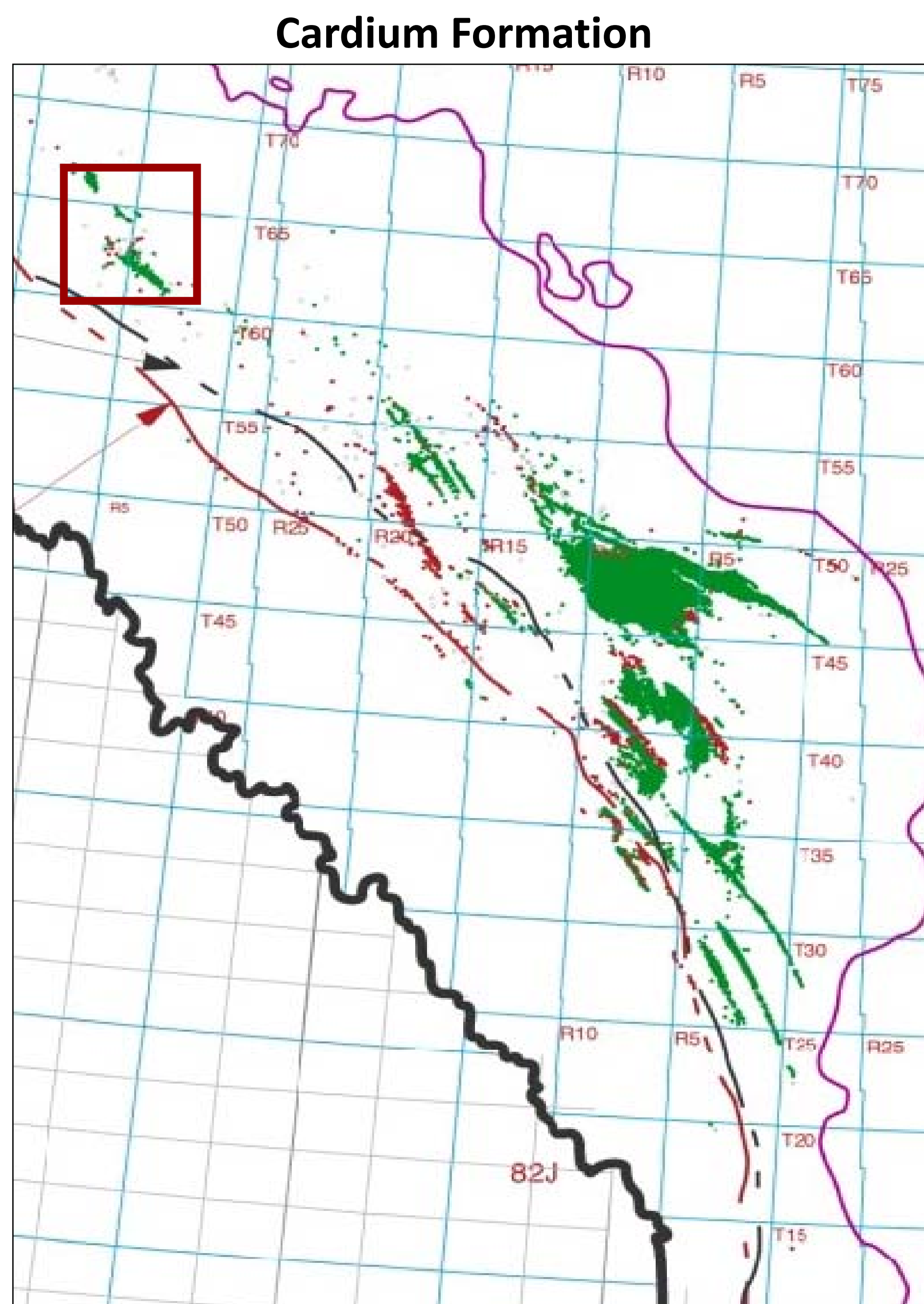


Unraveling Cardium Tight Sand Paleo-depositional Trends and Subtle Structural Features using Seismic Reservoir Characterization

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Shoreface sands of Cardium formation is one of the most prolific hydrocarbon reservoir in WCSB and to-date has produced 1.7 billion barrel of conventional oil. According to the recent estimates the Cardium formation may hold up to 15 Billion bbl oil in place. With new technologies like multi-stage frac of horizontal wells and various flooding techniques the recovery factor could reach as high as 20% thus putting the remaining oil potential to be more than a billion barrel. A large amount of this remaining oil is trapped in tight sand of Kakwa or Ram River Members

