Prediction of Reservoir Quality with Seismic Attributes in Eocene Submarine Conglomerates (Calclithites), Mexico

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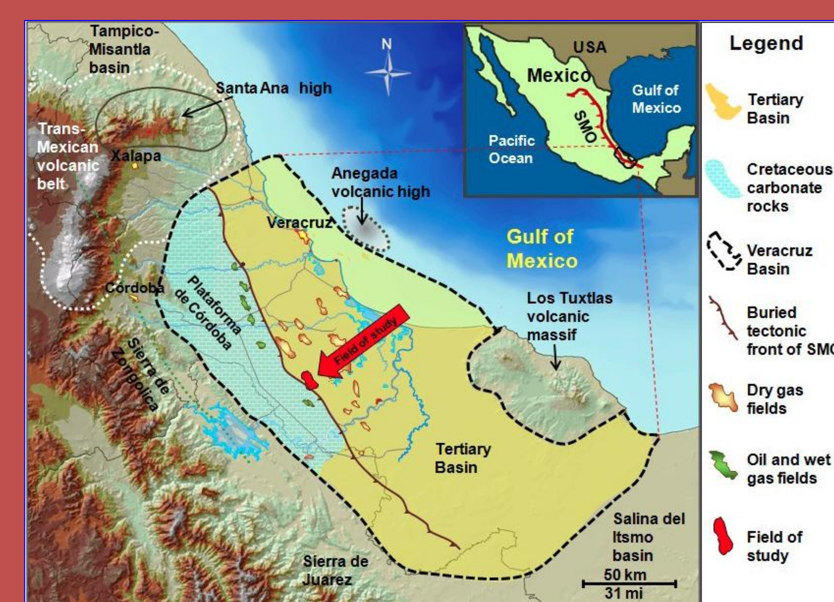
Objective

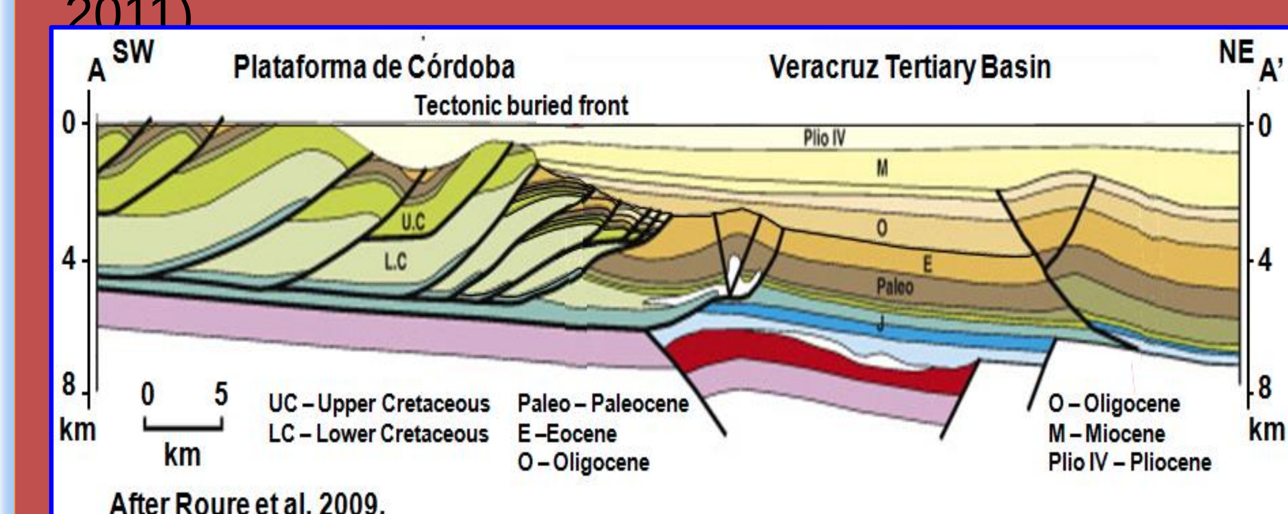
Use surface seismic data to predict changes in porosity and facies associated with reservoir quality of this redeposited carbonate oil field in the Veracriz Tertiary Basin. By better understanding of this field we may be able to extent the play concept to to find similar areas along the unexplored eastern margin of the tectonic front of Veracruz Basin

