PhD Open Days

CERENA
Centro de Recursos Naturais e Ambiente

Geostatistical History Matching coupled with Adaptive Stochastic Sampling

A zonation-based approach using Direct Sequential Simulation

Ph.D. in Petroleum Engineering

Eduardo Barrela (ebarrela@gmail.com)

1. Abstract

This study proposes a Geostatistical History Matching (GHM) technique applied in uncertain reservoir conditions, represented by a geologically consistent reservoir zonation methodology, coupled with adaptive stochastic sampling for geologic and engineering parameter optimization.

Geostatistical History Matching provides a way of assimilating perturbation of a reservoir model to ensure its geological consistency.

A geologically consistent perturbation methodology aims to avoid solutions that are unrealistic under the reservoir's general geological characteristics.

By handling multiple stochastic realizations, GMH, coupled with adaptive stochastic sampling can iteratively update static reservoir model properties through conditional assimilation constrained to the production data, using geologically consistent perturbation.

2. Algorithm Workflow

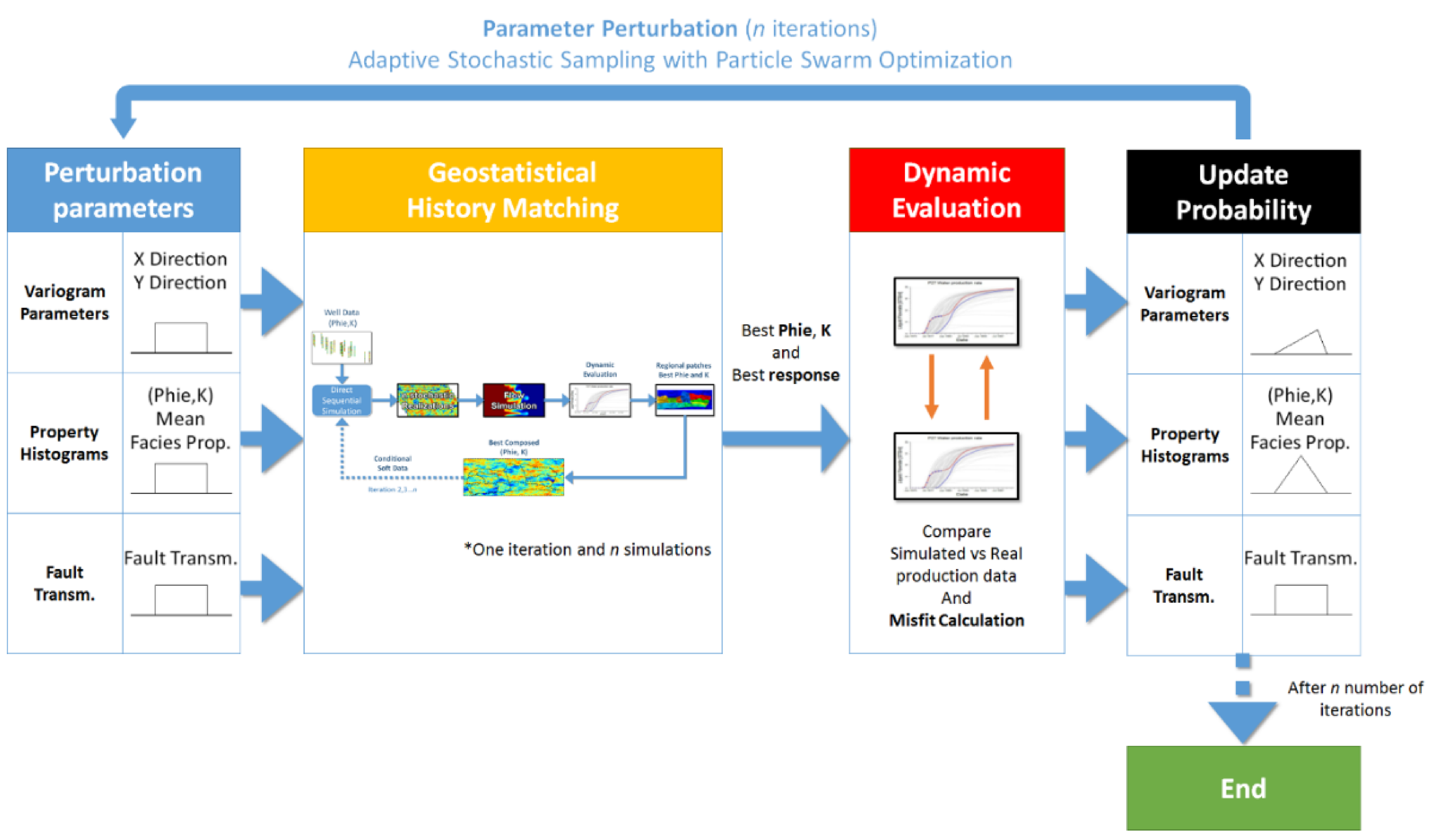


Fig. 1: Algorithm Workflow (inner loop Geostatistical History Matching; outer loop – Adaptive stochastic sampling)

3. Zonation Methodology

Fault and Streamline zonation:

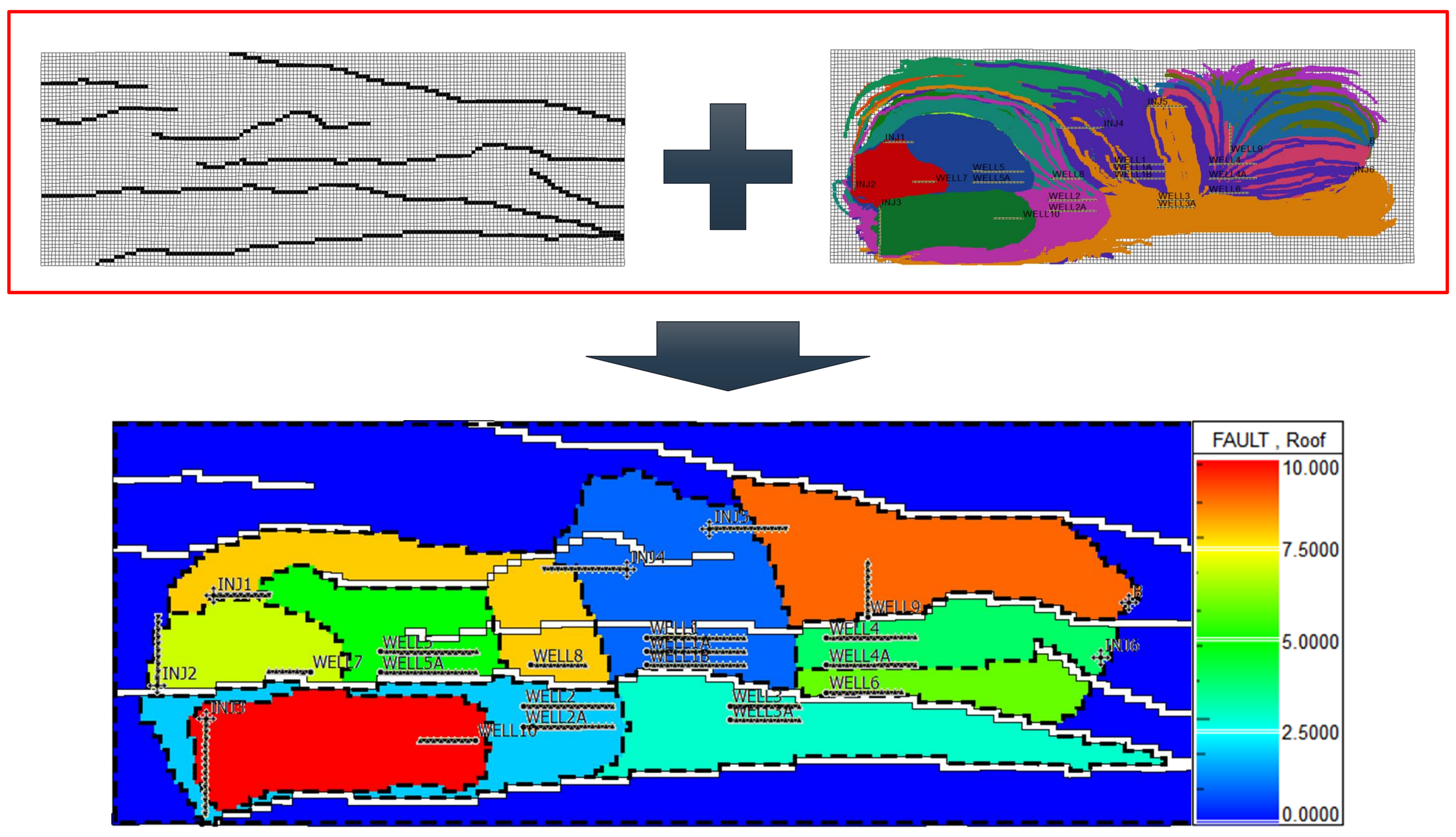
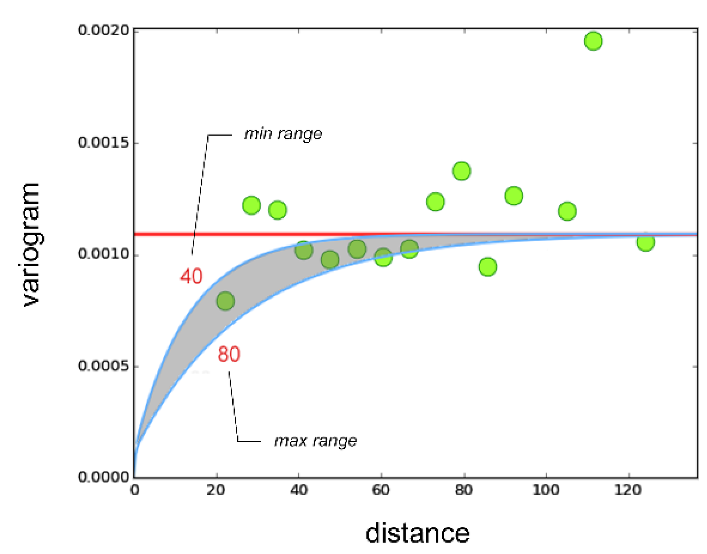