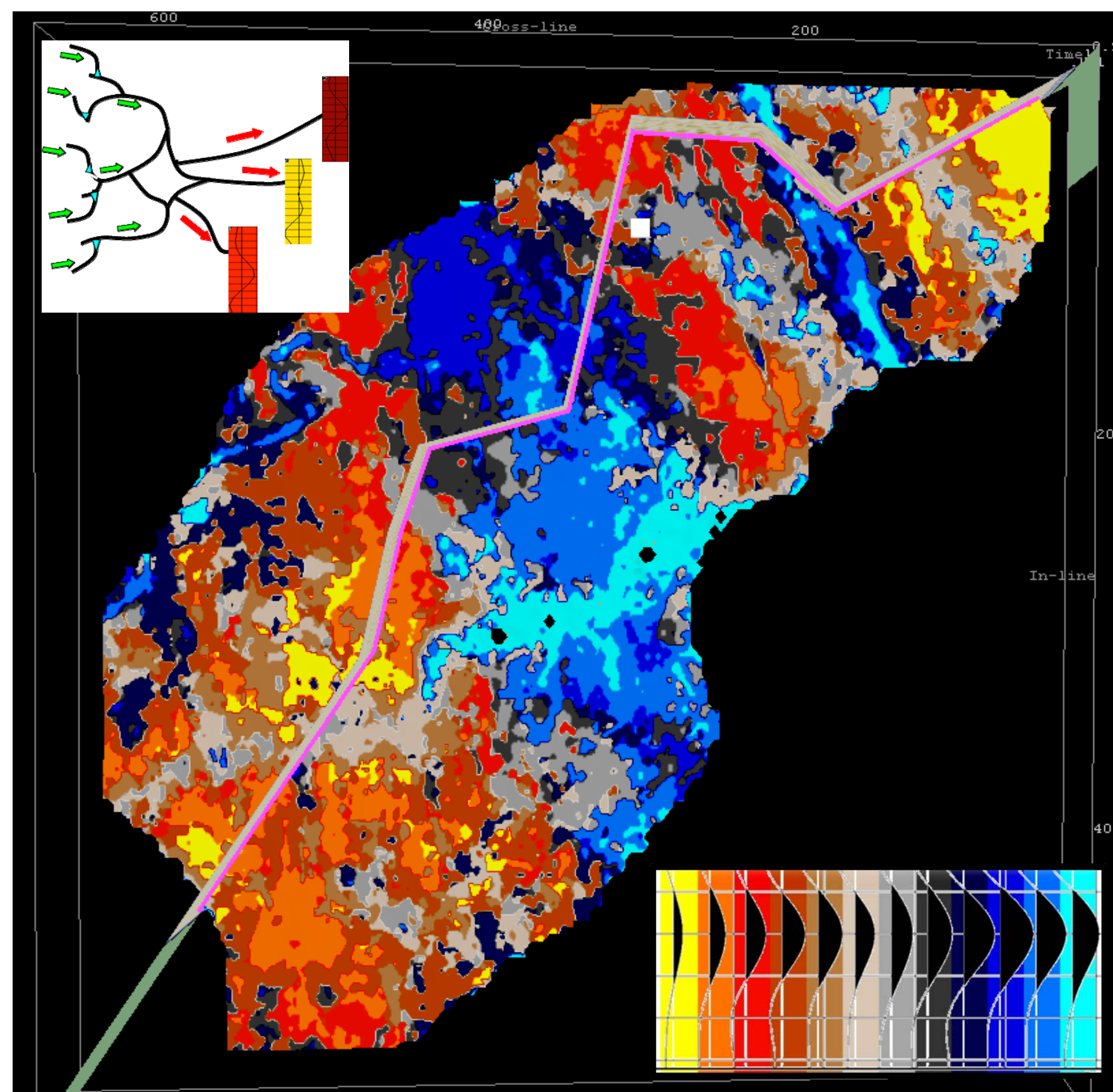
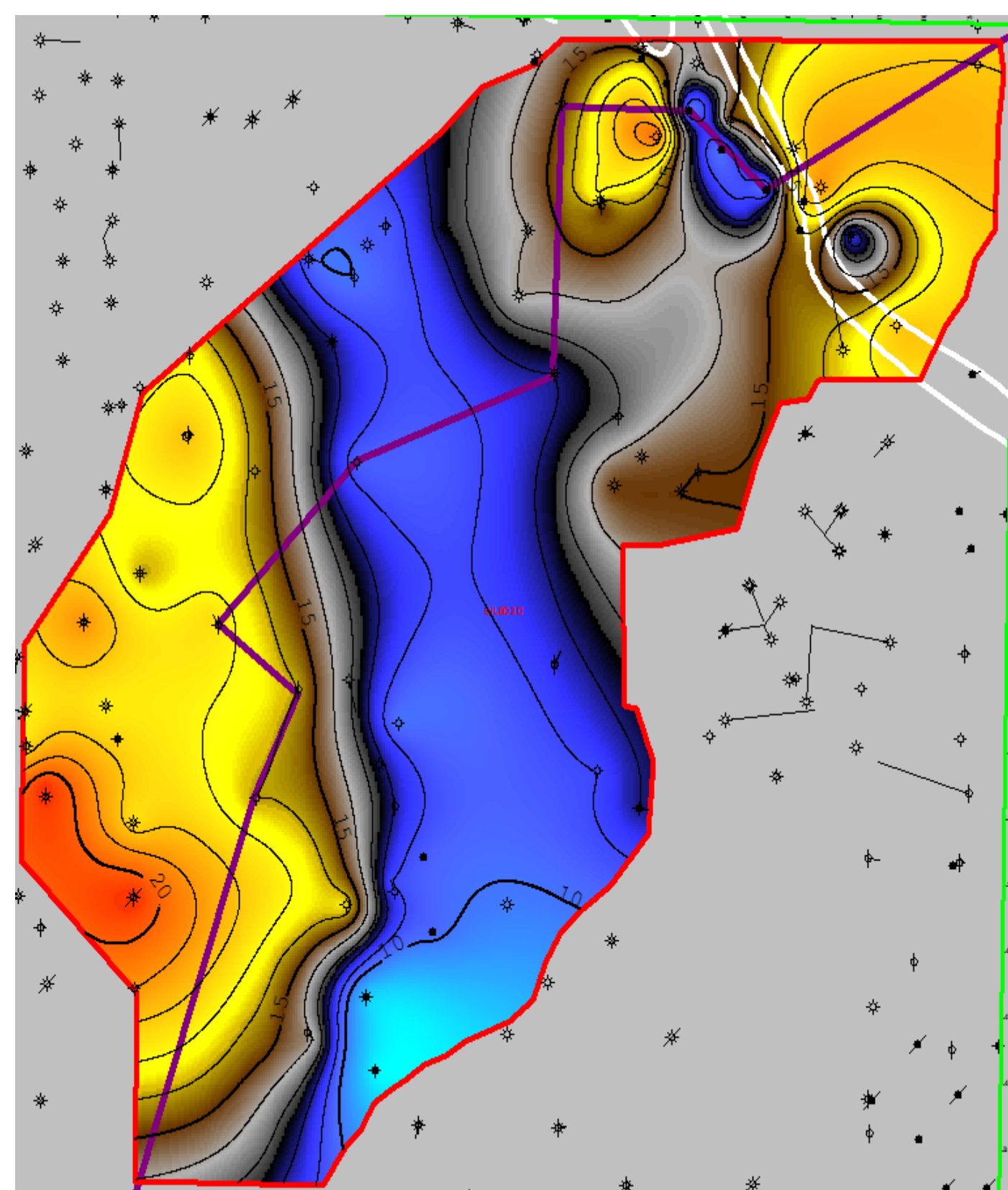