1. Geology

The Veracruz Tertiary Basin (VTB) produces dry gas and a minor quantity of oil in the field of study located at its western margin. The VTB is the second most productive basin of non-associated Gas in Mexico. The Tertiary target is of particular interest since VTB has primary Mesozoic rather than Tertiary oil production. The field of study produces mainly from Eocene resedimented carbonates eroded from Cretaceous strata (PEMEX, 2011).

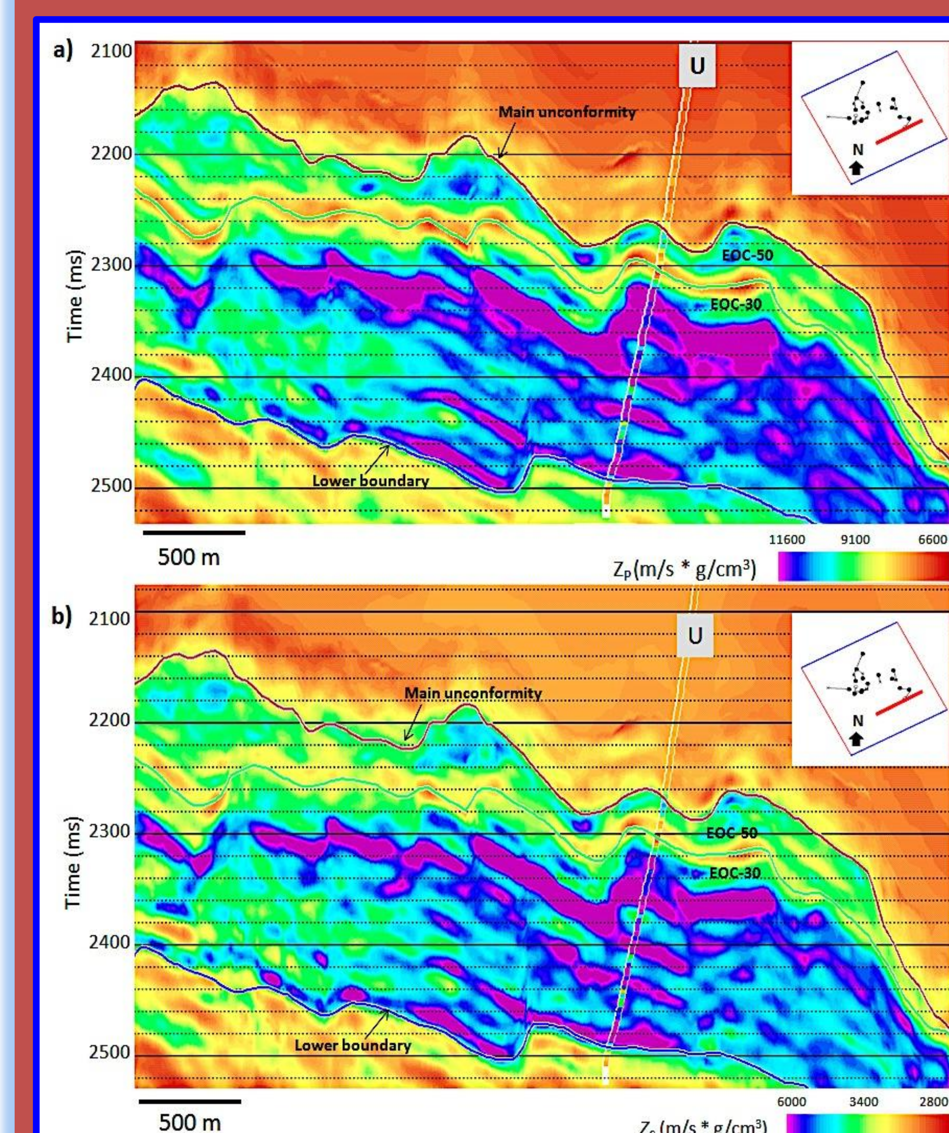


