

Accounting for rock physics models in stochastic seismic inversion

MSc Candidate:

Catarina Amaro

catarinampa11@gmail.com



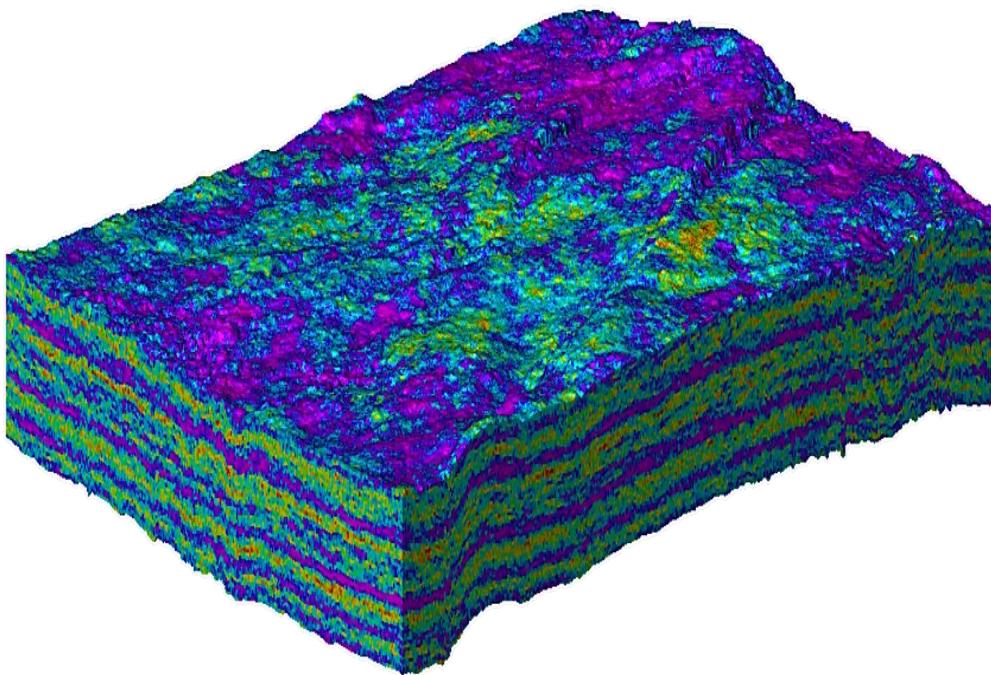
TÉCNICO LISBOA

Prof. Dr. Leonardo Azevedo



Prof. Dr. Dario Grana

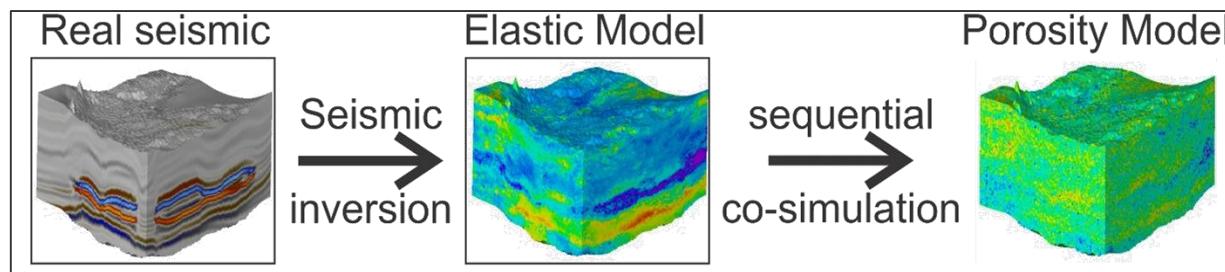
Summary



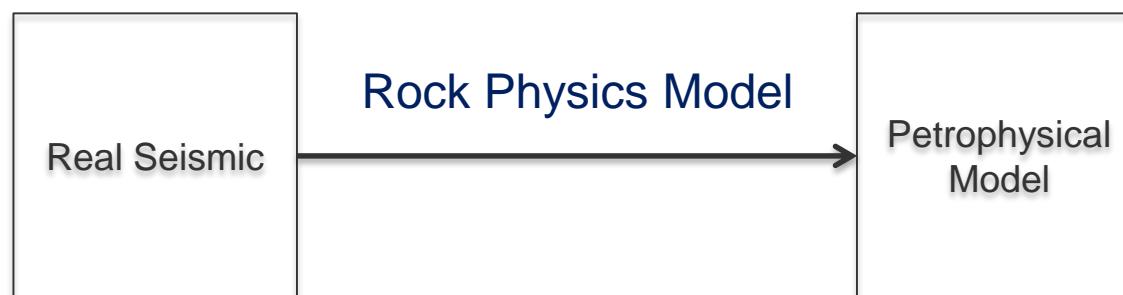
- Motivation
- Rock Physics Models (R.P.M.)
- Proposed methodology
- Available dataset
- Results
- Final Considerations
- References

Motivation

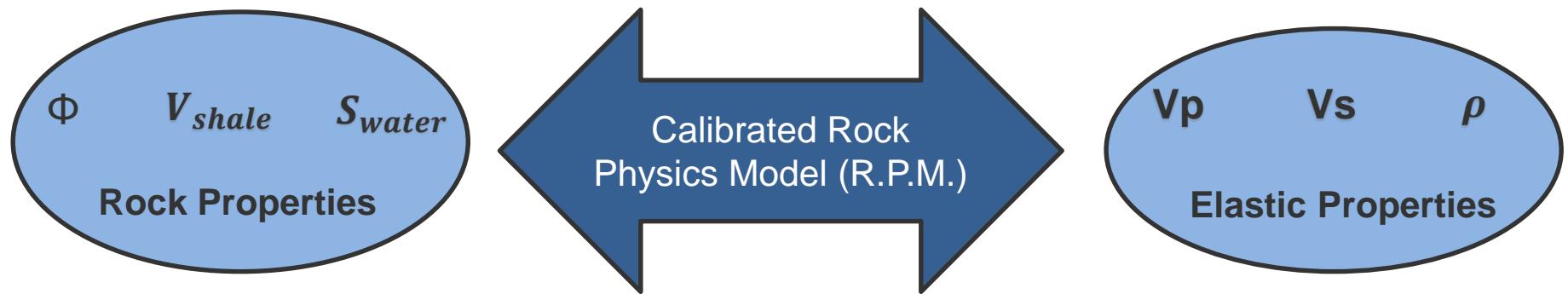
Problem



Solution



Rock Physics Models



R.P.M.