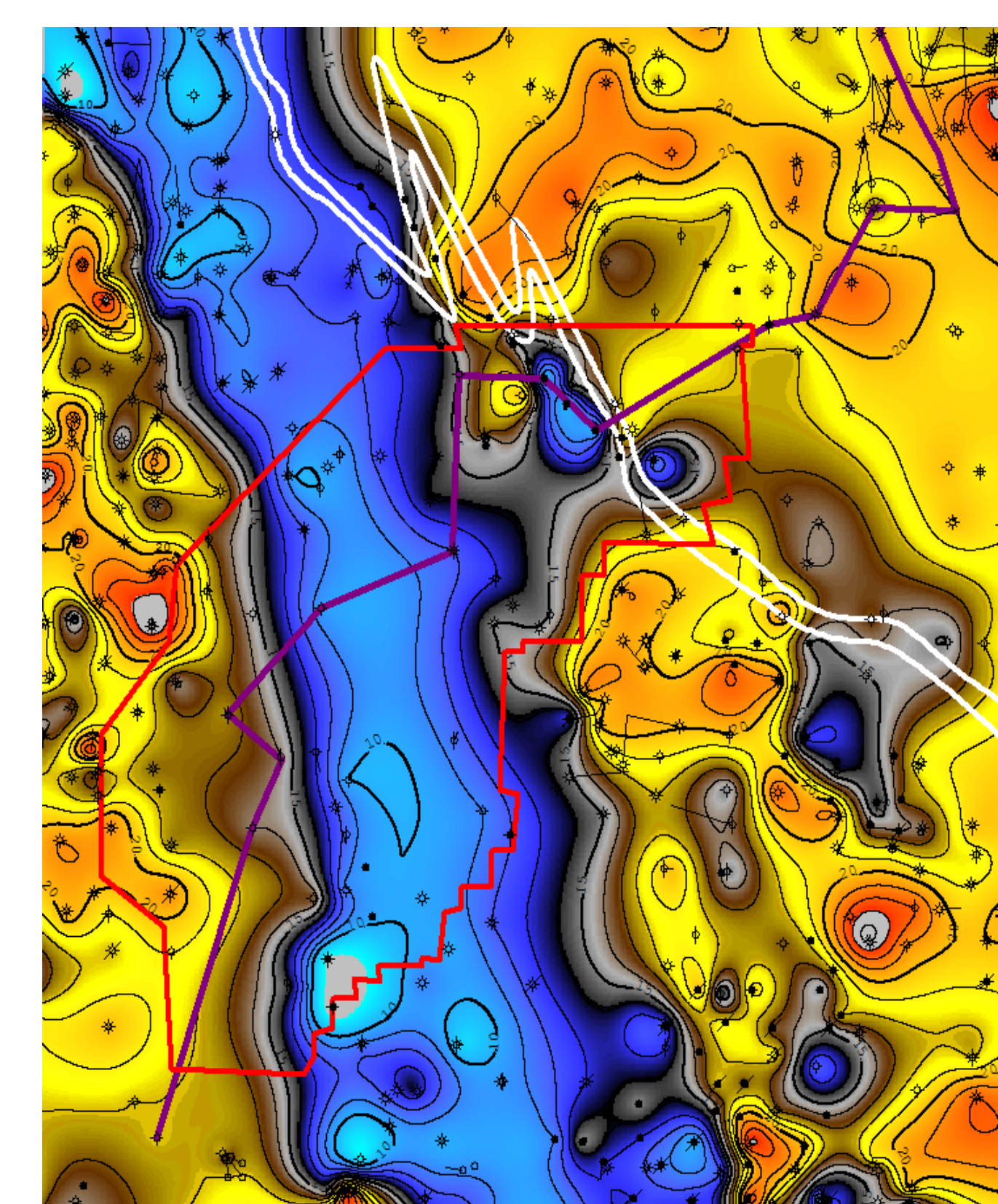
Project Methodology