Detail of the Veracruz Basin showing its boundaries and its two geological subprovinces: The Plataforma de Córdoba and the Veracruz Tertiary Basin. The field of study (indicated by the red arrow) is located in the eastern margin of the buried tectonic front in Upper and Middle Eocene age Tertiary sediments (Map courtesy of PEMEX E&P).

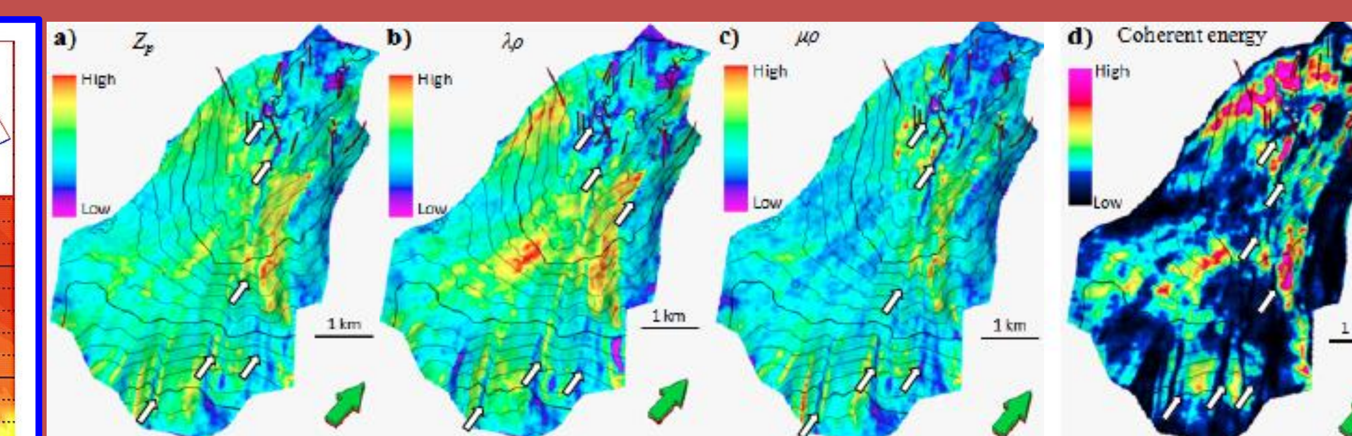


Structural cross-section through the Veracruz Basin. The Veracruz Tertiary Basin is a foreland basin filled with Tertiary sandstones, shale and conglomerates.

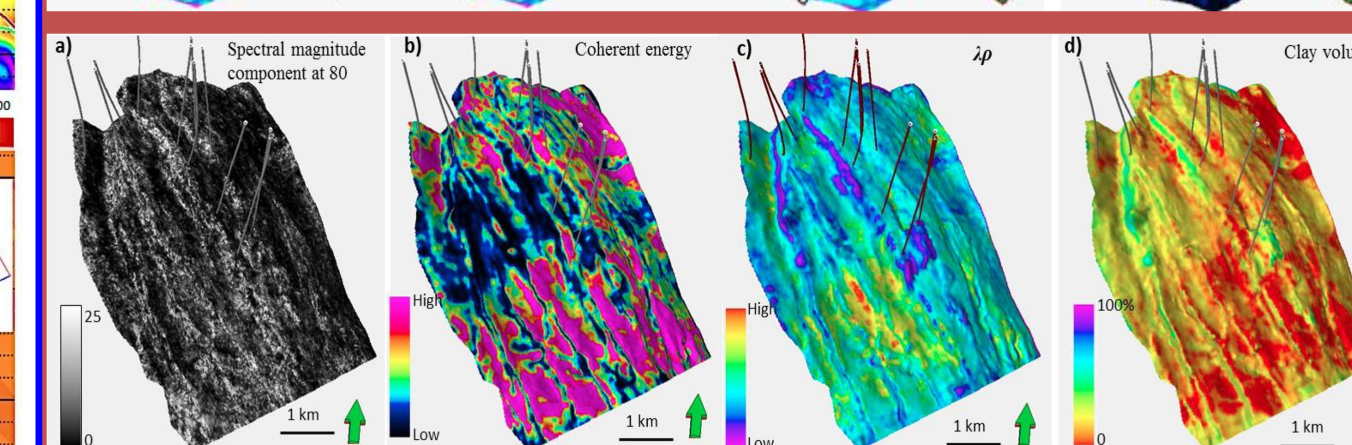
2. Seismic Inversion for rock properties



