STRATIGRAPHIC TRAPS DELINEATION, SOUTHERN PATTANI BASIN, GULF OF THAILAND

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Abstract

Pattani basin reservoirs has been heavily explored traditionally, focusing on structural traps. This study has been initiated to construct a new analogue model for identifying potential stratigraphic traps that have not been explored in the basin. Volumetric attributes have been used for data enhancement after a detailed analysis of the frequency spectrum. Spectral decomposition with RGB blending for three specified magnitudes has been used as a new method for random noise suppression and for stratigraphic imaging that is beyond seismic resolution. Detailed three-dimensional seismic interpretation and attributes analysis reveals that the potential stratigraphic traps at the eastern part of southern Pattani basin are an onlapping trap at unit two and truncation trap at unit one separated by an unconformity. The onlapping trap over a paleo-high area is formed because of basin subsidence and transgression phase. Stack of sand fill channels are observed within units three and four. These sands filled channels have been interpreted because of high sedimentation rates of South East Asia basins and because of transgressive sedimentation. A schematic model was constructed to understand the potential stratigraphic traps in the basin and can help in future exploration and well planning stages in Pattani basin.

Keywords: Stratigraphic Traps, Spectral decomposition, Pattani basin

1. Introduction

Pattani basin reservoir is one of the main reservoirs for oil and gas exploration in the Gulf of Thailand. The reservoirs are dissected by post depositional faults (Morley & Racey, 2011).The basin has been heavily explored for structural traps and most of the discovered structural traps have been put on production. The future of exploration searches for the remaining hydrocarbon potential is probably stratigraphic trap. A new analogue model should be constructed for identifying potential stratigraphic traps that have not been explored in the basin.

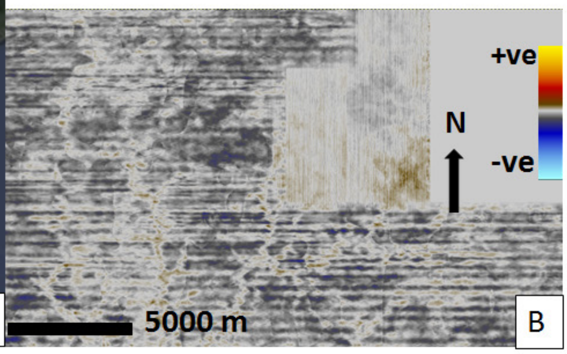
2. Objectives

The key objectives of this study are: 1) To define the potential stratigraphic traps in the eastern part of southern Pattani basin. 2) To generate a new analogy for spectral decomposition with RGB blending in stratigraphic reconnaissance. 3) To demonstrate the impact of using geologically meaningful frequencies in acquisition footprints suppression. The new model and methodology is required since stratigraphic and subtle combination traps are not usually discovered using the standard exploration strategies designed for structural traps that are easier in prediction using conventional seismic imaging.

3. Study Area

The study area lies at the southern part of the Pattani basin. Figure 1 shows the location map of the study area. The rifting processes of the Basin are believed to be initiated by the collision of the Indian plate with the Eurasian Plate shaping the rift basin with half graben geometry (Morley and Racey, 2011). This Basin contains more than 8000m thick sediments in the deeper part. Most of the sediments are of fluvio-deltaic origin. The sediments have been divided into five units (Morley and Racey 2011). The depositional units advance from lacustrine and alluvial syn-rift deposits through late syn-rift fluvial deltaic deposits and are overlain by post rift fluvial and marine deposits. The basin fill is divided into five stratigraphic units by Morley and Racey 2011. Unit One comprises dominantly lacustrine and alluvial syn-rift sediments that were deposited during Eocene-Oligocene. Unit two is mostly fluvial and alluvial plain, post-rift sediments of lower Miocene. Unit three mainly transgressive fluvial and marginal marine sediments that were deposited during early Middle Miocene epoch. Unit four is an overall regressive fluvial and alluvial deposit of the late Middle Miocene epoch. The uppermost, Unit five is predominantly transgressive marginal marine sediments that was deposited from thelate Miocene to present.