Mineral Parameters,

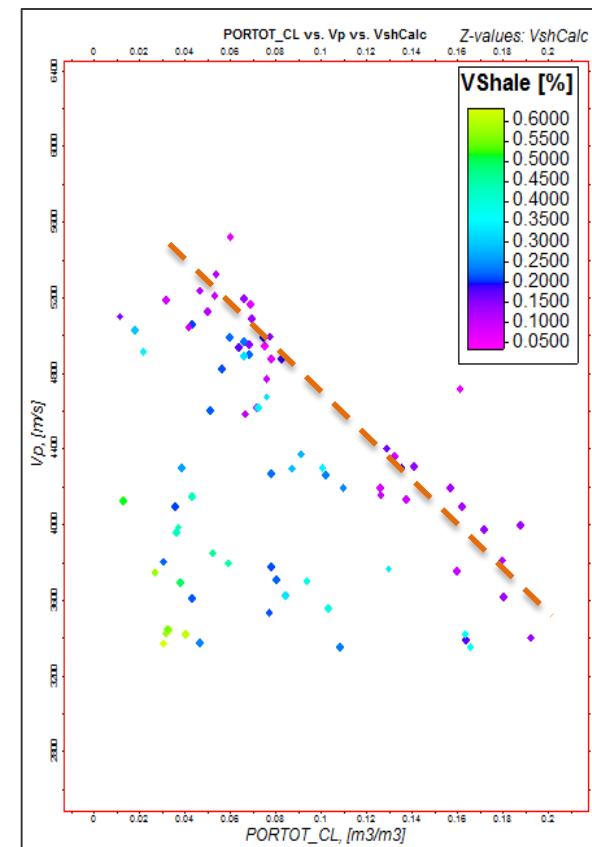
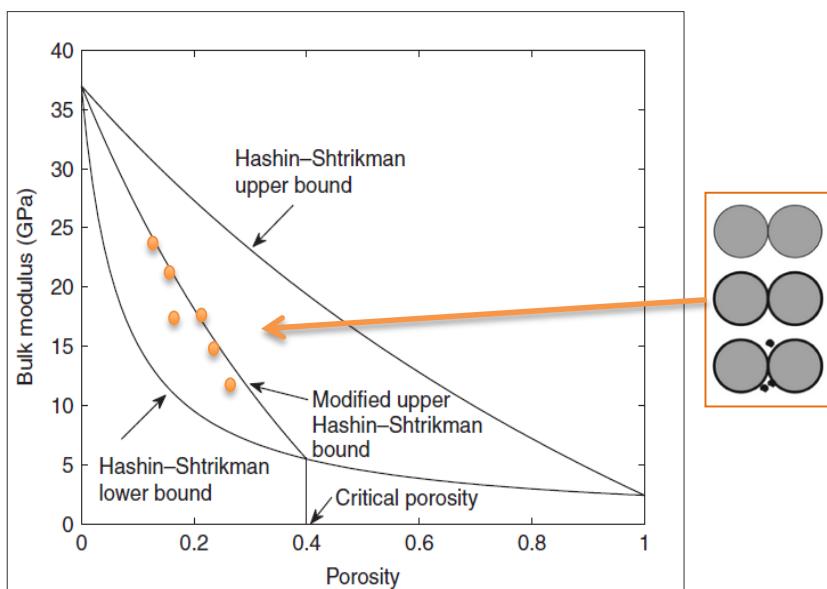
Mineral fractions,

Fluid properties,

Pore type and pore fluid.

Rock Physics Models

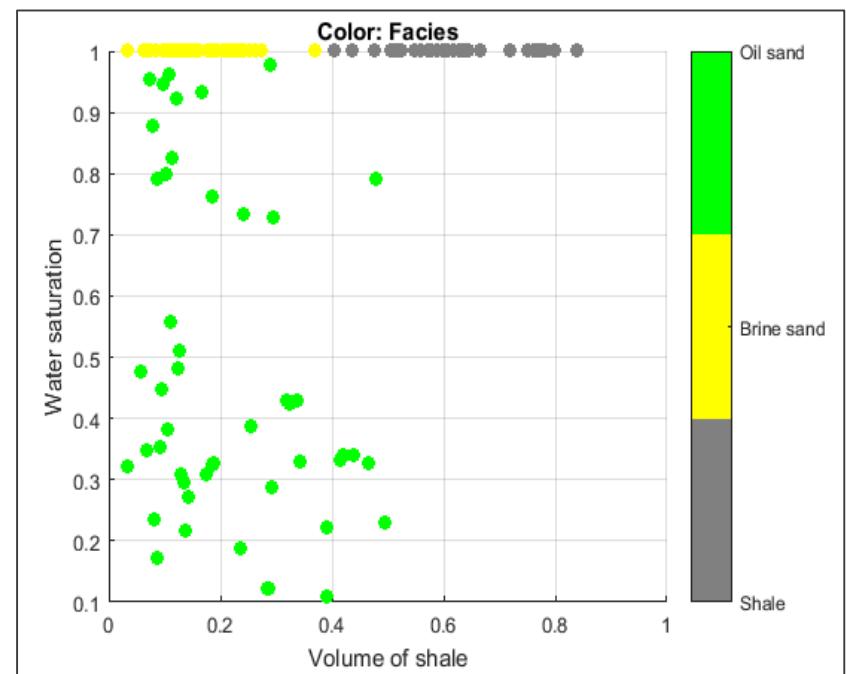
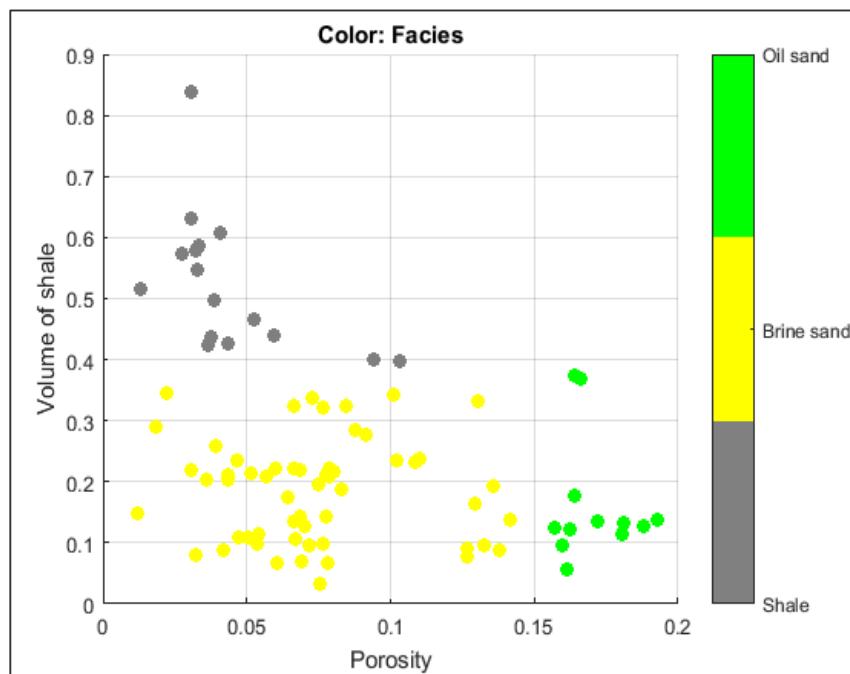
Calibration