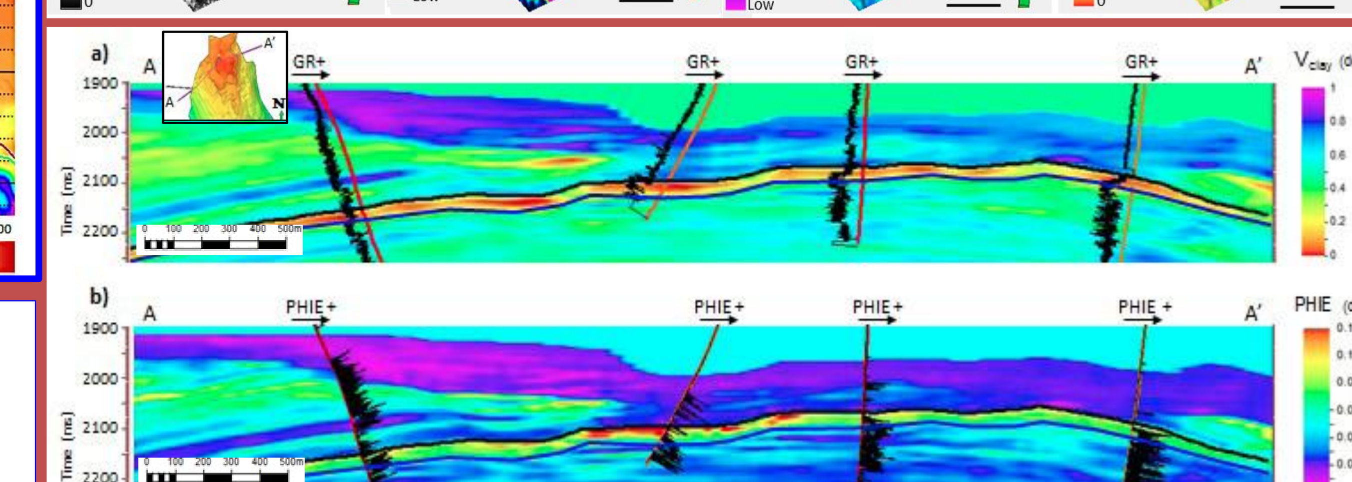
Vertical slices thought (a) P-wave and (b) S-wave impedance resulting from model-based simultaneous inversion.



Horizons slices through (a) P-impedance, (b) λρ, (c) μρ, and (d) coherent energy 10 ms below the top of EOC-10. Note that high coherent energy areas correlate with relatively high μρ and λρ.



Horizons slices through (a) spectral magnitude component at 84Hz, (b) coherent energy, (c) inverted λρ and (d) clay volume calculated with PNN. High coherent energy correlates with low clay and high λρ.



Vertical seismic section through (a) clay volume and (b) effective porosity. The black and blue horizons correlate with the unit of interest. The predominant facies have low clay content (warm colors). The reservoir unit is limited by clay-rich facies.