Figure1 A Location of Pattani basin. **1B** Time Slice at 50 msec.



4. Methodology

4.1 Post Stack Seismic Processing

The data frequency is a broadband frequency with dominant frequency of 10 HZ. The data is filtered to 70% of its original Nyquist before resampling it to 4 msec. to avoid any aliasing Then the data is filtered again to final frequency filtered as 7-60 HZ using wide taper as many recursive algorithms rely implicitly on boxcar windows to achieve efficiency. There are two volumes have been created for different purposes. The first volume is used for fault interpretation that includes median filter, SOF of petrel then ANT tracking for faults extraction. The second volume is SOF of DUG software for horizon interpretation and attributes extraction. Figure 2 shows frequency spectrum before and after processing where it is obvious the enhancement of the entire spectrum. It also shows that median filter produces gibbs effect to the spectrum which cause aliasing during Fourier transform. Thus, it has been avoided to apply for the attributes extraction volume.

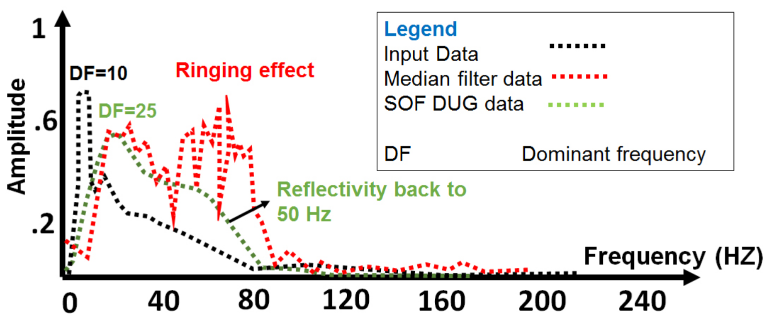


Figure2 frequency spectrum before and after processing

4.2 Seismic Interpretation

There are seven interpreted horizons over the study area. Horizon marker B which represent top Oligocene shows an angular unconformity surface with a tilted fault block beneath it. This horizon is evaluated for sub unconformity traps while unit two shows an onlapping reflectors over basement Pale-high which would be a potential Supra unconformity trap which is onlapping trap. Then unit three and four are a potential stratigraphic trap which lies within normal conformable sequence.