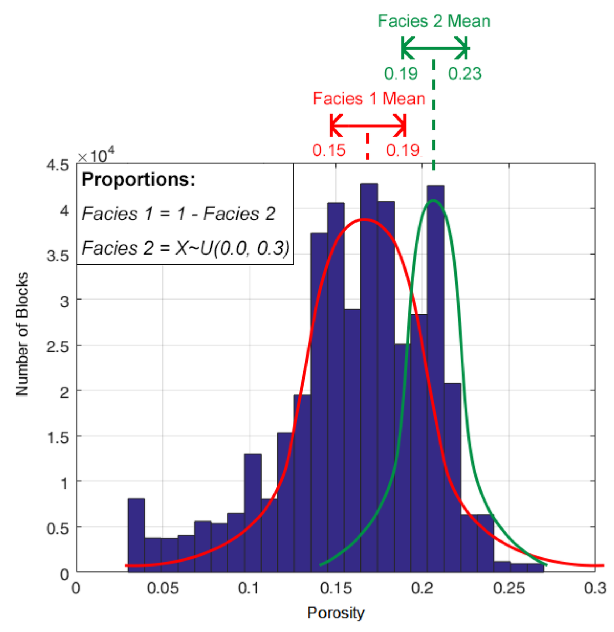
Fig. 2: Fault and streamline zonation – Groups of wells are associated to a specific zone delimited by fluid flow pattern and fault presence.