Within this study area seismic sequence stratigraphy, seismic geomorphology, volume curvature and neural network based facies analysis are integrated with extensive geological and well log analysis work to predict thickness, paleo-trends, permeability barriers and natural fracture trends. By knowing these factors better horizontal well planning can be achieved thus exploiting hidden high permeability trends. Seismic reservoir characterization using state-of-art tools are applied to un-fold subtle stratigraphic features.

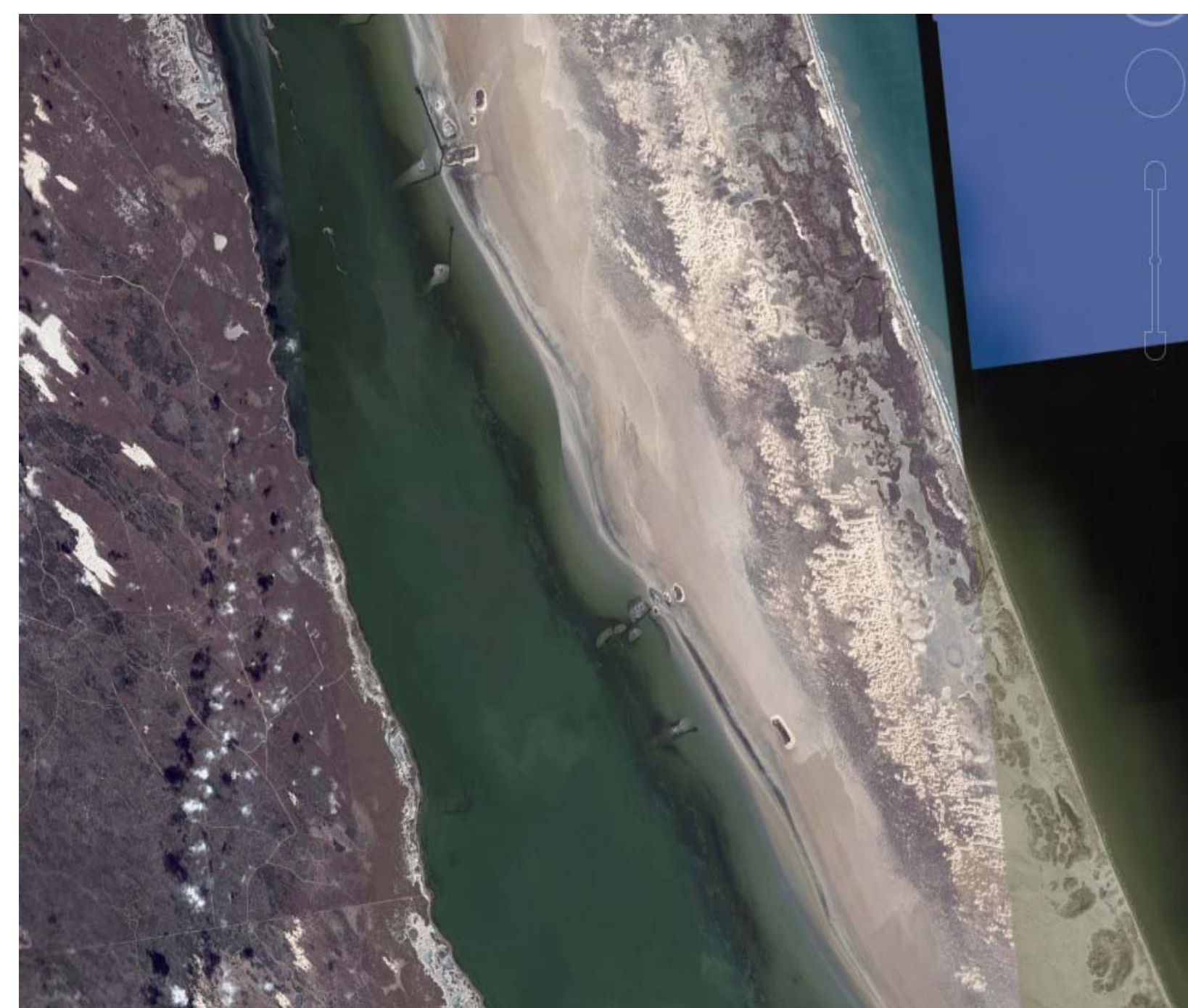
Seismic Data Quality

The seismic data needs to be processed with zero-offset processing in order to recover the amplitudes which truly reflect the underlying geology. The extracted amplitudes along the horizons and other attributes like peak/trough ratio and peak-trough distance are then compared to separate some of the sand signatures from above and below. Cardium main sand is usually 10-20 m thick and on seismic data represents itself as a trough on peak. Cardium formation comprises of numerous small unconformities which makes their geometry very complex. Seismic signatures of these complexities need to be observed parallel to the depositional time lines. Seismic sequence stratigraphic tools including horizon cube are applied to slice through the seismic to comprehend the features which could create permeability barriers.