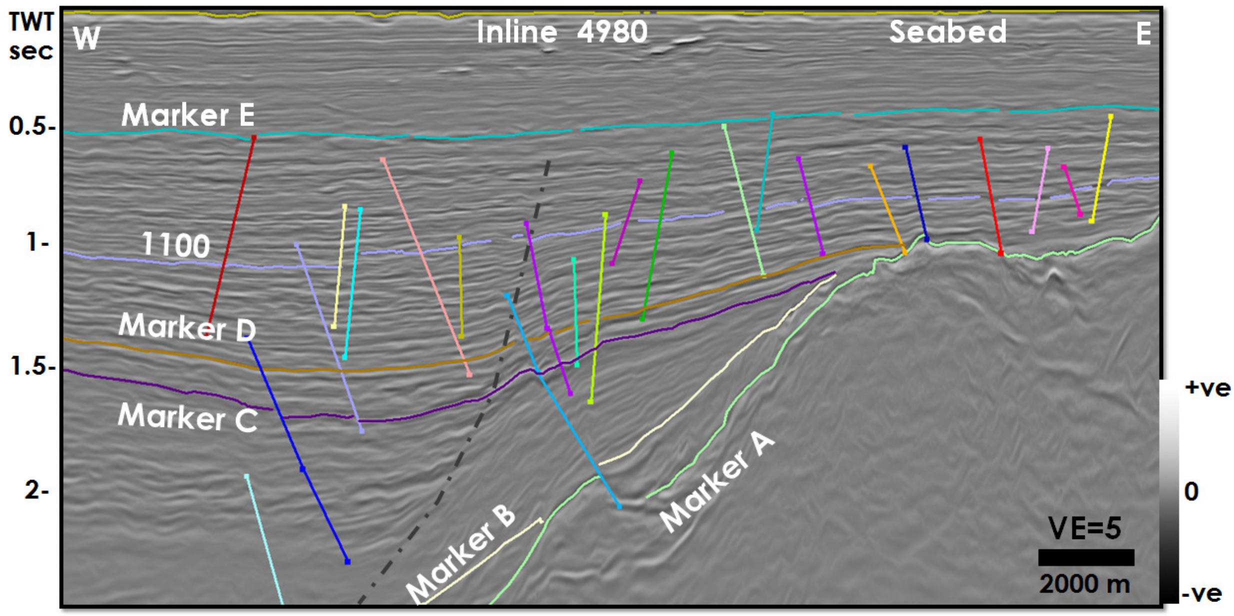


Figure3 2D seismic cross section with the picked horizons.

4.3 Seismic Reconnaissance Using Spectral Decomposition.

Seismic reconnaissance is done using spectral decomposition with RGB display. Since most of seismic attributes don't show satisfactory results in subtle stratigraphic images. Spectral decomposition with RGB display provides a solution for the data quality. After analyzing the frequency spectrum of the dominant frequency attributes. Three discrete frequencies which are geologically meaningful are extracted using Iso frequency attributes. Then they are blended on RGB display. RGB display interpretation helped in reducing the acquisition artifacts which appears randomly in a temporal domain. This kind of result has been never noticed before. Assuming 2500 m/sec then the selected frequencies are corresponding to these thicknesses 37.2, 27.9, 18.6 m which means that the blue color highlights thickness that is below seismic resolution. RGB results highlights the channels edges and shows where they are cross cutting and have internal heterogeneity inside each channel.

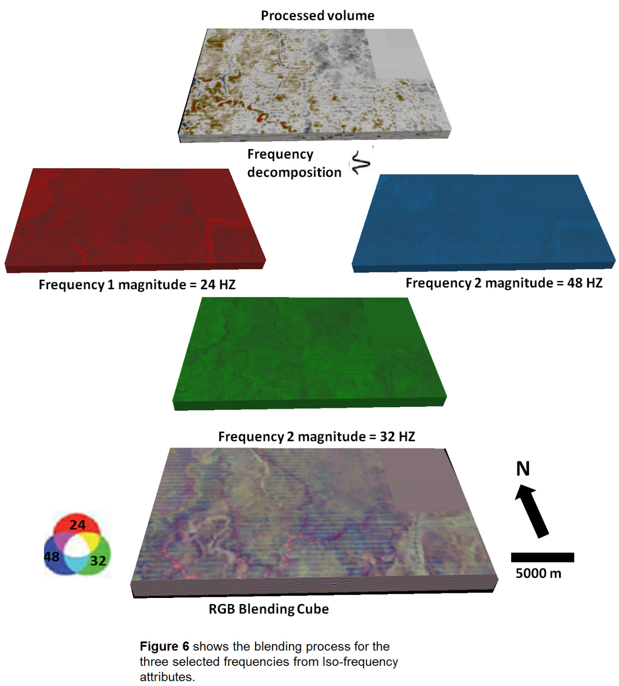


Figure4 shows the blending between three discrete frequencies on RGB display.

5. Results

5.1 Sub unconformity traps

A cropped volume with 1750 m in crossline direction and 8750 m in inline direction is used for generating structural framework that is filled with envelope and sweetness attributes for evaluating the potential traps at unit one. The result of envelope attributes shows two different attributes signatures and the high amplitude anomalies are giving sweet spots. The amplitude anomalies are located below the unconformity which might be a truncation trap and on the upthrow side of the fault which might be a structure tilted fault block trap. It is assumed that these anomalies are reservoir rock deposits. Assuming siliciclastic deposits then the high amplitude with sweet spots could be sand with HC accumulation and the low amplitude is shale. However, since unit one is known as a source rock interval unit then it might be shale and organic rich shale deposits. This unit has HC potential relying on the attributes results and relying on the reflection on its faults as in figure 5B. This reflection could be an indication for HC inclusions if it is not attributed to processing error or pressure differences. Unit one is a potential unit for truncation stratigraphic trap exploration or even unconventional exploration.