4. Conclusions

- Porosity has been successfully predicted in many carbonates reservoir using just poststack seismic inversion. However, exploratory data analysis of my well measurements showed that P-impedance is insufficient to predict porosity of my carbonate wash facies.
- Well correlation shows that the clay volume was successfully predicted by a supervised neural network and can be used with confidence to identify clay-rich facies. In contrast, effective porosity was underestimated. This inaccuracy is linked to the resolution of the method, which is insufficient to illuminate changes in porosity of the thin layered, interbedded cemented and porous calclithites.
- GTM seismic facies provided a more effective identification of reservoir heterogeneity, consistent with production data.

5. Acknowledgements

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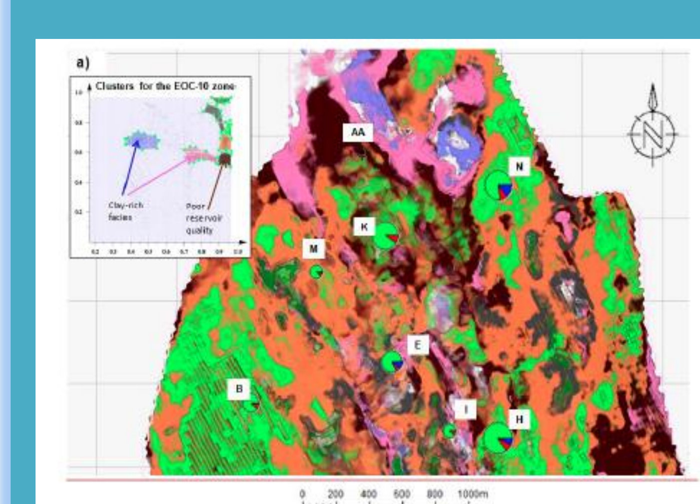
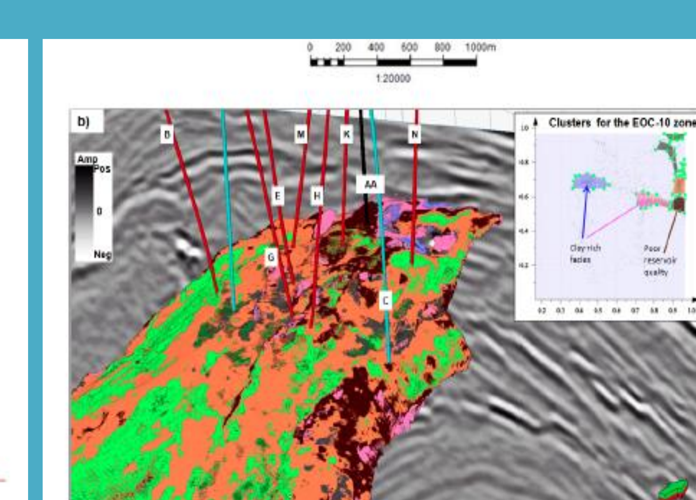
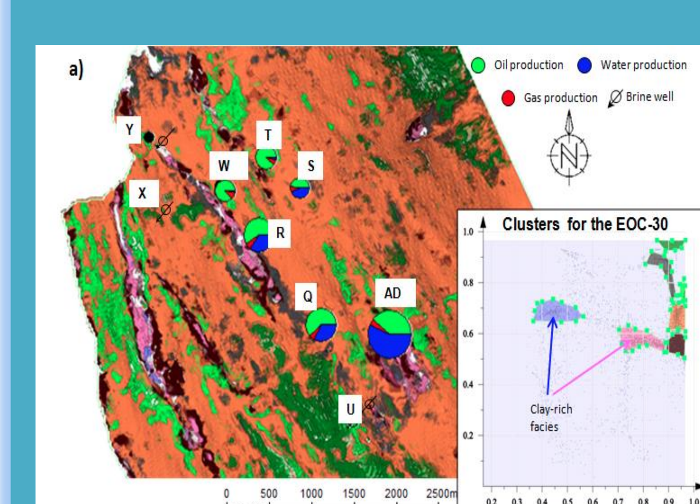
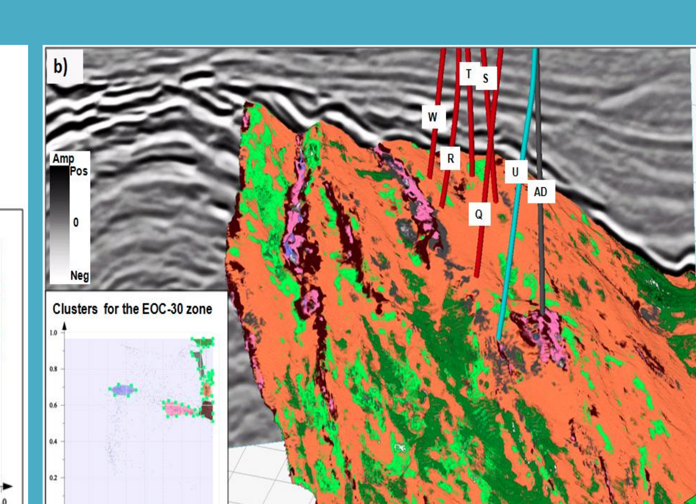
3. Correlation with Production and Facies Classification



