Ultra-deep hydrocarbon reservoir modelling and characterization off W. Africa

CERENA

PHD PROGRAMME IN PETROLEUM ENGINEERING

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Abstract

Petro-elastic models retrieved from seismic inversion are key tools for reservoir modelling and characterization. Their use during the geo-modelling workflow is of extreme importance for both exploration and development plans. Geostatistical seismic inversion methodologies allow not only the inference of these properties, but in addition allow assessing the associated intrinsic spatial uncertainty allowing for better risk assessment and decision making. In ultra-deep offshore the use of stochastic methodologies is even of most interest due to the complexities of the subsurface geology and the lack of well data. This work shows a successful application of a geostatistical acoustic inversion in the ultra-deep offshore W. Africa.

Methodology

The Global Stochastic Inversion (GSI; Figure 1) is an iterative geostatistical seismic inversion methodology, developed by the Petroleum Group of CERENA (Soares 2007) to infer acoustic impedance models from fullstack seismic reflection data based on two main key ideas:

1) The perturbation of the model parameter space recurring to direct sequential and co-simulation

2) the use of a genetic algorithm based on the correlation coefficient between inverted and real seismic traces to iteratively converge the procedure towards convergence.

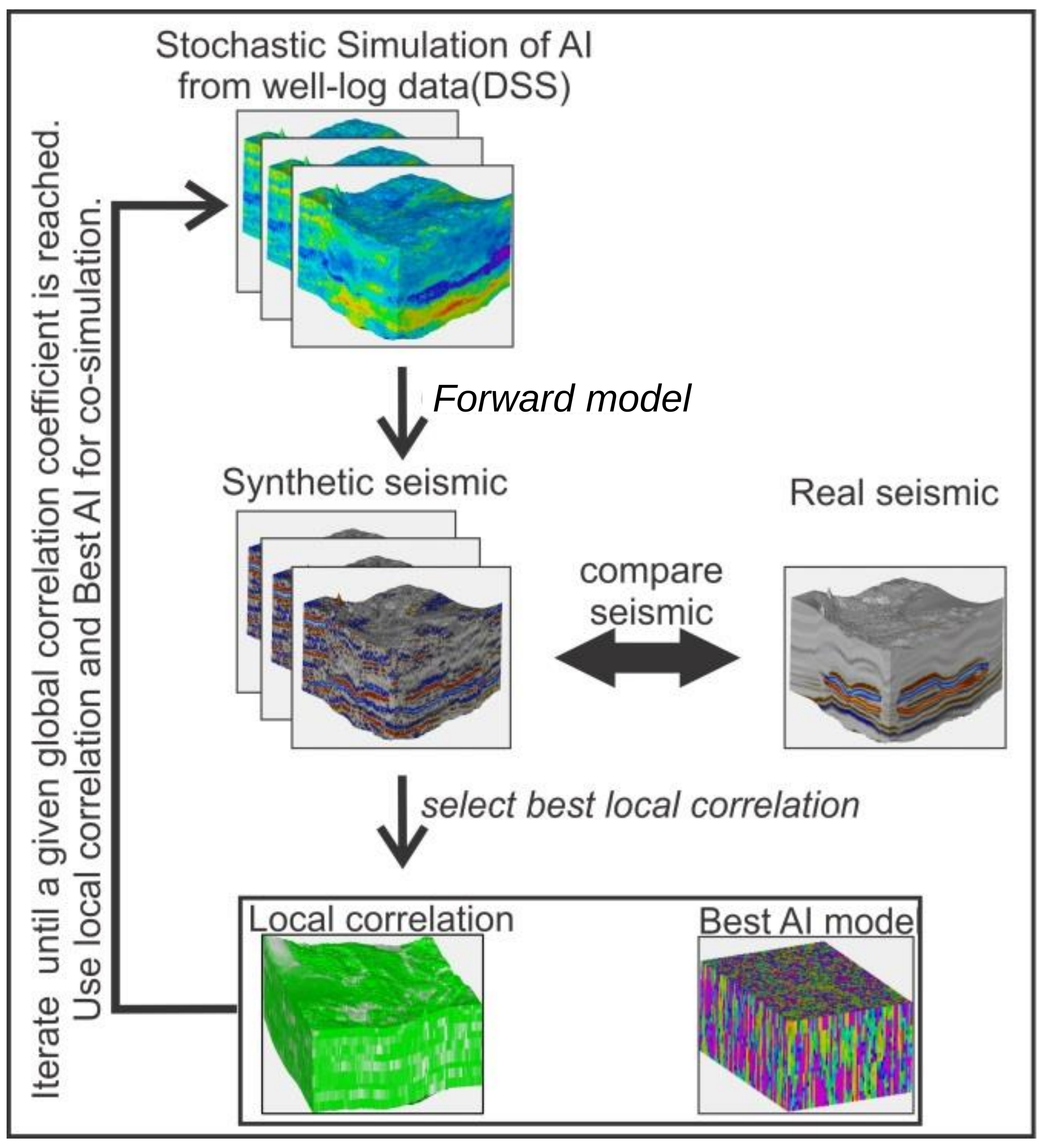

Figure 1: Global Stochastic Inversion methodology.