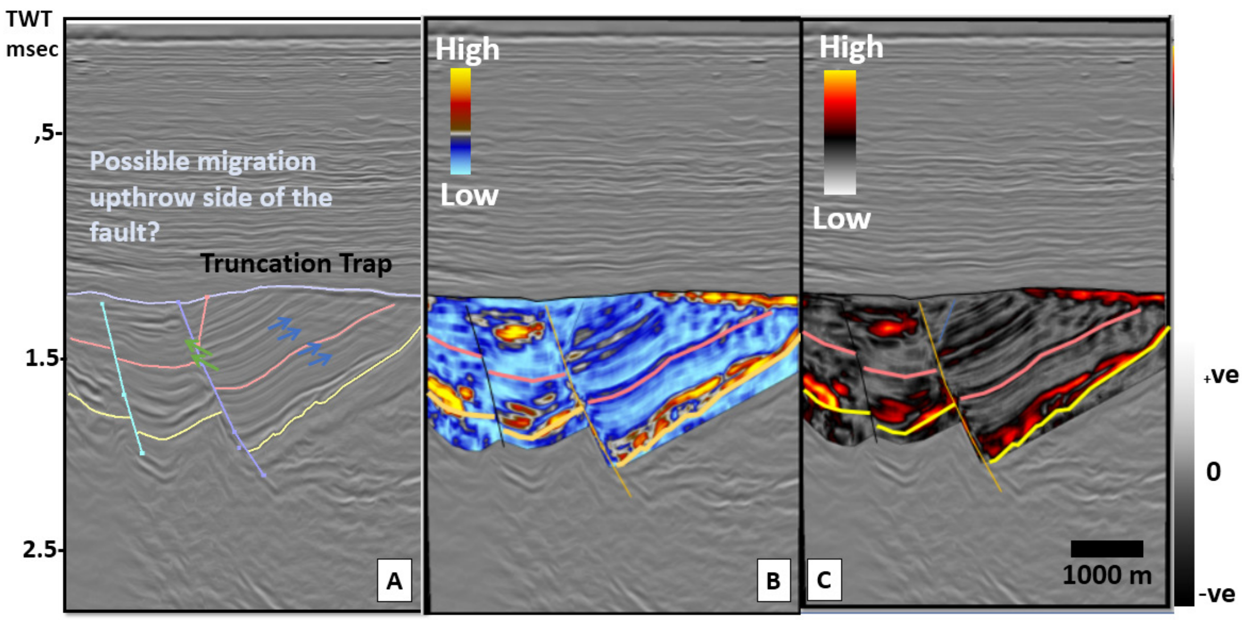


Figure5A structural framework display for unit one with attributes filling.