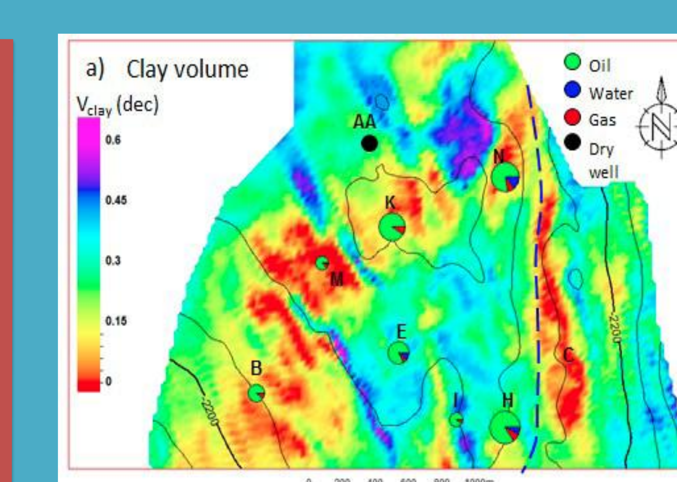


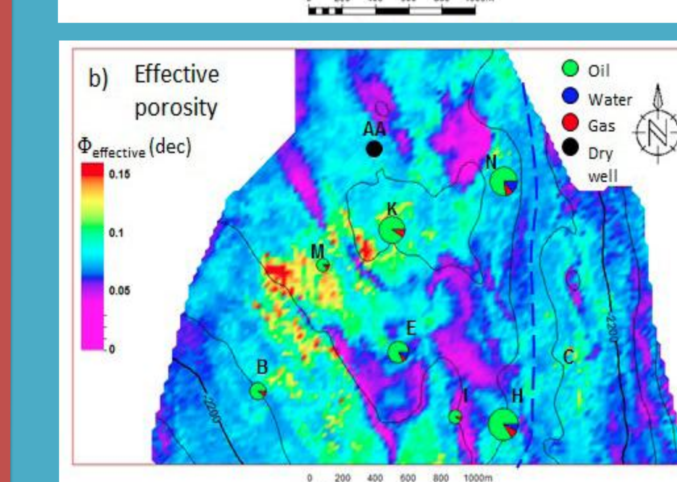
Facies classification from GTM for reservoir unit. (a) Seismic facies map 10 ms below top of EOC-10. Pie charts are proportional to daily average production for the first seven months. (b) 3D view of the volume probe containing clustering from GTM analysis. Insert crossplots are generated directly in the 2D latent space.





Facies classification from GTM for reservoir unit EOC-30. (a) Seismic facies map 10 ms below top of EOC-30. Pie charts are proportional to daily average production for the first 7 months. (b) 3D view of the volume probe containing clustering from GTM analysis. Note that most productive wells fall in orange seismic facies.





Higher production is not associated with highest effective porosity or with clay content