Real Case Application

This seismic inversion methodology was first time applied under the scope of this Ph.D. program to a challenging ultra-deep offshore reservoir. The inversion grid encompassed not only well-known oil and gas reservoirs from shallow waters but also a complex medium-to-high energy turbiditic sedimentary environment heavily affected by salt tectonics (Figure 2). Both the very non-stationary behaviour of the turbiditic system and the salt bodies represent an extra challenge to this project (Figure 3).

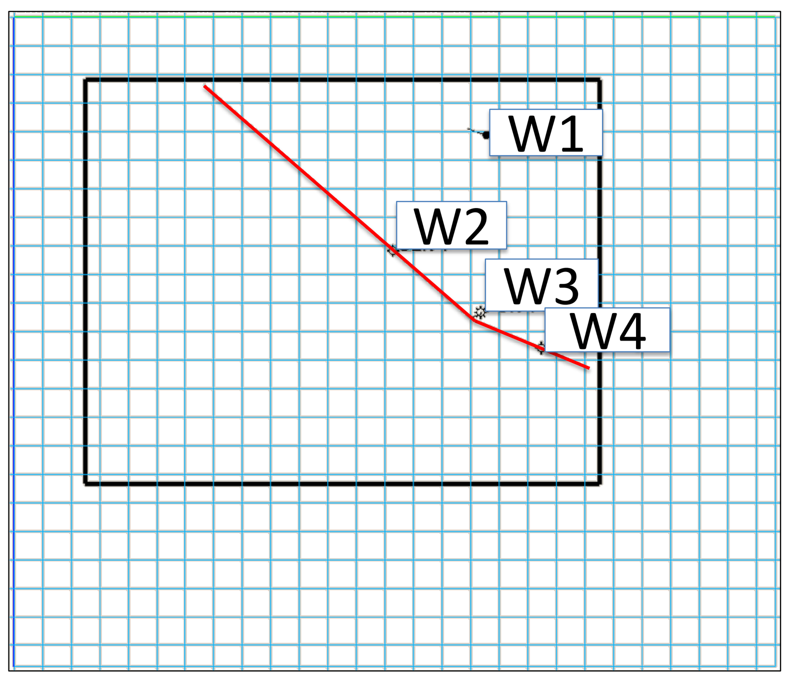

Figure 2: Seismic grid with the location of the 4 available wells and inversion grid delimited by the black thick rectangle. Inversion grid composed of 1411 x 1795 x 200 cells.

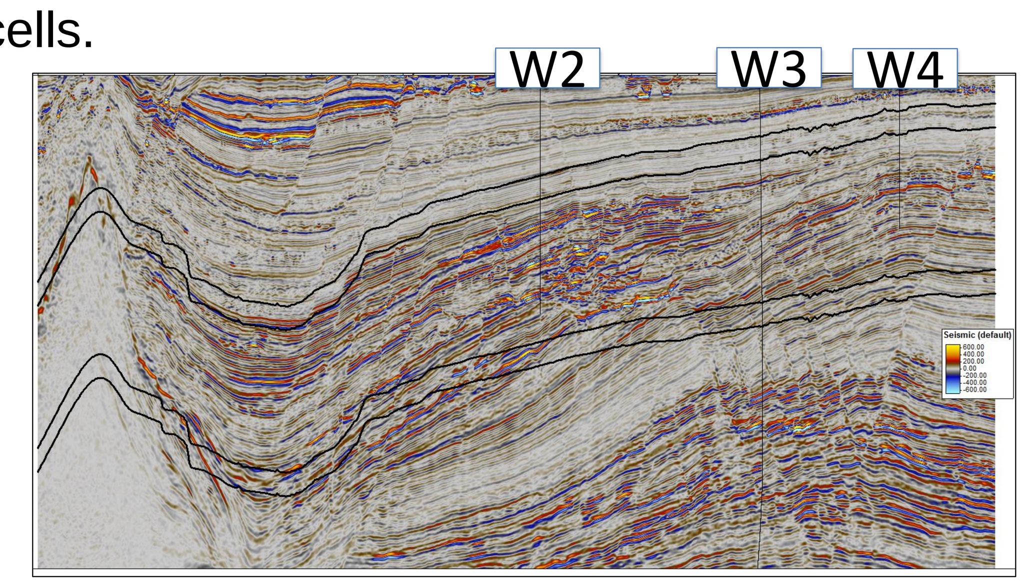

Figure 3: Vertical seismic line from the real seismic data along the profile represented in red in Figure 2.