Consolidated sand

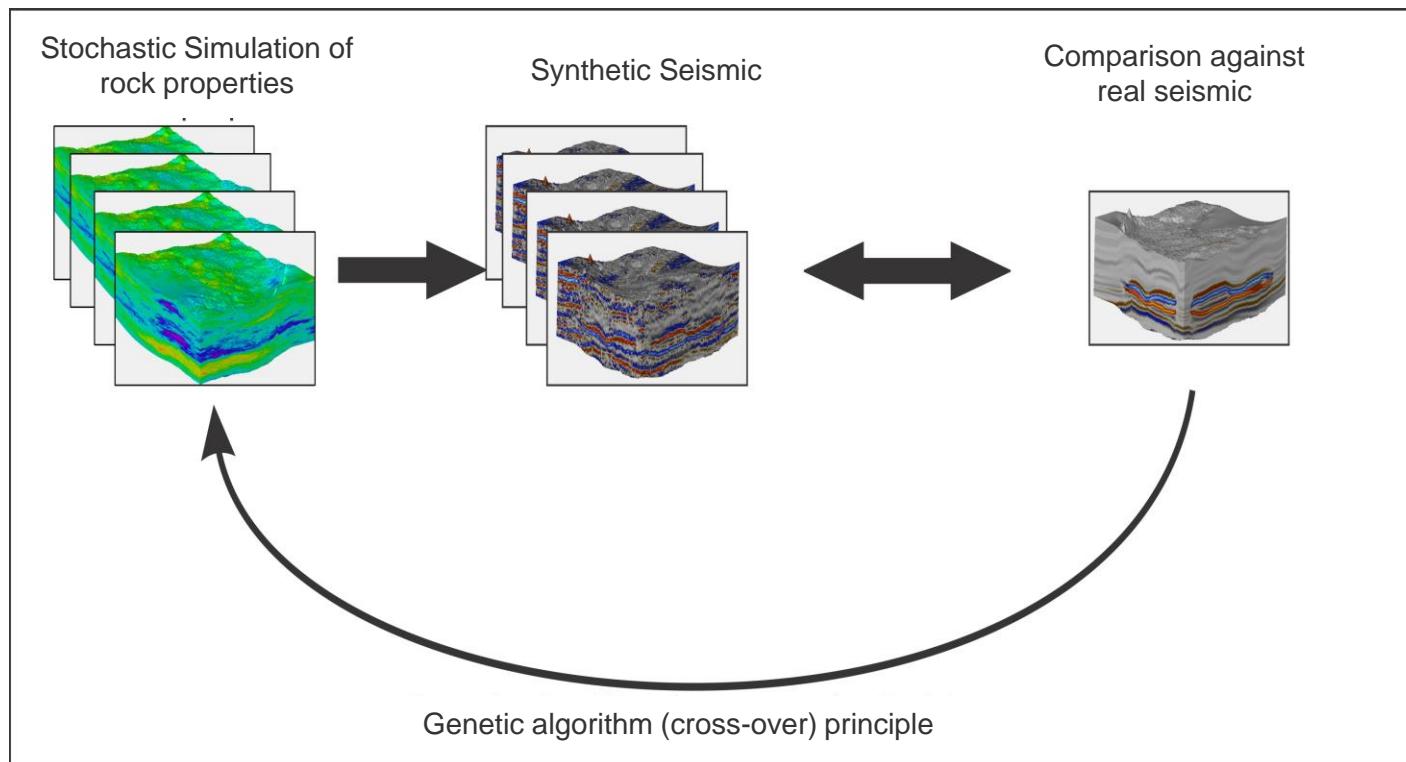
Stiff-Sand
Model

Facies Classification

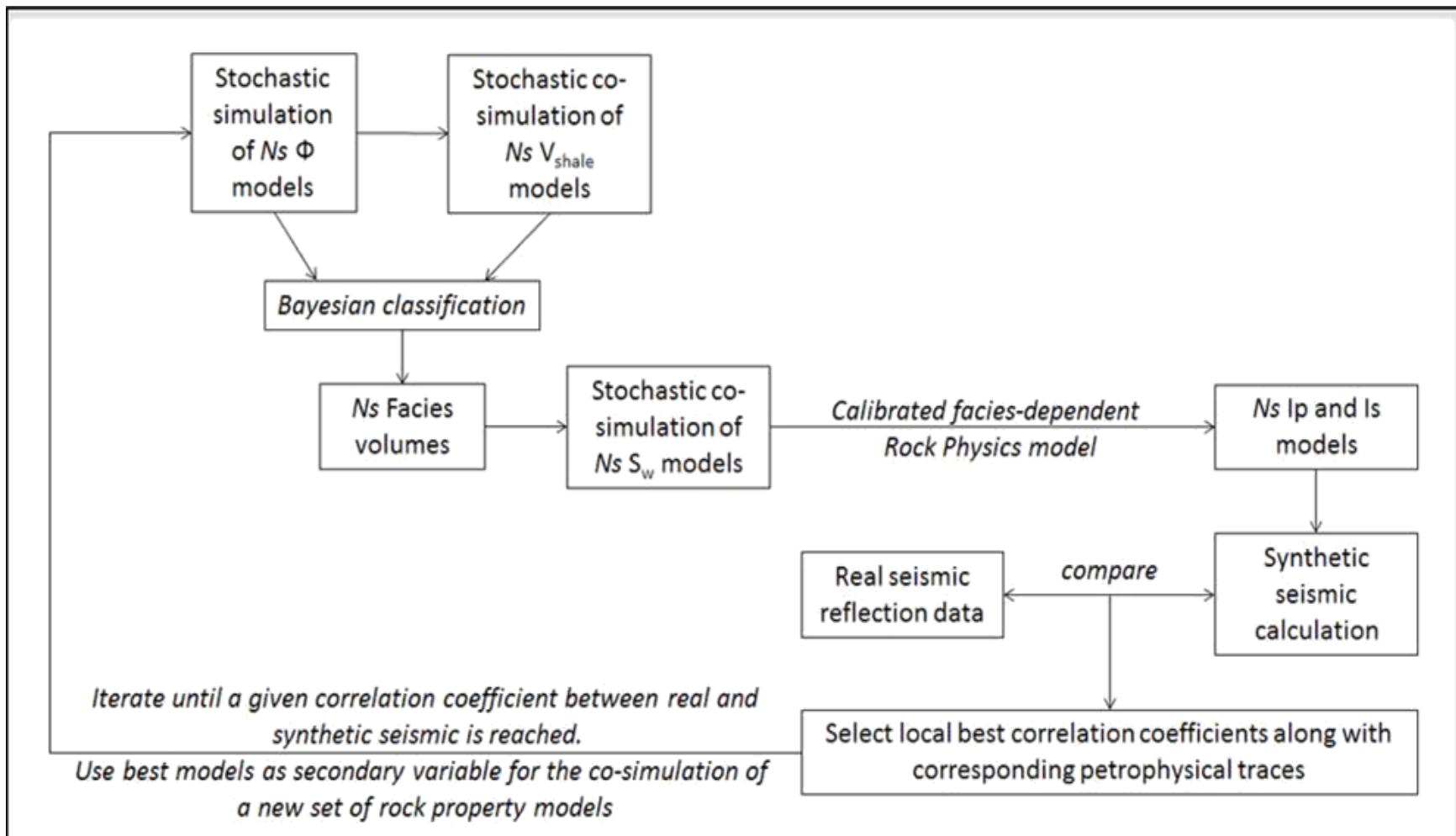


Seismic Inversion

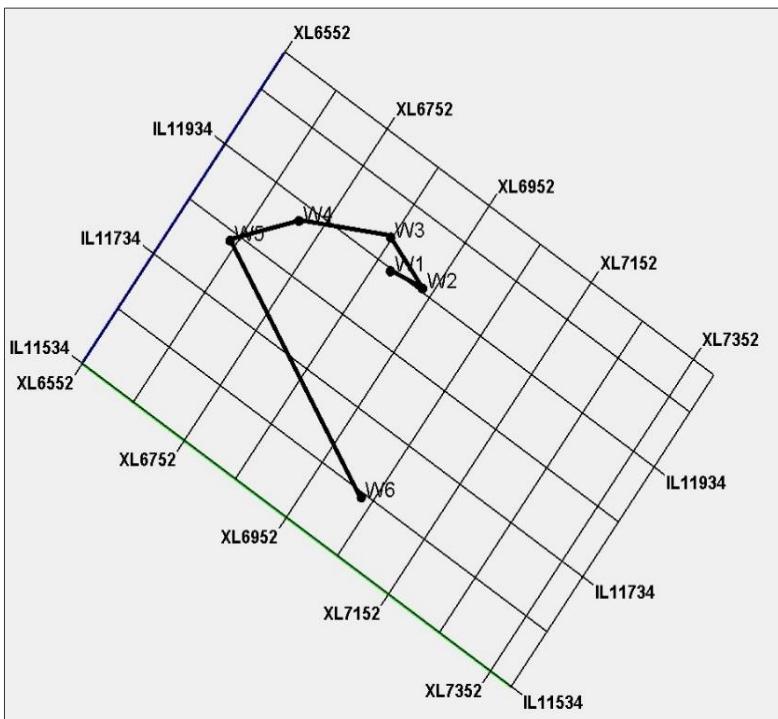
Iterative Geostatistical Inversion



Proposed Methodology

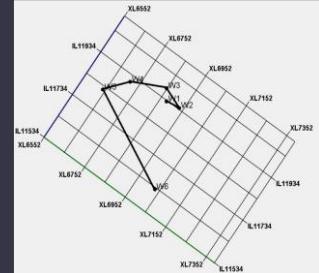


Available dataset



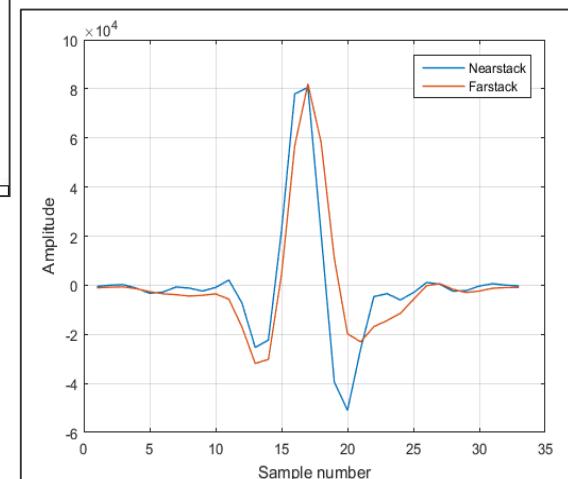
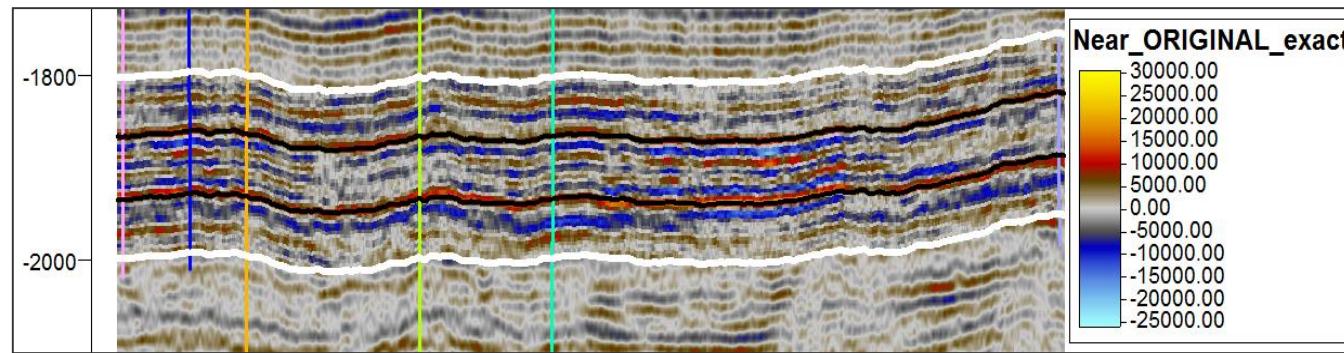
- Two partial-angle stacks: 15° and $27,5^\circ$
- Two angle-dependent wavelets.
