonesia

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Abstract. Geologically, Ketaling area consists of a local high considered as flexure margin of Tempino-Kenali Asam Deep in west part and graben in east part also known as East Ketaling Deep. Numerous proven plays were established in Ketaling area with reservoir in early Miocene carbonate and middle Miocene sand. This area underwent several major deformations. Faults are developed widely, yet their geometrical features and mechanisms of formation remained so far indistinct, which limited exploration activities. With new three-dimensional seismic data acquired in 2014, this area evidently interpreted as having strike-slip mechanism. The objective of this study is to examine characteristic of strike slip fault and its affect to hydrocarbon trapping in Ketaling Area. Structural pattern and characteristic of strike slip fault deformation was examined with integration of normal seismic with variance seismic attribute analysis and the mapping of Syn-rift to Post-rift horizon. Seismic flattening on 2D seismic cross section with NW-SE direction is done to see the structural pattern related to horst (paleohigh) and graben. Typical flower structure, branching strike-slip fault system and normal fault in synrift sediment clearly showed in section. An echelon pattern identified from map view as the result of strike slip mechanism. Detail structural geology analysis show the normal fault development which has main border fault in the southern of Ketaling area dipping to the Southeast-East with NE-SW lineament. These faults related to rift system in Ketaling area. NW-SE folds with reactive NE-SW fault which act as hydrocarbon trapping in the shallow zone. This polyphase tectonic formed local graben, horst and inverted structure developed a good kitchen area (graben) and traps (horst, inverted structure). Subsequently, hydrocarbon accumulation potentials such as basement fractures, inverted syn-rift deposit and shallow zone are very interesting to explore in this area.

1. Introduction

Ketaling area is southeastern part of Jambi Sub-basin. NW-SE seismic cross-section reveals this area geologically consist of horst and graben that formed by paleogene tectonic event. Ketaling and Merang High represent horst whilst Sungai Gelam and East Ketaling Deep depict graben (Fig.1). In general, horst and graben in Jambi Sub-basin have northeast-southwest orientation as different to north-south trend in South Sumatera Basin [1].





Figure 2. Structural Trend of Ketaling Area.

While Global positioning System have been used in many previous studies analysis [2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13], this study utilize seismic data for further analysis. The structural characterization both geometry and style in this paper was interpreted using New 3D seismic acquired in 2014. The seismic quality is fair to good. The shallow zone shows high amplitude area with much faults shadow effect the seismic quality, whilst the deeper zone shows low amplitude area.

The Mapping of fault and Syn to Post Rift horizon was conducted to examine structural pattern and characteristic of strike slip fault in this area [14]. Moreover, variance attribute analysis was conducted for better analysis and refined interpretation. Seismic flattening with NW-SE direction is done to see the structural pattern related to horst and graben as well as knowing rifting-inversion history of Ketaling area from Early Miocene to Present time (Fig.3).

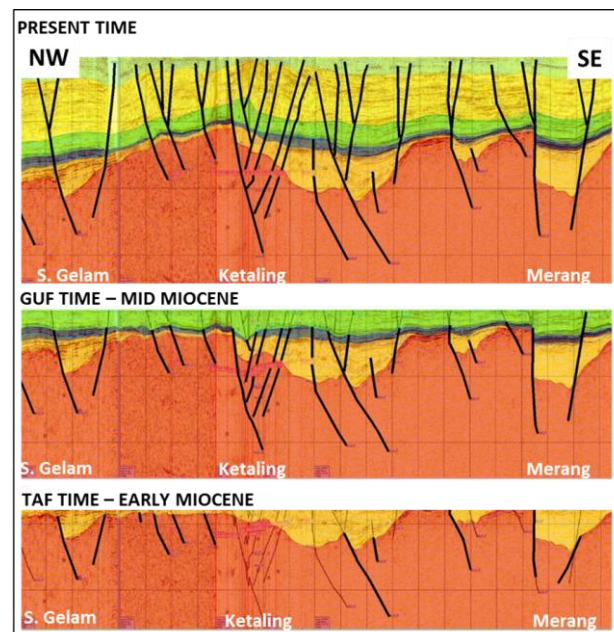


Figure 3. NW-SE Flattening through Gelam-Ketaling-Merang Area.