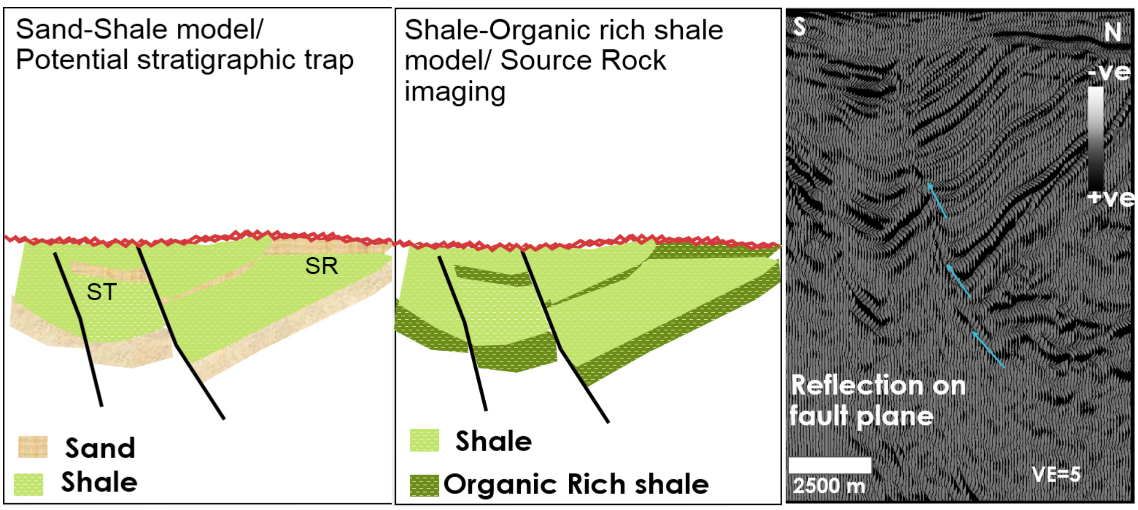


Figure 5B schematic model for unit one potential traps with one seismic cross section display shows reflections on the fault plane.

5.2 Supra unconformity traps

Marker horizon D shows a high amplitude at the position where the reflectors are onlapping over a basement paleo-high. This might refer to sand accumulation within transgressive shale deposits. Sweetness attributes shows also sweet spots as DHI indicator for possible HC accumulation within this sand.

5.3 Normal conformable sequence trap, Channel Trap

Horizon 1100 shows a channel like features with high amplitude. This might refer to sand accumulation within the channel.

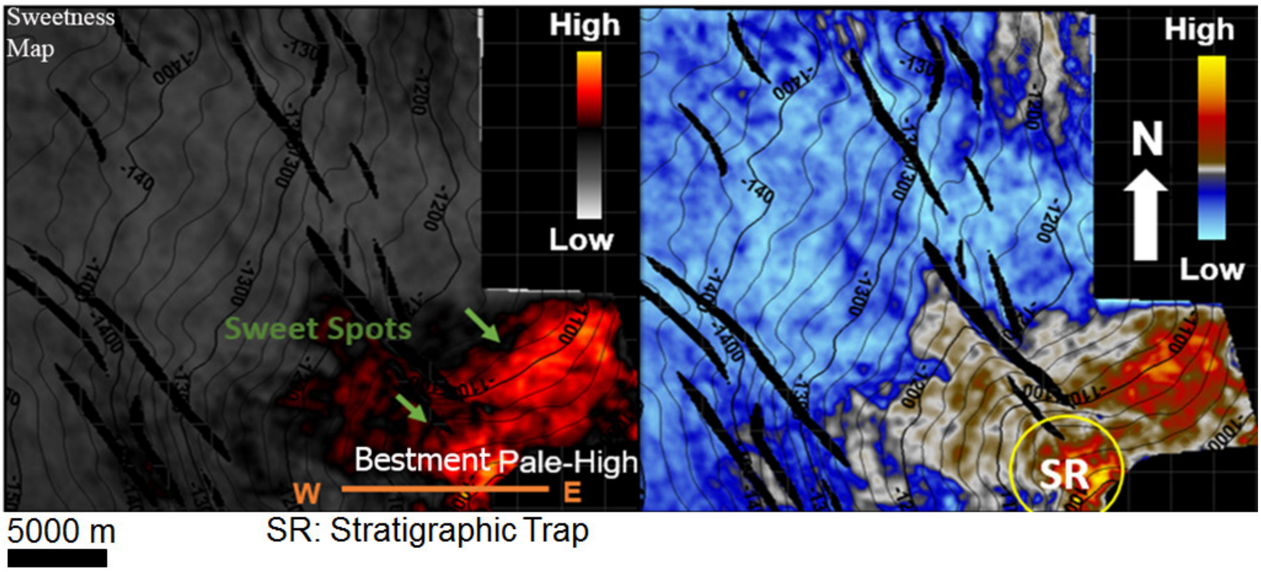


Figure6 RMS amplitude and sweetness map for horizon marker D

Sand fill channels would be formed in two different phases. The first one would be formation of the scour of the channel first and the second one would be filling the channel with sand during a transgressive phase. Spectral decomposition with RGB display helps in understanding the geomorphological shape within the horizon. Label B shows as several channels stacked up together which means that label B is not a single channel, it is a stacked of channels. While label A shows an internal heterogeneity inside the channel where the thickest part is highlighted with yellow and red color and the thinnest part of the channel is highlighted with blue color.