Attributes and Neural Network Analysis



Modern Analogue—Galveston, Texas
Lagoon-strandplains-beach-ocean



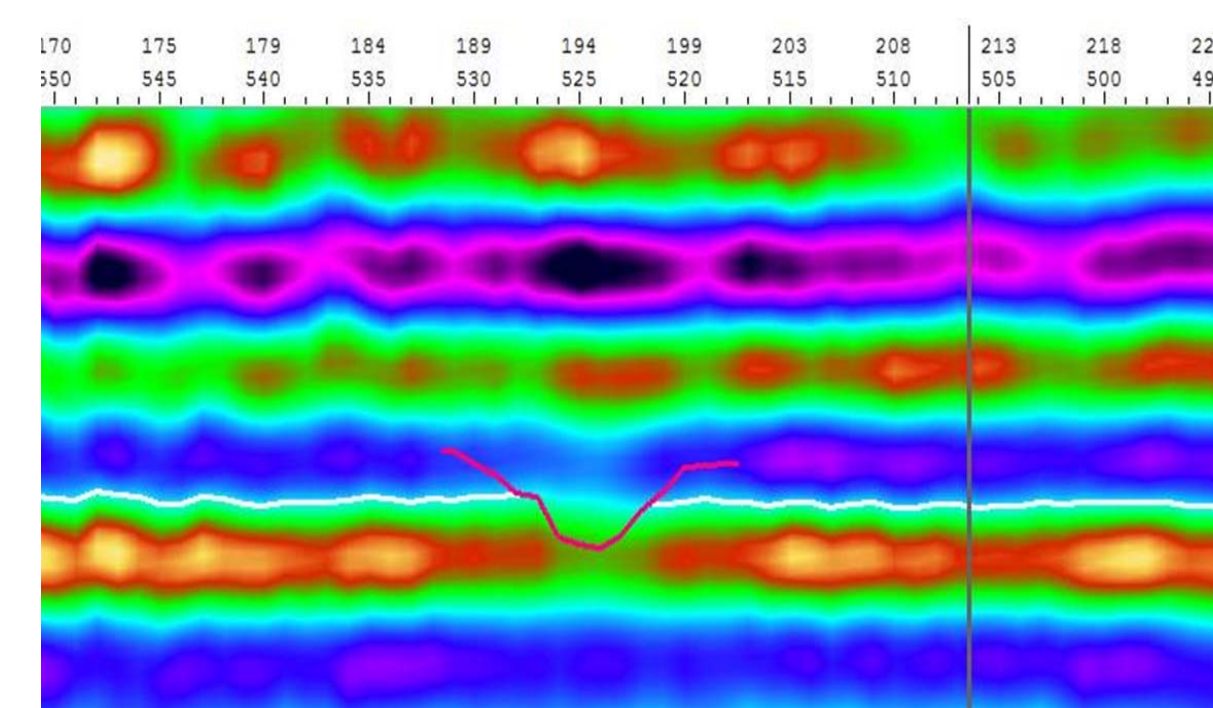
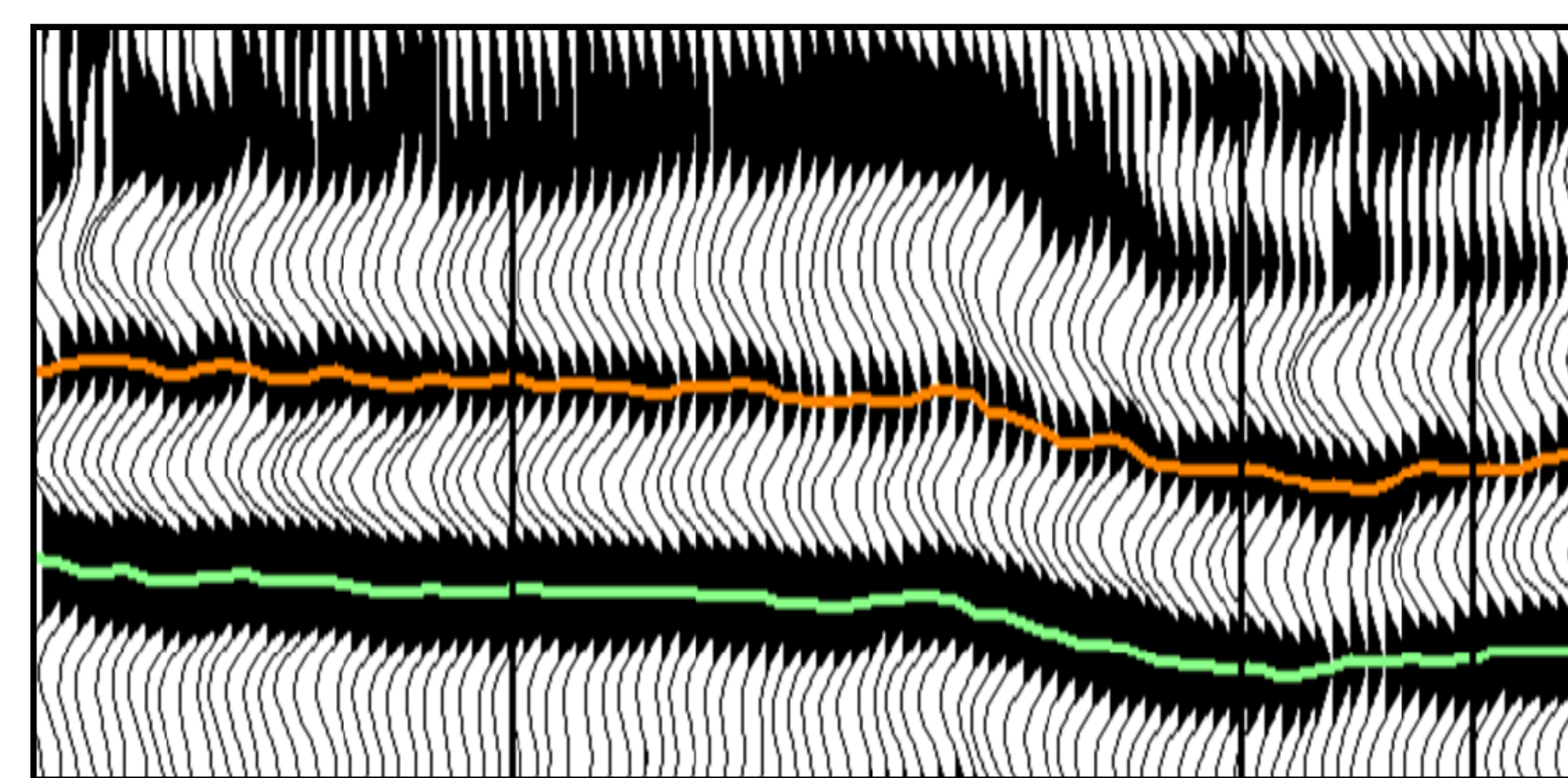
The isopach of Kakwa member shows a major change of thickness in the project area, although many wells to the NE show up as an anomalous thickness. The seismic facies map closely correspond to the thickness and reveals many other facies variations that may correspond to subsequent erosional events.