- Grid-size: $850 \times 567 \times 49$
- Well-logs for six wells composed by Φ , V_{shale} , S_{water}
- R.P.M.: Stiff-sand model, velocity-porosity-clay relation and Gassmann's equation
- 3 Facies: *Oil sands, brine sands and shales*

Available dataset

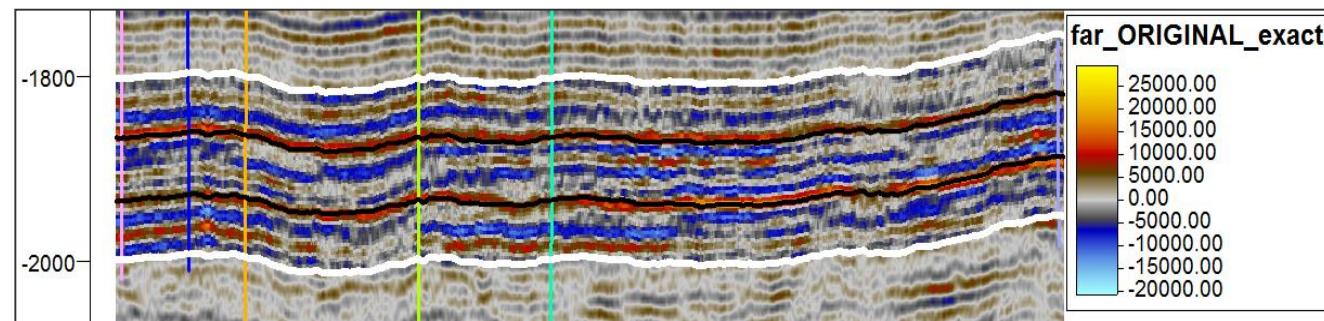


Real partial-stacks

Nearstack

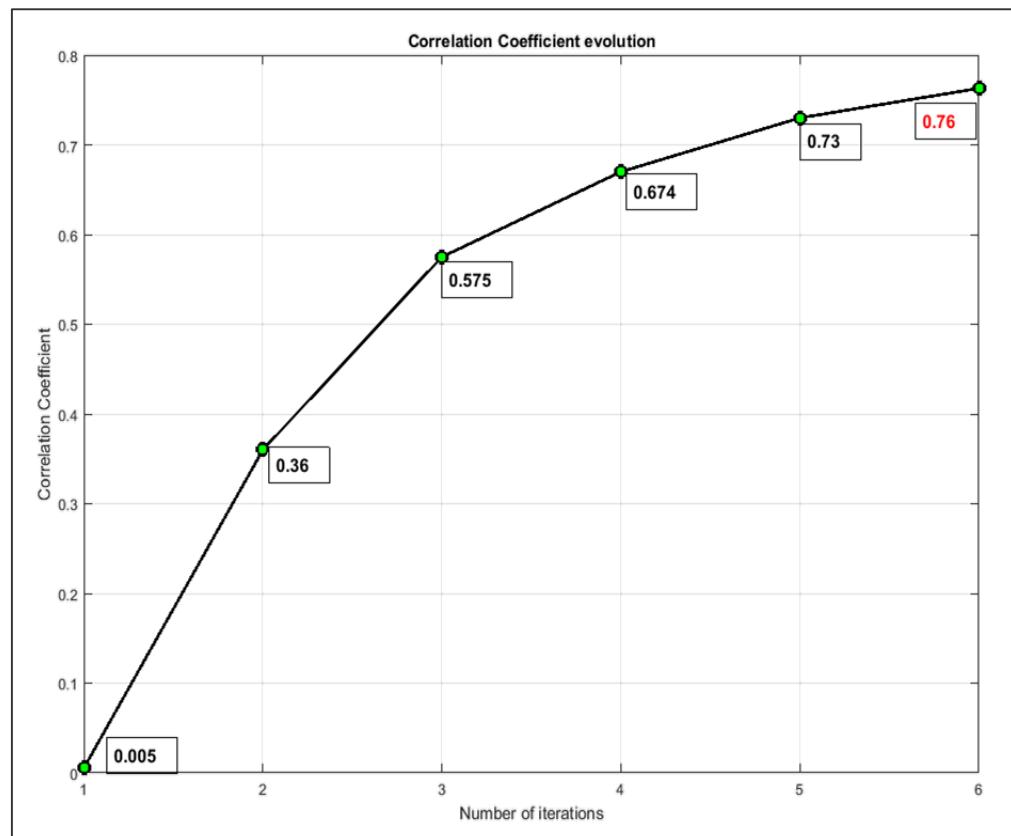


Farstack



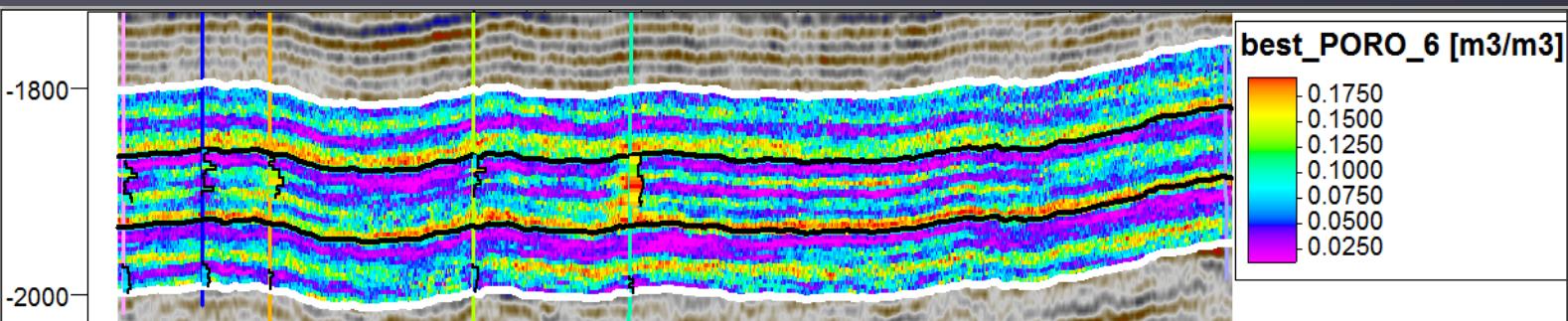
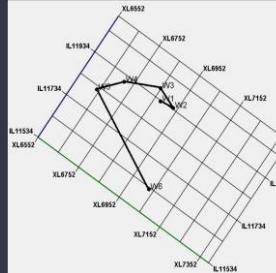
Results