3. Result and Discussion

3.1. A subsection

Seismic interpretation from new 3D seismic (Fig.4) reveals that the Ketaling Area shows several strike slip features. NW-SE seismic cross section indicates NE-SW main border fault with synthetic and antithetic dipping direction, branching strike slip fault system, positive structural inversion in Post Rift, and typical flower structure features. Whilst SW-NE indicates inverted Syn Rift Deposit, typical flower structure features and development of normal faults in the basement-rift sediment. Flower Structure in this area characterized by relatively planar with high fault-dip angle

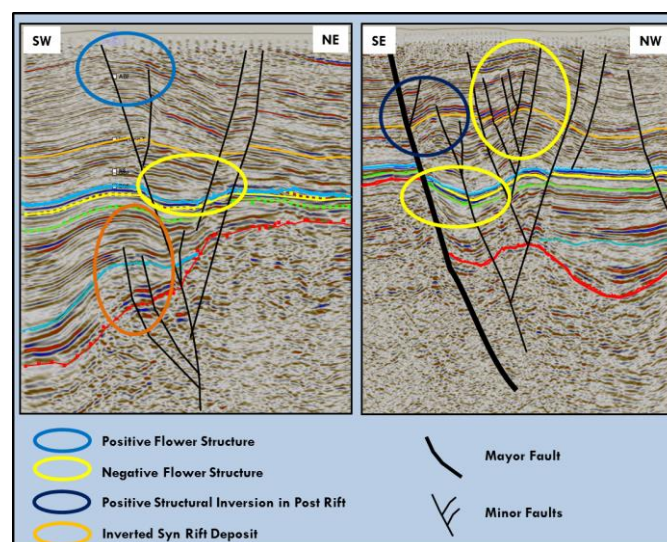


Figure 4. Structure interpretation and characterization in Ketaling area.

Variance seismic attribute is a tool to analyse structures such as faults or micro-faults in the 3D seismic data. This attribute indicates discontinuities in the neighbouring lithology and subsequently in the trace-to-trace variability they become detectable in 3D seismic volumes.

Variance seismic attribute in selected time slice (Fig.5) show Ketaling Area consist of two major NNE-SSW and NW-SE structural trend. NE-SW orientation was formed by transtensional system in Palaeogene yield main border fault with SE dipping. Subsequently, NW-SE structural trend as en echelon fold truncated with NE-SW fault triggered by transpersonal system in middle Miocene to Pliocene. NE-SW fault trend in shallow zone similar to fault trend which formed in Palaeogene hence it showed a reactive fault. This evidence denotes this area experienced polyphase deformation. Those fault features and pattern confirms strike slip mechanism exist in this area.

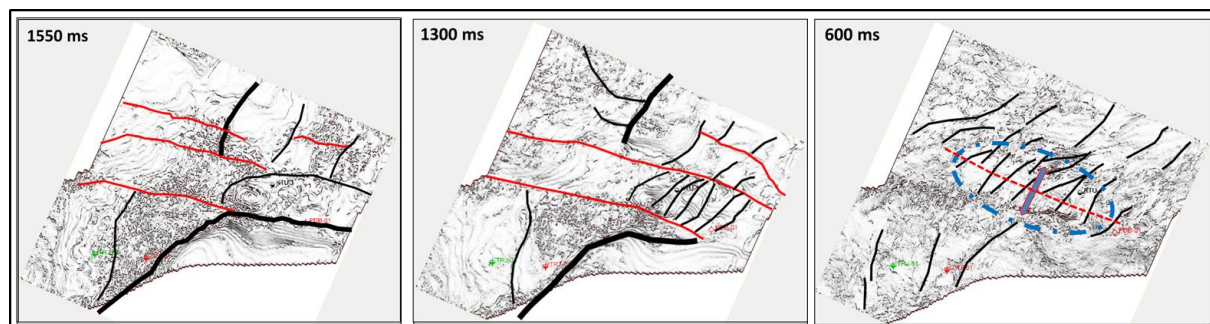


Figure 5. Time slice of variance seismic attributes in - 1550 ms (Basement), -1300 ms (TAF), and -600 ms (Intra ABF) show the changes of structural pattern from Eo-Oligocene to Pliocene time.