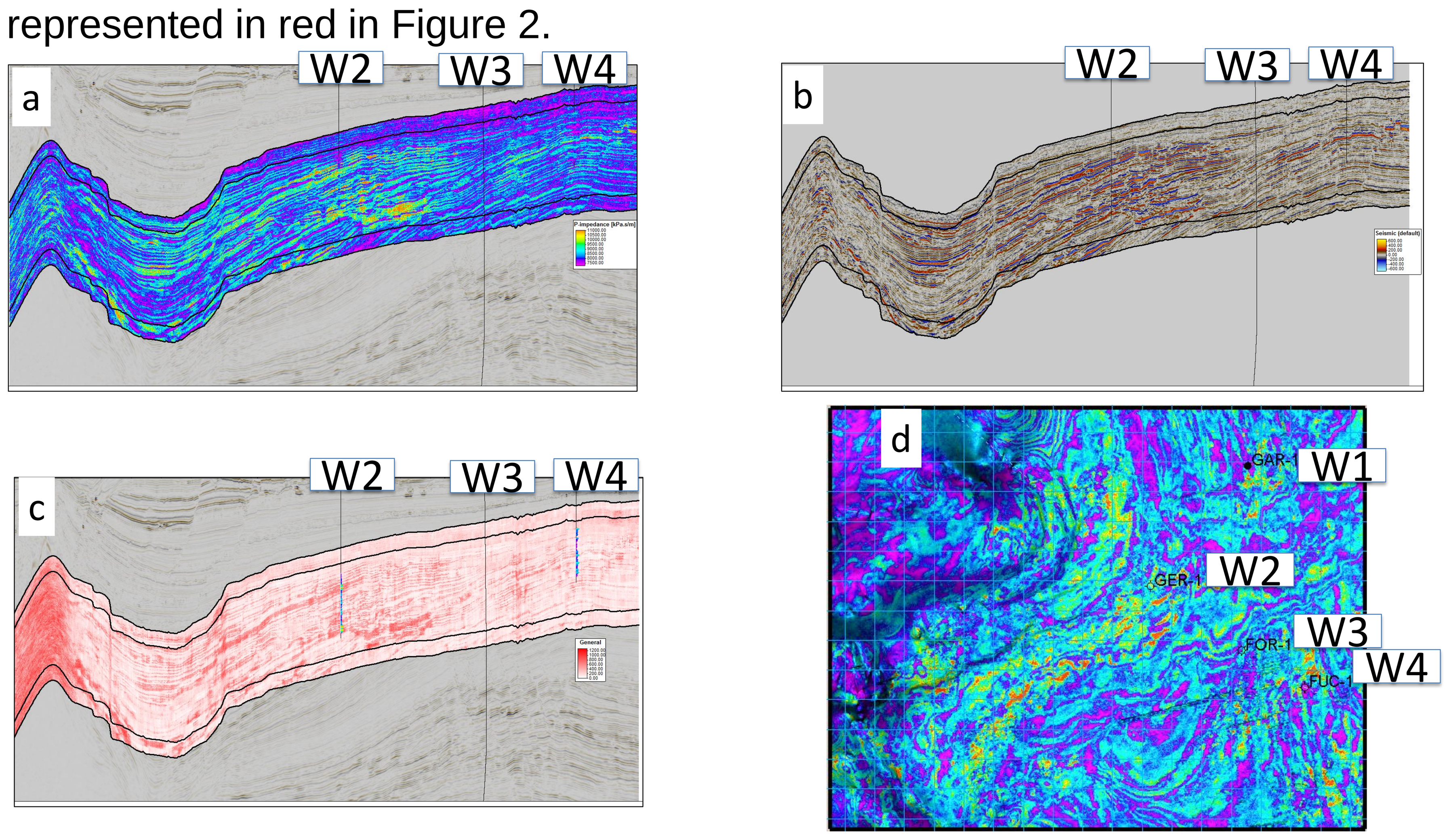

Figure 4: Vertical seismic section extracted from a) best-fit inverse impedance mode; b) synthetic seismic resulting from a); c) variance model from last iteration; d) horizontal section the model represented in a) showing the turbiditic environment.

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