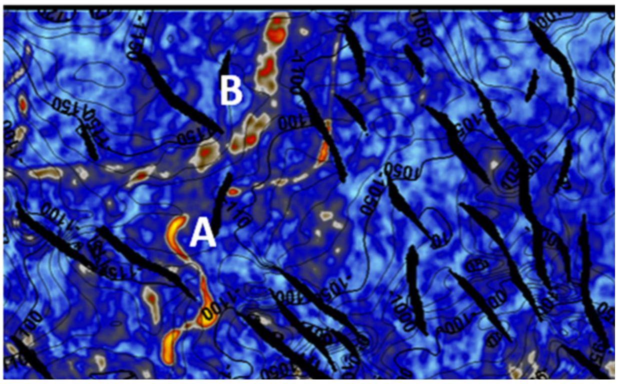


Figure7A RMS map for horizon 1100. Label A highlights sand fill channel with 250 m width and 30 m thick while label B highlights channel belt with 500 m width and 35 m thick.

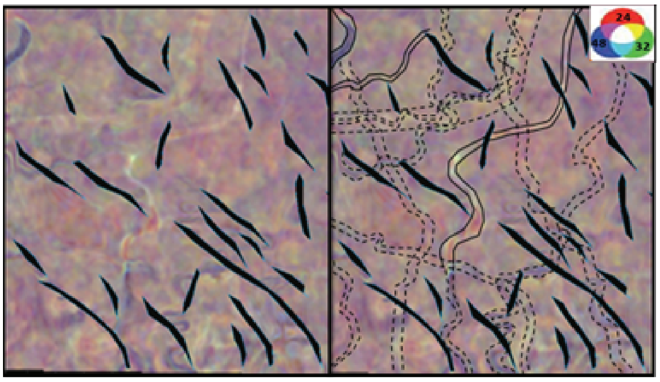


Figure7B spectral decomposition with RGB blending over horizon 1100

6. Discussions

6.1 Potential Traps at southern Pattani basin

The observed potential stratigraphic and structural traps on the study area can be summarized inside the represented schematic graph as the following: truncation trap and tilted fault block traps within unit one. Onlapping traps with small converging normal fault traps within unit two. Sand fill channels and stacked of point bars within unit three and four. Lots of shallow gas reservoirs at unit five. Due to the small faults displacement that raise HC leaking (Kaldi,2014) and the occurrence of the basement paleo-high area, the potential traps on the study area would be stratigraphic and combination traps. The observed traps could be probably explored in other areas of Pattani basin like Northern Pattani basin while central Pattani basin syn-rift is claimed to be beyond seismic resolution (Morley & Racey, 2011). Comparing the structural style and stratigraphy between Pattani basin and adjacent basins. Then North Malay basin would also a basin that can be explored for the observed traps. Since the basin has the same structural and stratigraphy of Pattani basin.