Global correlation evolution

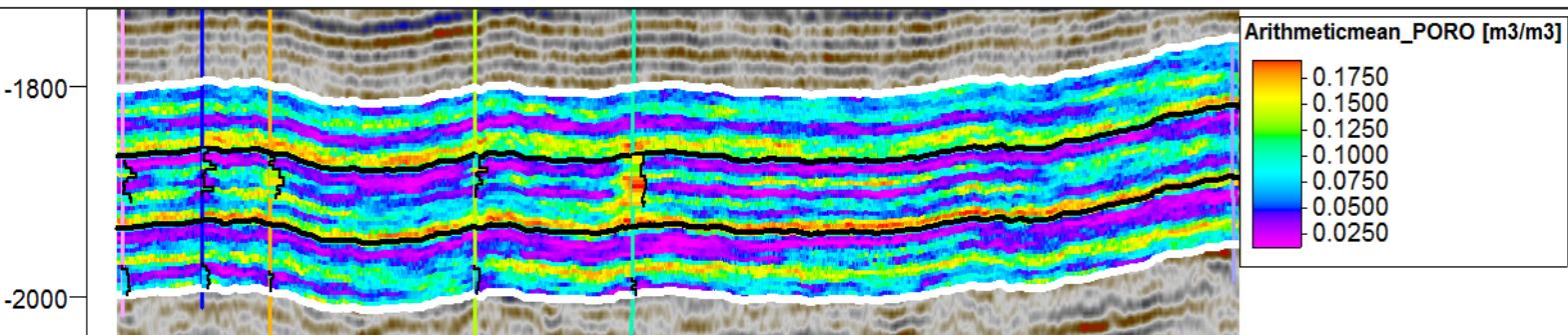


Results

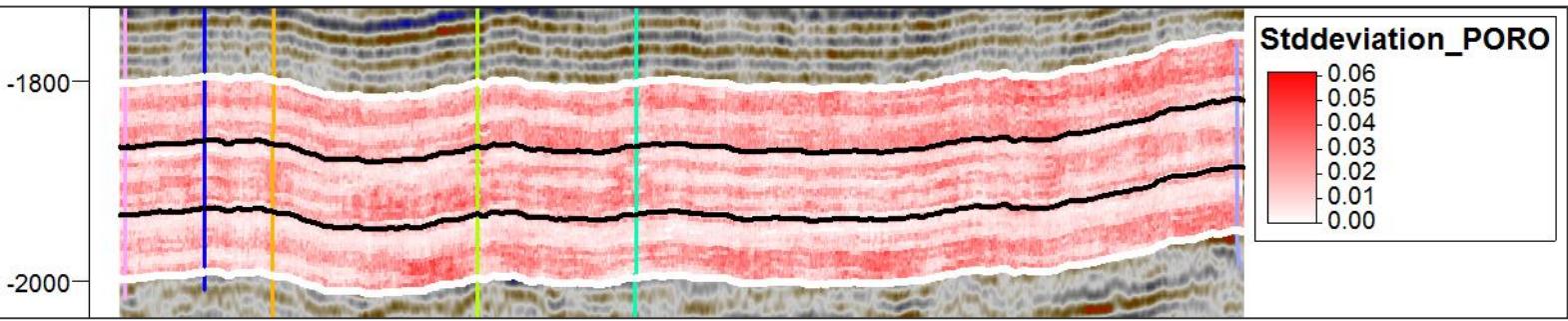
Inverted models of Φ



Best Fit Model



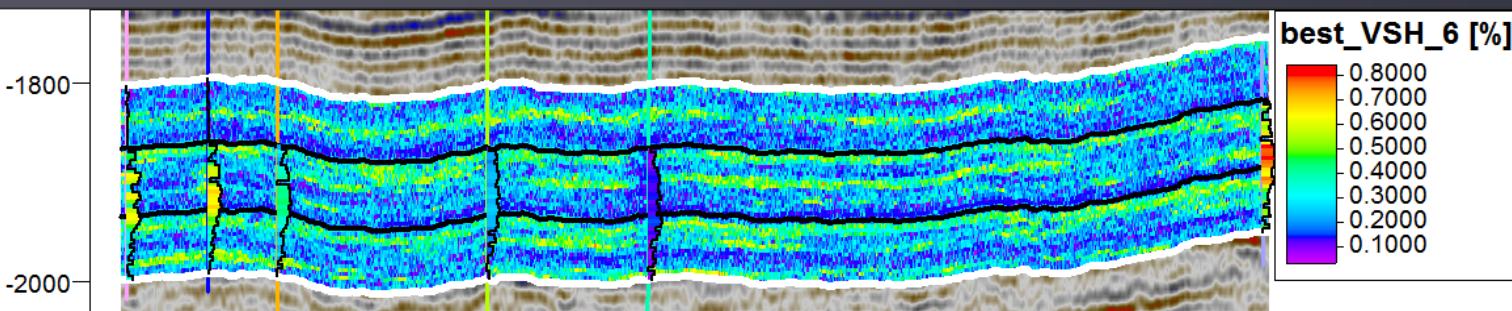
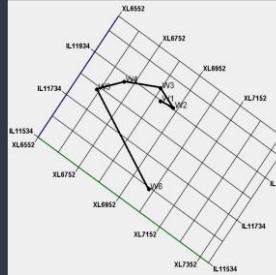
Mean model of the last simulations