3.2. Hydrocarbon Trapping

Eo-Oligocene transtensional tectonic event in Ketaling Area formed graben and horst with NE-SW direction. The graben, Sungai Gelam and East Ketaling Deep, are becomes the kitchen area for Syn Rift organic-rich shale source rock. The Organic-rich sediment in kitchen area consider already mature with regional oil window maturity cut-off at 1700-1800 meter depth.

The horst, Ketaling High, is potential as hydrocarbon trapping especially in basement level. Based on seismic flattening, the Ketaling High was a paleo-high and this area also experienced polyphase deformation that allow for extensive fracture exist in basement level. Moreover, this area directly facing the East Ketaling graben hence increases the chance to be charged by kitchen. The mechanism would magnify geological change in basement level for hydrocarbon accumulation.

Inversion structure in Syn Rift deposit has potential to be home of hydrocarbon accumulation. This structure surrounded by mature source rock, due to its position in kitchen area, which directly charge to reservoir. In shallow zone, proven hydrocarbon trapping occurred mostly on the NW-SE fold follows the major structure trend (East Ketaling Field) formed by middle Miocene to Pliocene transpersonal tectonic event. In this area, the migration pathway through strike slip fault considers as effective mechanism to accumulate HC in the positive structure near the fault system. The existence of hydrocarbon accumulation (East Ketaling Field) proved that hydrocarbon has accumulated and petroleum system has been running in this area.

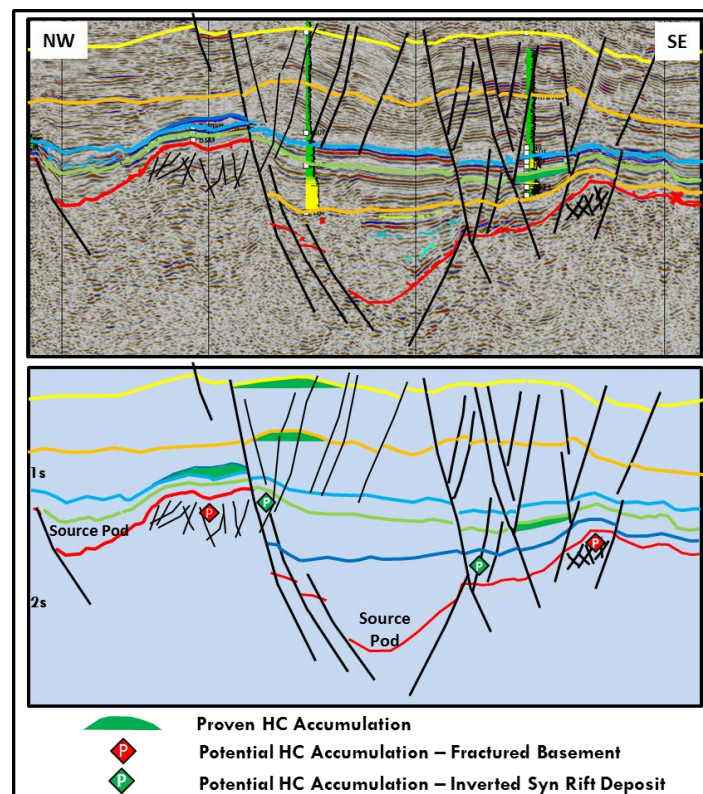


Figure 6. Proven and Potential Accumulation in Ketaling Area.

4. Conclusion

- Transtensional system in Ketaling area formed local graben as kitchen area, while horst developed as traps for hydrocarbon accumulation.
- Transpersonal system in middle Miocene to Pliocene yields NW-SE fold and reactivated NE-SW fault. The product of this system act as trap in sediment and potential fractured reservoir in basement.
- Integrated normal seismic and variance seismic attributes interpretation show polyphase deformation from transtensional system with NE-SW orientation to transpersonal system with NW-SE fold and reactivated NE-SW fault.
- The change of transtensional to transpersonal system adding the occasion of HC accumulation in Ketaling area.
- Strike slip fault consider as effective migration pathway to store HC in the positive structure near the fault system.
- The existence of hydrocarbon accumulation (East Ketaling Field) proved that hydrocarbon has accumulated and petroleum system has been running in this area.

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