Spectral Decomposition revealing channel and shorefaces

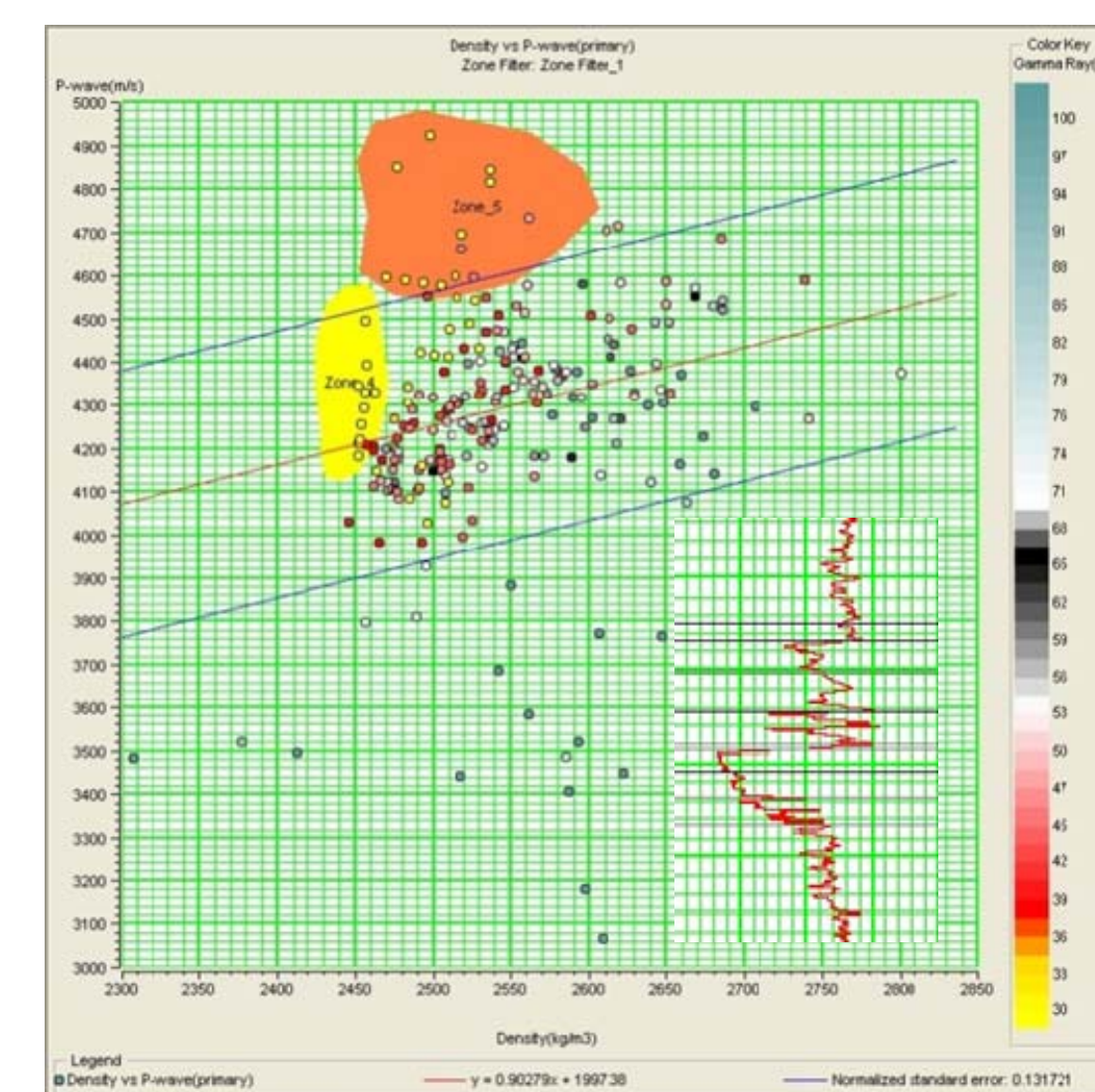
Spectral decomposition with RGB color blending is a tool which is extensively used in the visualization to separate the areas of various thicknesses and to learn the frequency tuning of thin intervals. An RGB blended cube with 30, 40 and 60 Hz frequency shows the variation in the main sand separating the effects of the lithologies above and below the target tight sands.

The Cardium Channel

Post-stack seismic showing very little variation visible by normal interpretation methods