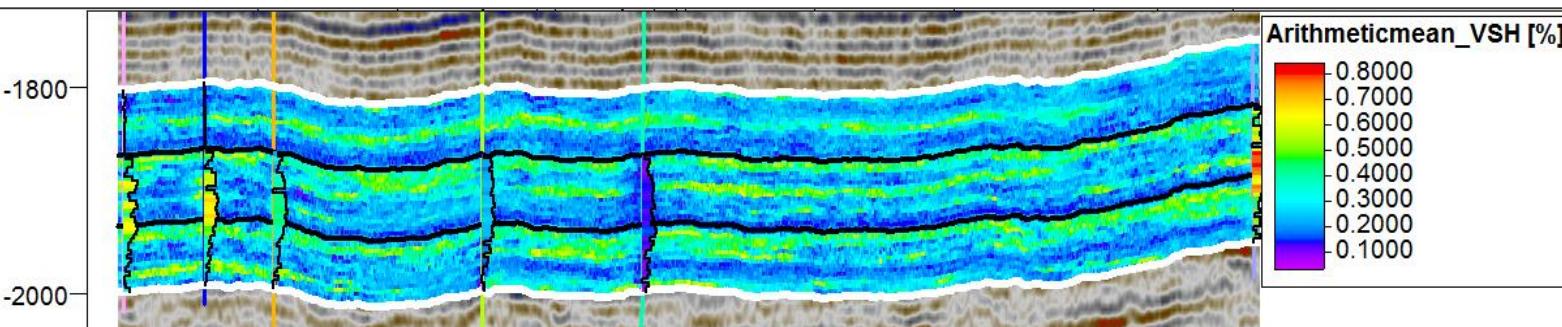
Standard deviation

Results

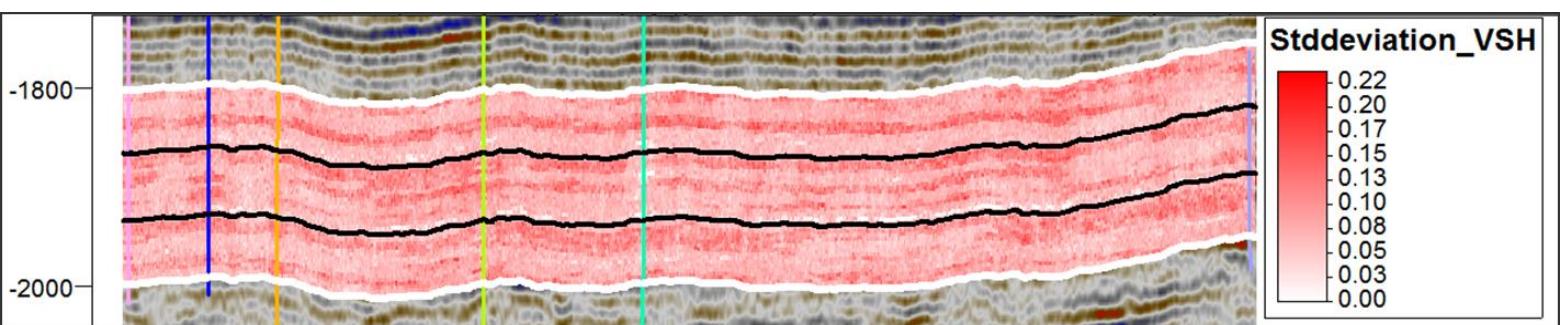
Inverted models of Vsh



Best Fit Model



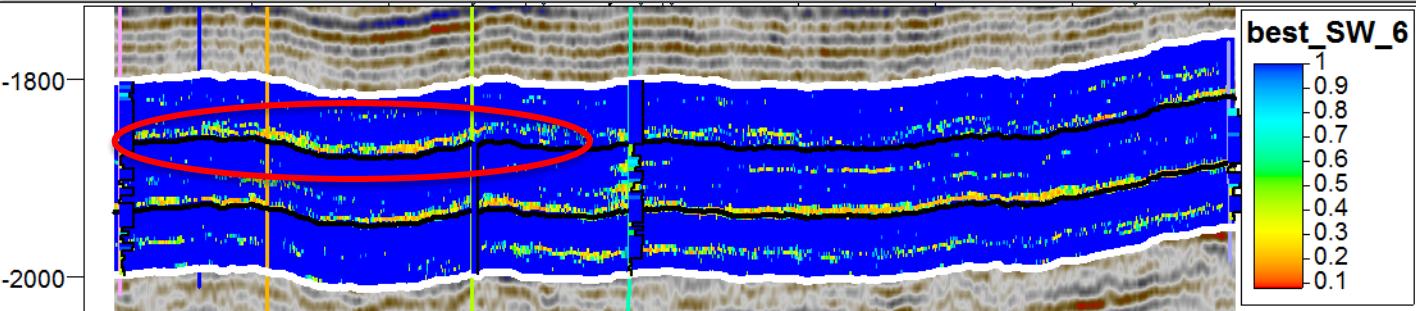
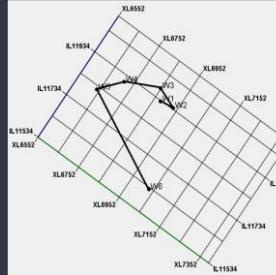
Mean model of the last simulations