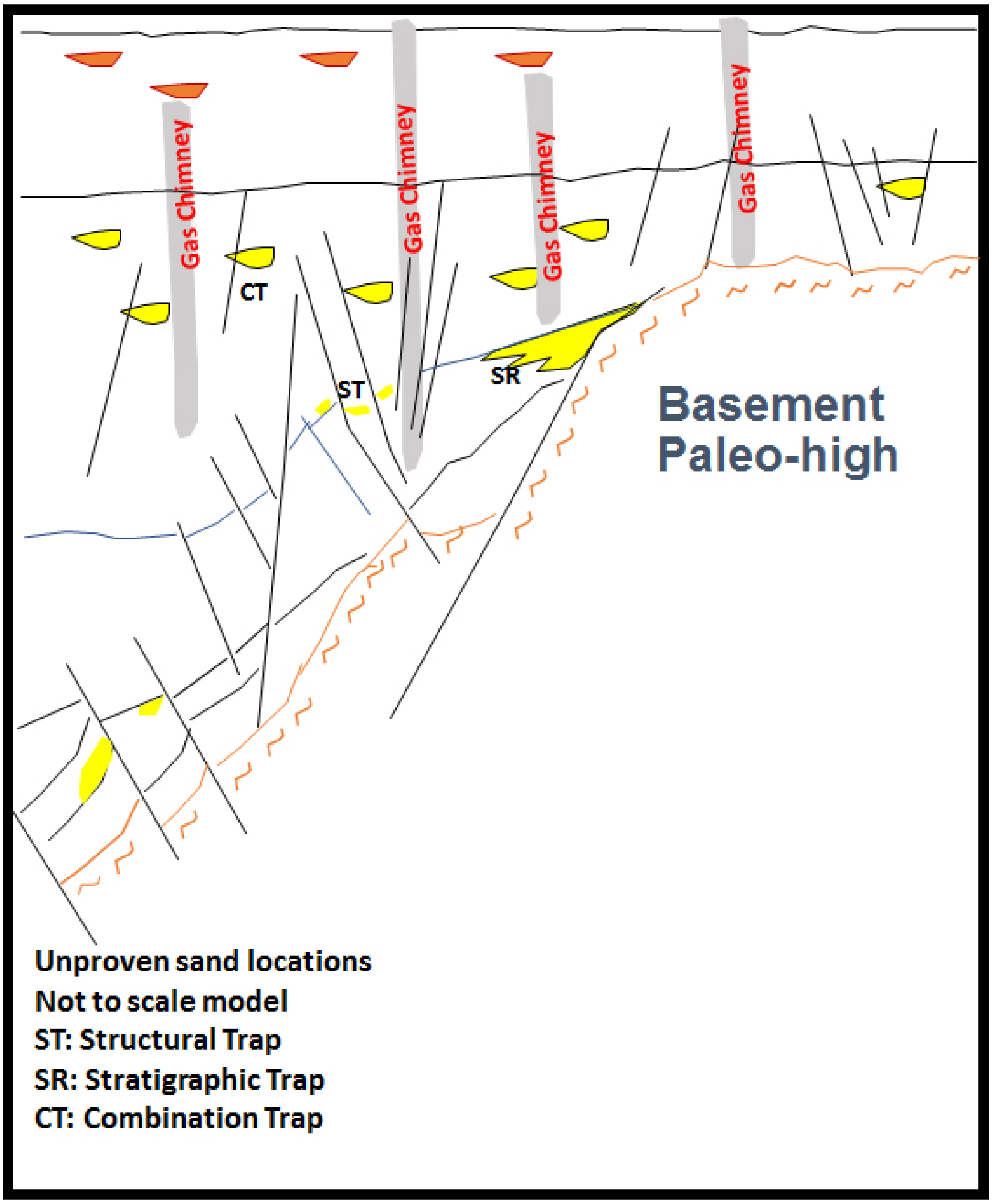


Figure8 schematic model represent the potential traps at the study area.

6.2 Tectonics control traps formation at Pattani basin

All the observed traps are believed to be formed due to tectonic control on Pattani basin. The onlapping traps are formed due to the basin subsidence (Posamentier,2001) which highlight the potential of getting basement paleo high areas at southern and northern Pattani basin. The deposition of unit two as a transgressive unit made the potentiality for exploring the onlapping traps increase in the southern and northern part of Pattani basin. The high sedimentation rates that occur on the basin (Lambiase, 2011) was the reason of getting sand fill channels within unit three and four. The rifting processes on the basin was the reason for getting the tilted fault block geometry within unit one. The inversion episodes that occurs on Pattani basin might enhance or retard fluid migration or it might cause breaching to the traps.