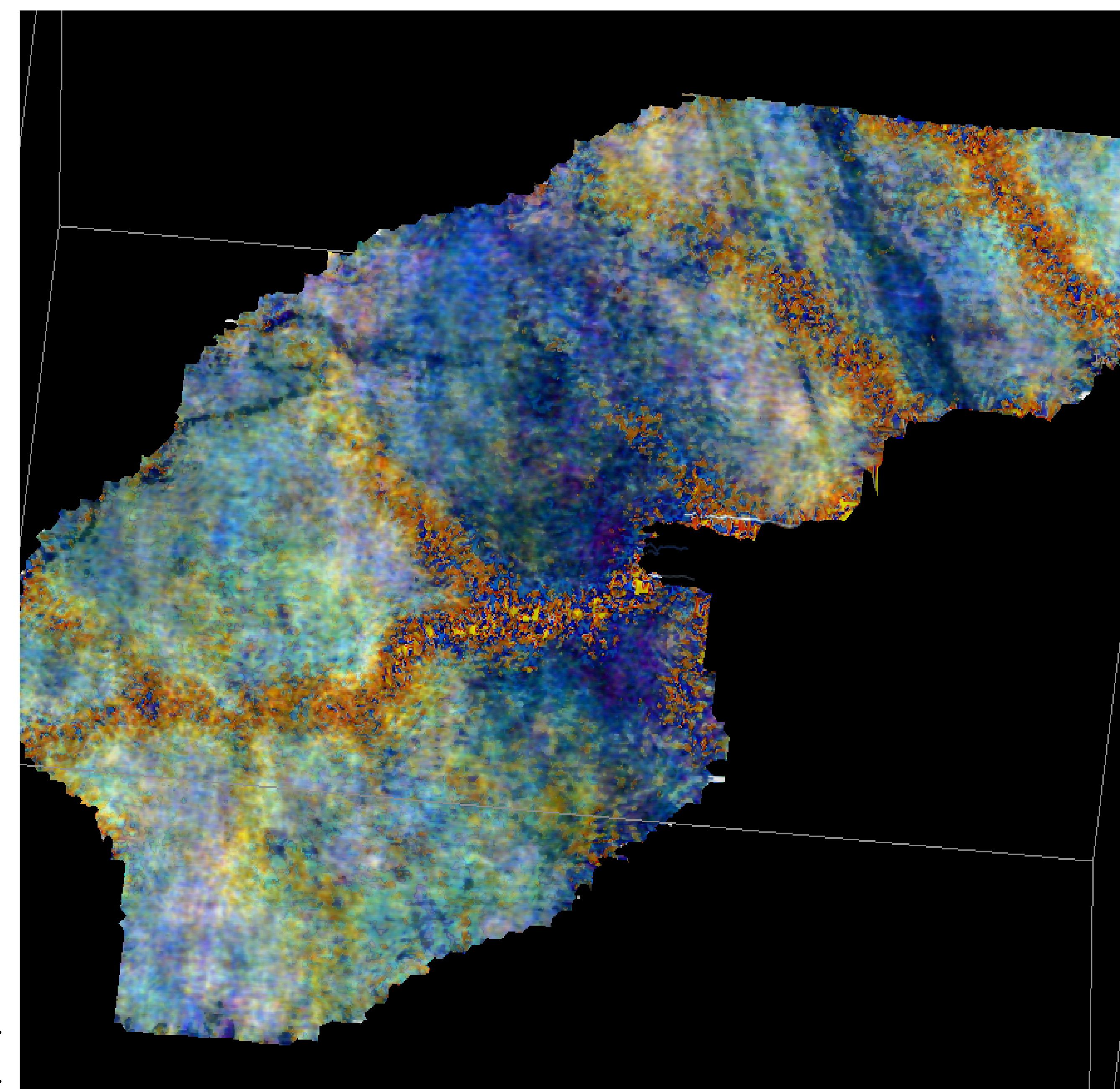


Sonic vs Density x-plot



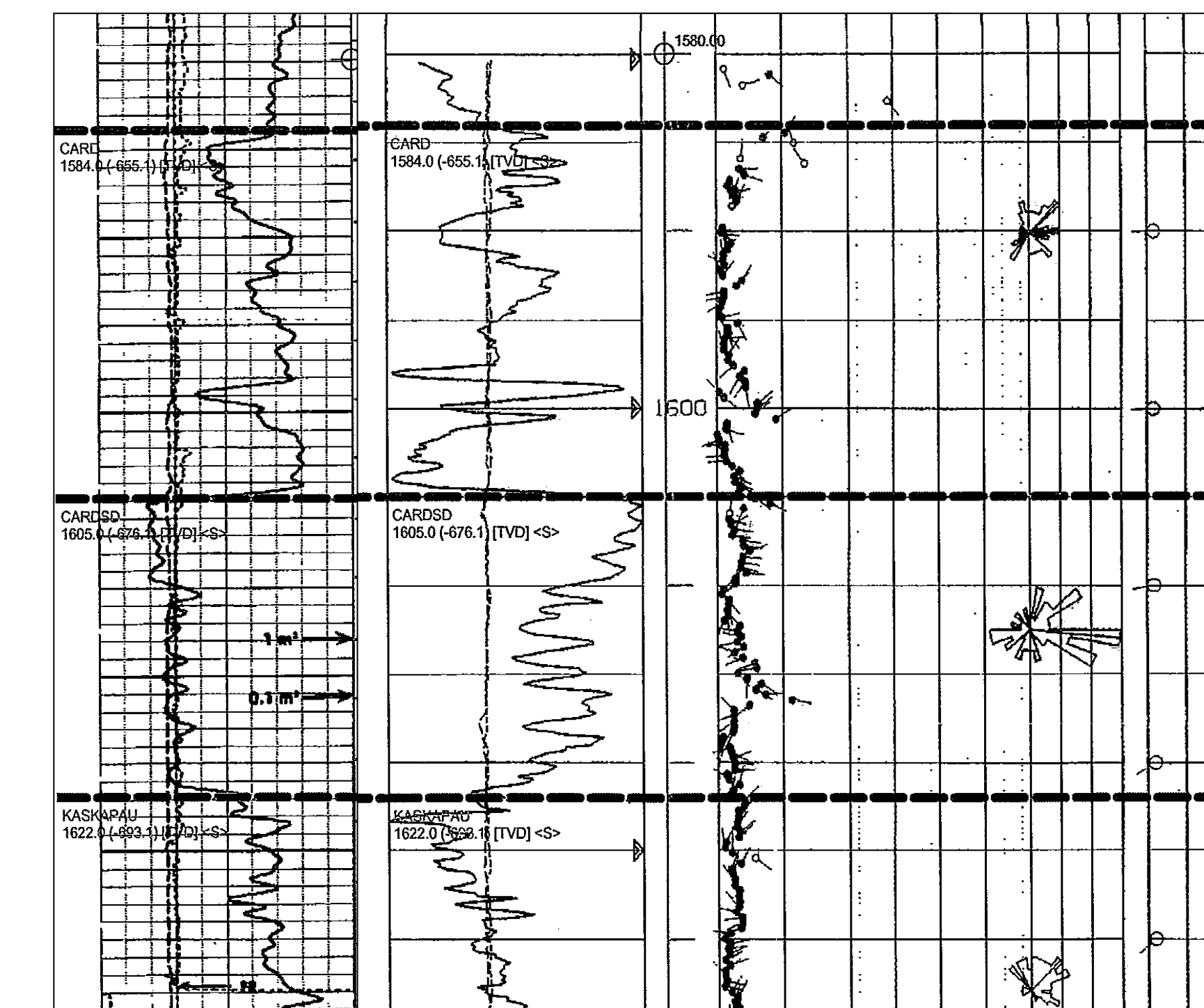
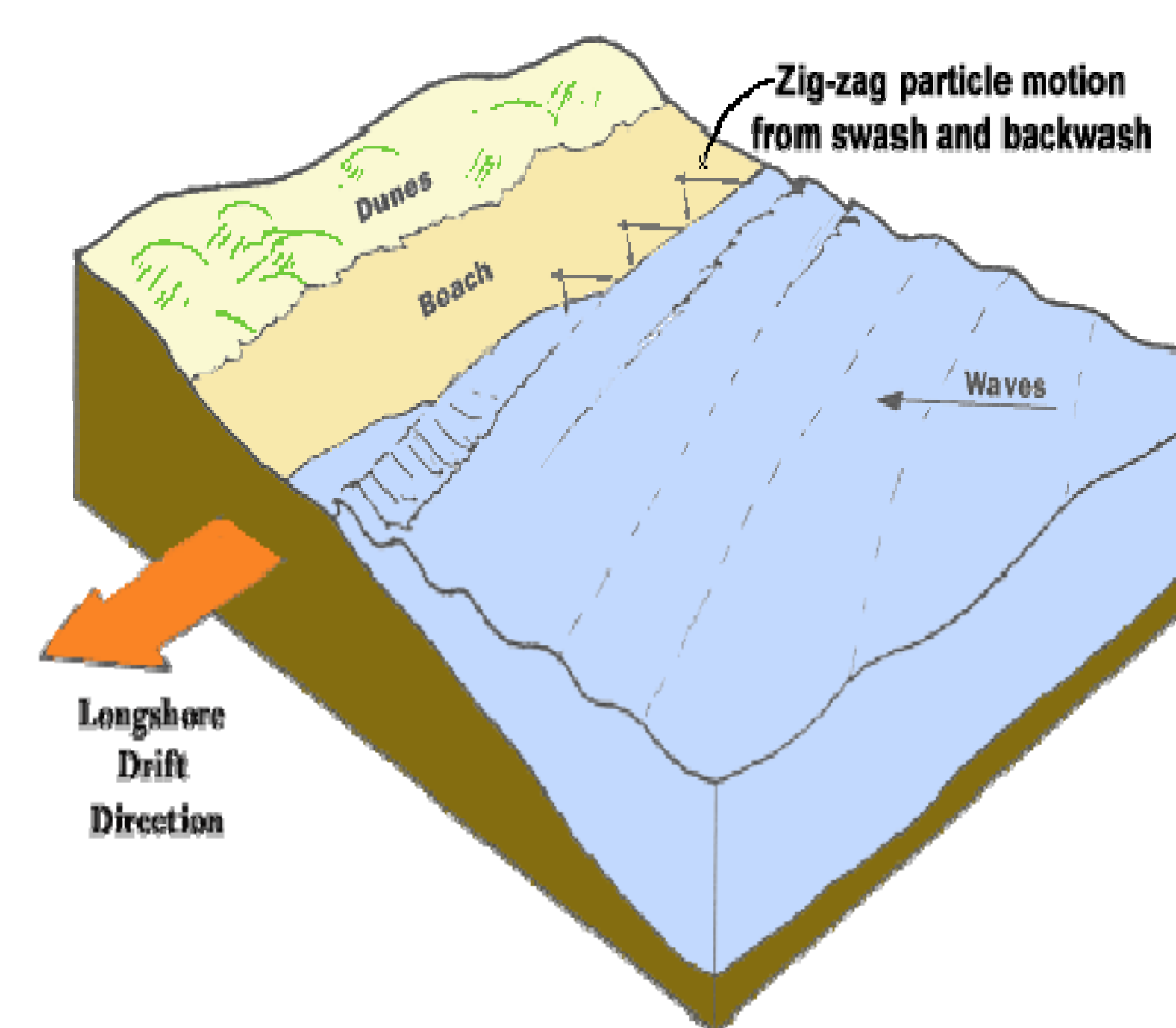
Post-Stack Inversion

Individual shorefaces seen through well analysis cannot be resolved by interpreting the seismic data due to limited bandwidth. Post stack inversion using sequence stratigraphic framework to produce backgrounds does reveal the stacking pattern of depositional timelines.



The Geological Model

The seismic and dipmeter data shows the longshore drift model and can help in planning horizontal wells. The high permeability shoreface chert dominated sand can be tracked on seismic



Conclusions

High resolution sequence stratigraphy associated with seismic attribute analysis can help distinguish paleo-geographic features and natural sediment lineaments within Cardium formation. Moreover, the areas with different lithology and fluid types can be recognized using interval analysis. Seismic reservoir characterization tools allow better development drilling and if followed in conjunction with other data may result in better application of fracture simulation and eventually better yield of oil from tight oil sand package.

We conclude in this study that using seismic reservoir characterization along with high-quality 3D data and target oriented processing can make a huge difference in understanding the geology when it comes to development drilling and locating the areas of maximum yield in tight oil play.

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