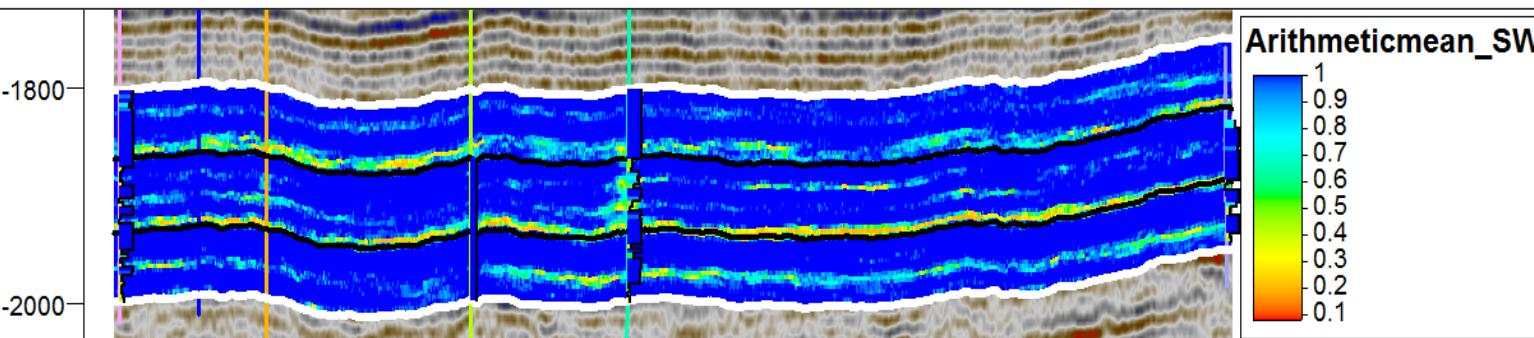
Standard Deviation

Results

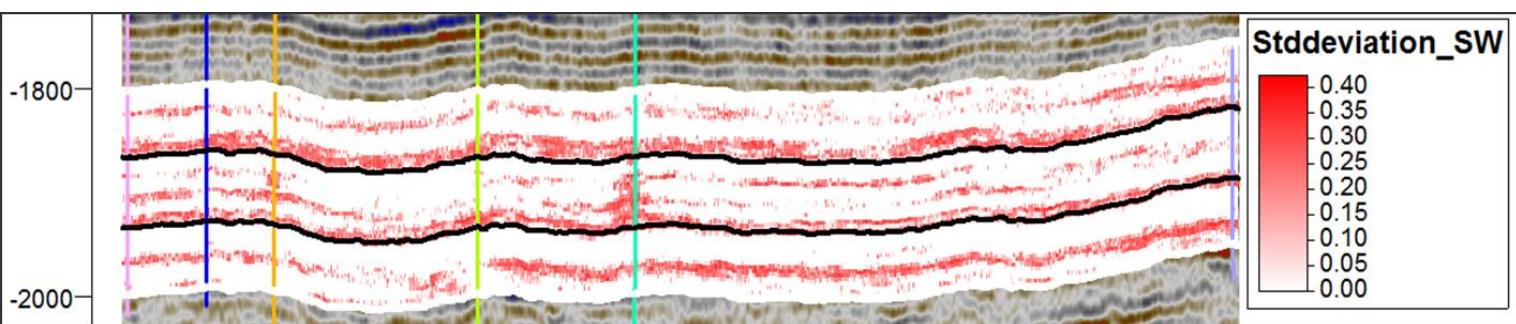
Inverted models of Sw



Best Fit Model

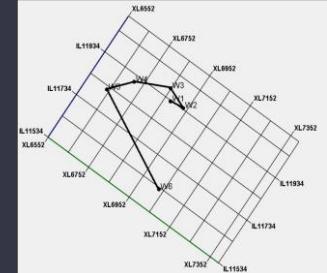


Mean model of
the last
simulations

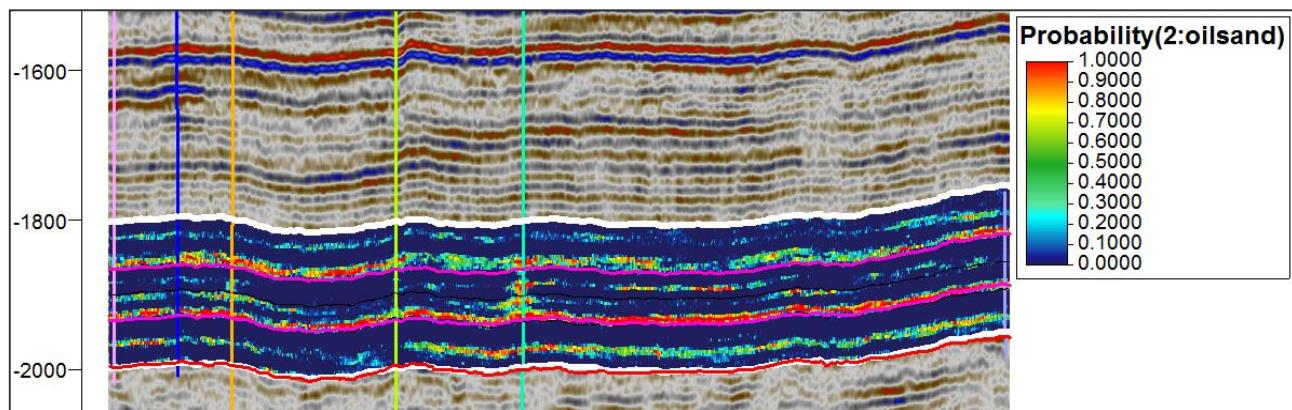
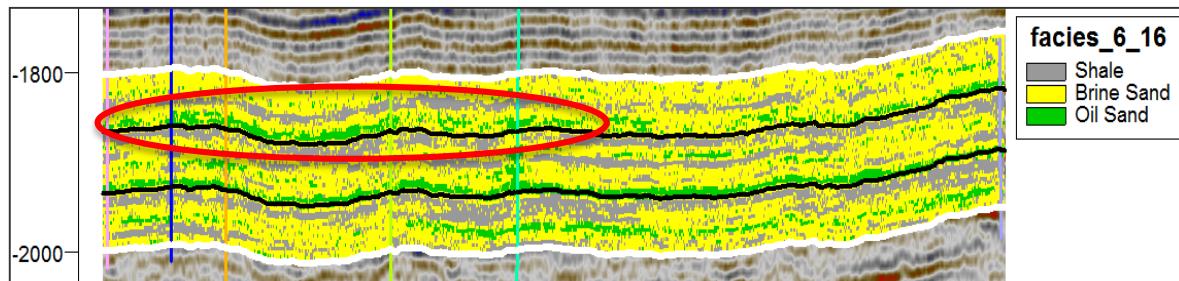


Standard
Deviation

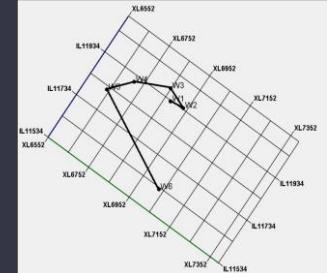
Results



Facies volume - 6th iteration



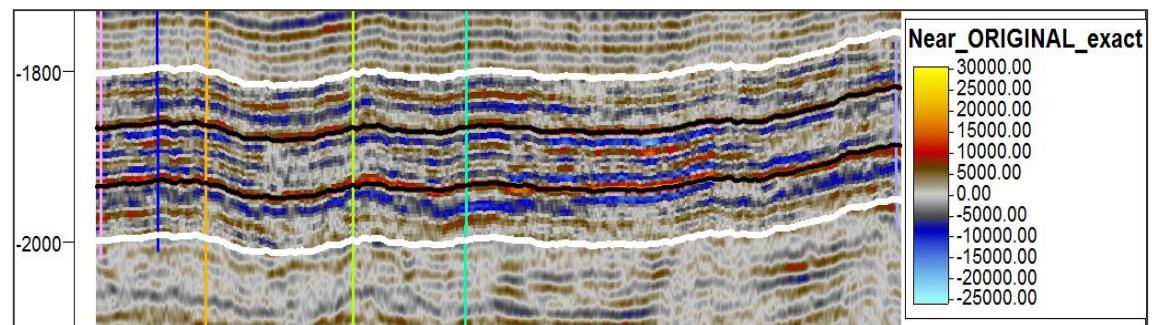
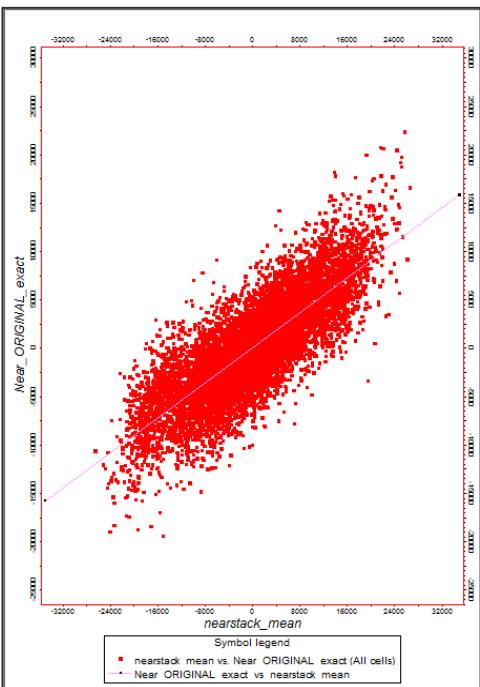
Results



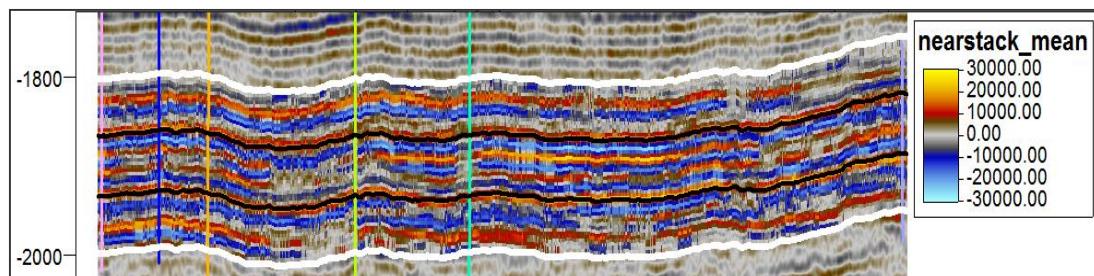
Synthetic nearstack - mean 6th iteration

Correlation

Coefficient: **80%**

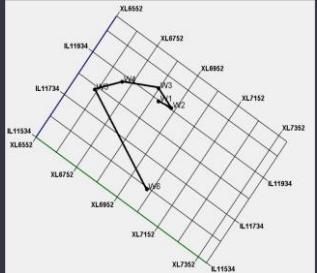


Real
Seismic



Synthetic
Seismic

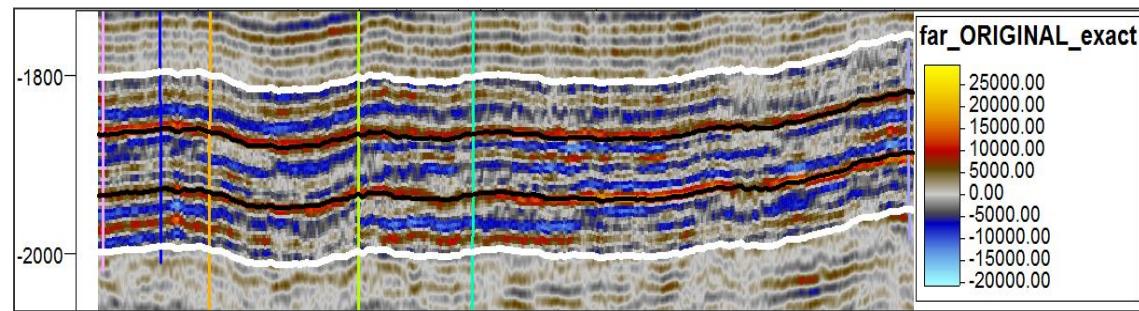
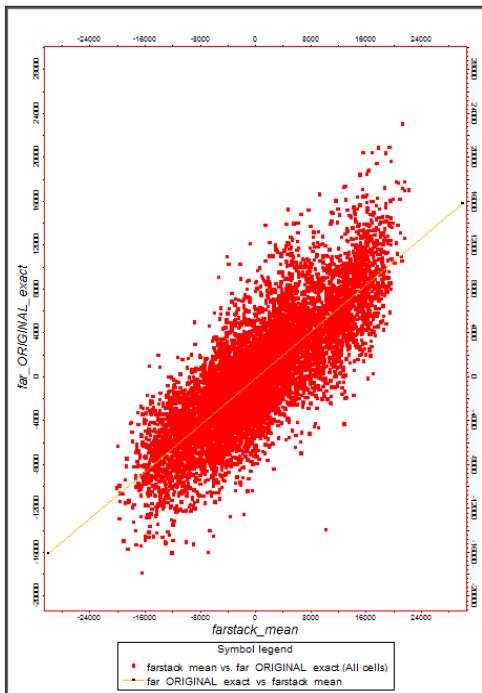
Results