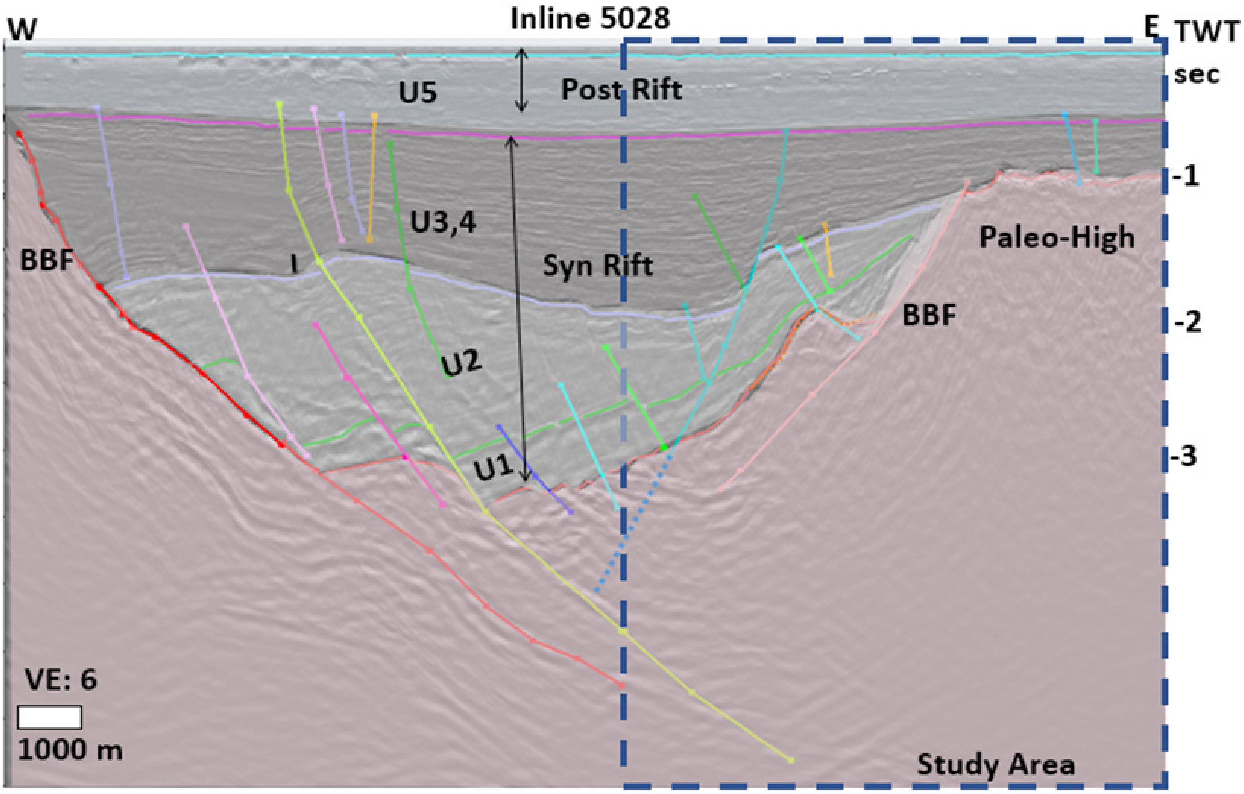


Figure9 seismic cross section shows half graben rift basin with the structural style on the basin.

7. Conclusion

An analysis of volume attributes and geobody extraction reveals that volume attributes helps in understanding structural and stratigraphic patterns with emphasis on seismic frequency spectrum enhancement as data can be filtered to any desired frequency bandwidth that allows useful information to be better seen for interpretational purposes, smoothing of seismic pattern and enhancement of discontinuity effects.

Spectral Decomposition has assisted in understanding the fluvial patterns on the syn-rift deposits which is interpreted in RGB blending display for pattern clarity. It also helped in acquisition artifacts suppression on the data.

An investigation of potential stratigraphic traps in the eastern side of southern Pattani basin based on detailed seismic interpretation and seismic attributes analysis determined that the potential stratigraphic traps on the basin can be subdivided into three types: 1) Truncation trap below top Oligocene unconformity encountered with unit one. 2) Onlapping traps encountered with unit two over paleo-high basement that formed during transgressive phase and basin subsidence. 3) Stack of fluvial channels sand encountered with unit 3,4. Due to the small fault displacement of the study area and the presence of the basement paleo high, the potential traps for exploration on the study area would be stratigraphic and combination traps. The schematic model of the potential stratigraphic traps in southern Pattani basin assist in understanding the potential traps in the basin which can help in future exploration well planning in the area.

8. Acknowledgement

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9. References

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