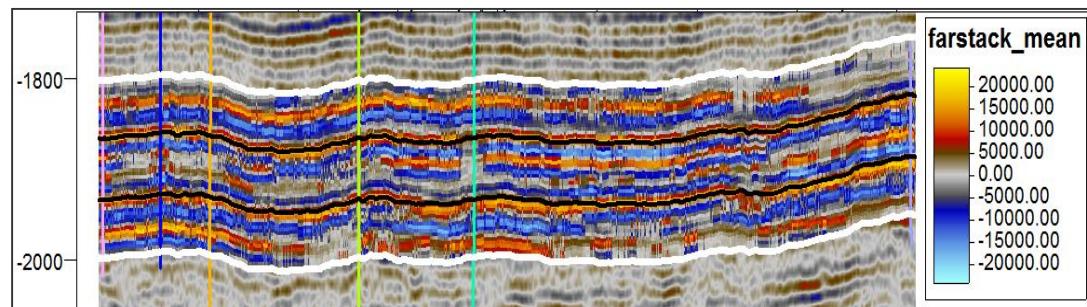
Synthetic farstack - mean 6th iteration

Correlation

Coefficient: 81%

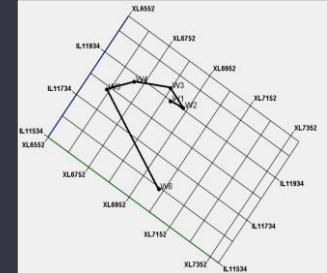


Real
Seismic

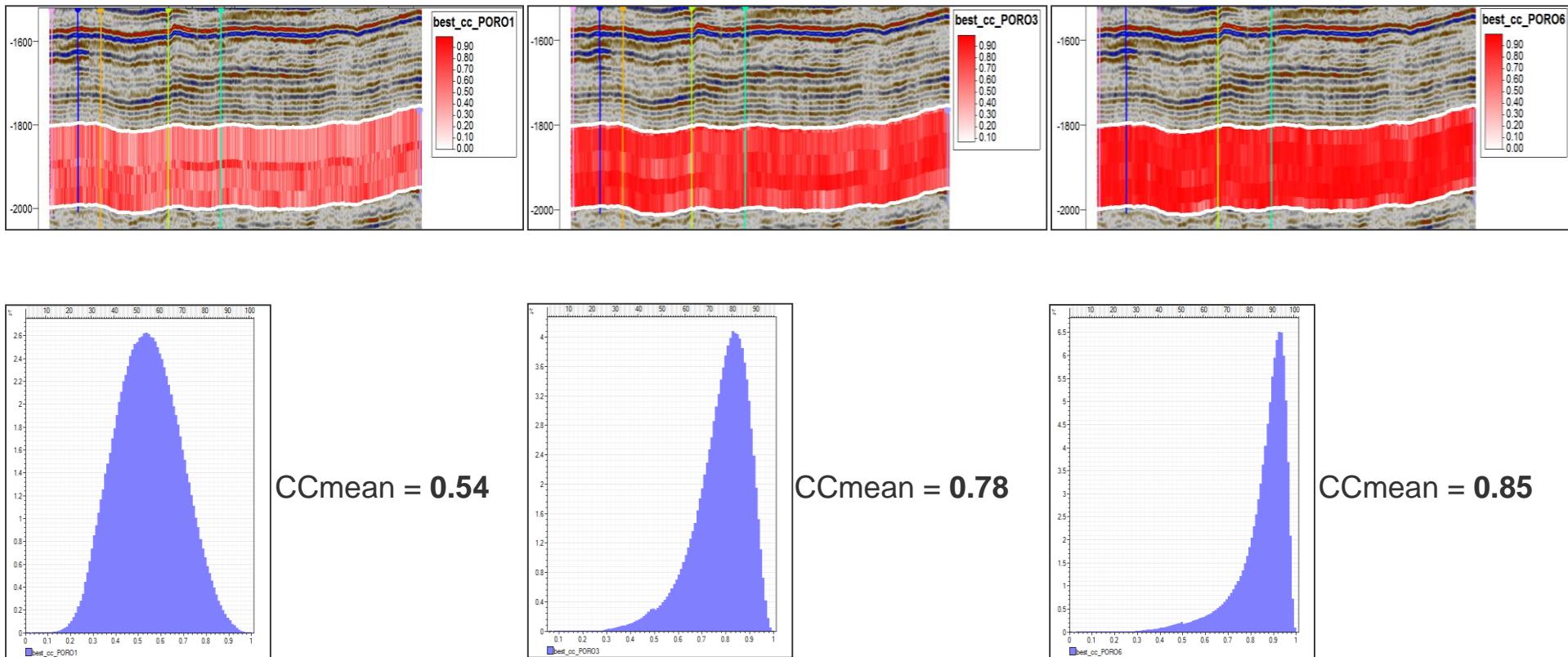


Synthetic
Seismic

Results



Best Correlation Cubes - 1,3,6 iterations



Final Considerations

- ✓ This new method was successfully applied to a real reservoir.
- ✓ Facies volumes are consistent with the rock property models.
- ✓ This methodology allows the uncertainty assessment of each property individually by for example, the variance model at a given iteration.
- ✓ Good correlation coefficients between the synthetic seismic and real seismic.
- ✓ The main structures are in agreement with the ones interpreted from the original seismic data and from previous inversion study over this reservoir (Azevedo et al. 2013).

References

- Avseth, P., Mukerji, T., & Mavko, G. (2005). *Quantitative Seismic Interpretation*. Cambridge University Press.
- Azevedo, L., Nunes, R., Soares, A. & Neto, G. S. (2013). Stochastic Seismic AVO Inversion. 75th EAGE Conference & Exhibition, (June 2013), 10–13.
- Deutsch, C.V. & Journel, A. G. (1998). GSLIB: Geostatistical Software Library and user's guide. (2.ed. ed.). New York: Oxford University Press.
- Doyen, P. (2007). Seismic reservoir characterization: an earth modelling perspective. Constraints. EAGE.
- Dvorkin, J., Gutierrez, M.A., Grana, D. (2014). *Seismic Reflections of Rock Properties*. Cambridge University Press.
- Fatti, J. L. (1994). Detection of gas in sandstone reservoirs using AVO analysis: A 3-D seismic case history using the Geostack technique. *Geophysics*, 59(9), 1362.
- Gassmann, F., (1951) Elasticity of porous media: Über die elastizität poroser medien, *Vierteljahrsschrift der Naturforschenden Gesellschaft*, 96, 1-23.
- Han, D.-H. (1987). Effects of Porosity and Clay Content on Acoustic Properties of Sandstones and Uncosolidated Sediments [Ph.D. thesis]. *Stanford University*.
- Hossain, Z., & de Newton, P. V. (2013). Advanced rock physics diagnostic: A new method for cement quantification. *SEG Technical Program Expanded Abstracts 2013*, (c), 2681–2685. <http://doi.org/10.1190/segam2013-0988.1>
- Horta, A., & Soares, A. (2010). Direct sequential Co-simulation with joint probability distributions. *Mathematical Geosciences*, 42(3), 269–292.
- Soares, A. (2001). Direct Sequential Simulation and Cosimulation. *Mathematical Geology*, 33(8), 911–926.
- Wood A.W., 1955. *A Textbook of Sound*, MacMillan Publishing Company, New York, NY.

Thank you for your attention!