4. Parameter Uncertainty/Perturbation

Variogram Perturbation:



Histogram Perturbation:



Fault transmissibilities perturbation:

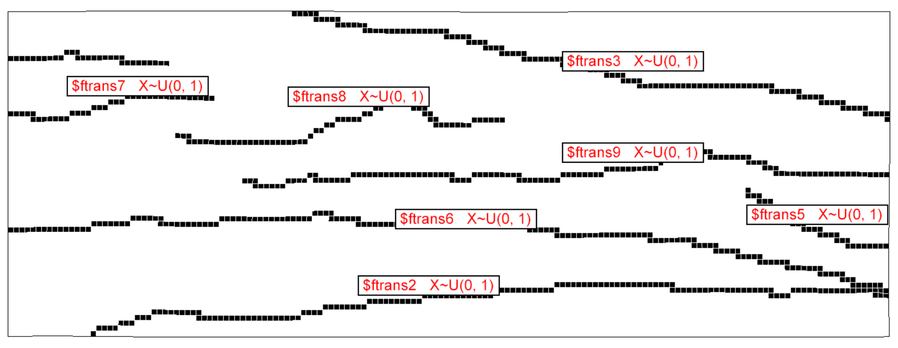
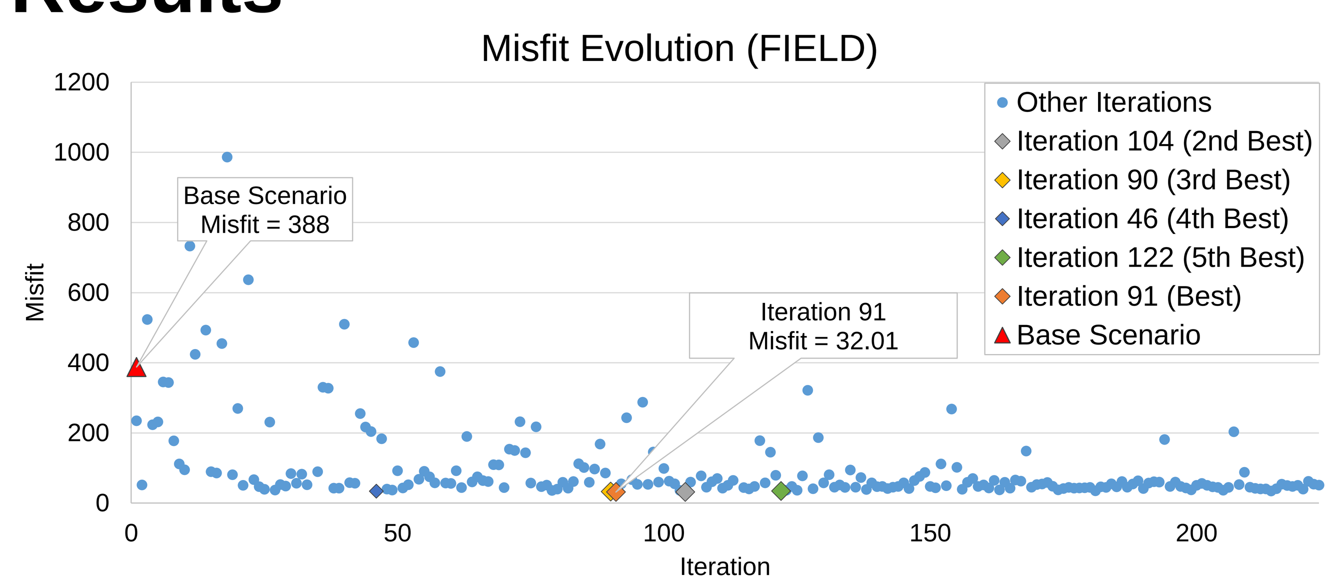


Fig. 3: Assumed prior uncertainties (illustrated example: porosity and fault transmissibilities) and their respective ranges of perturbation.

5. Results



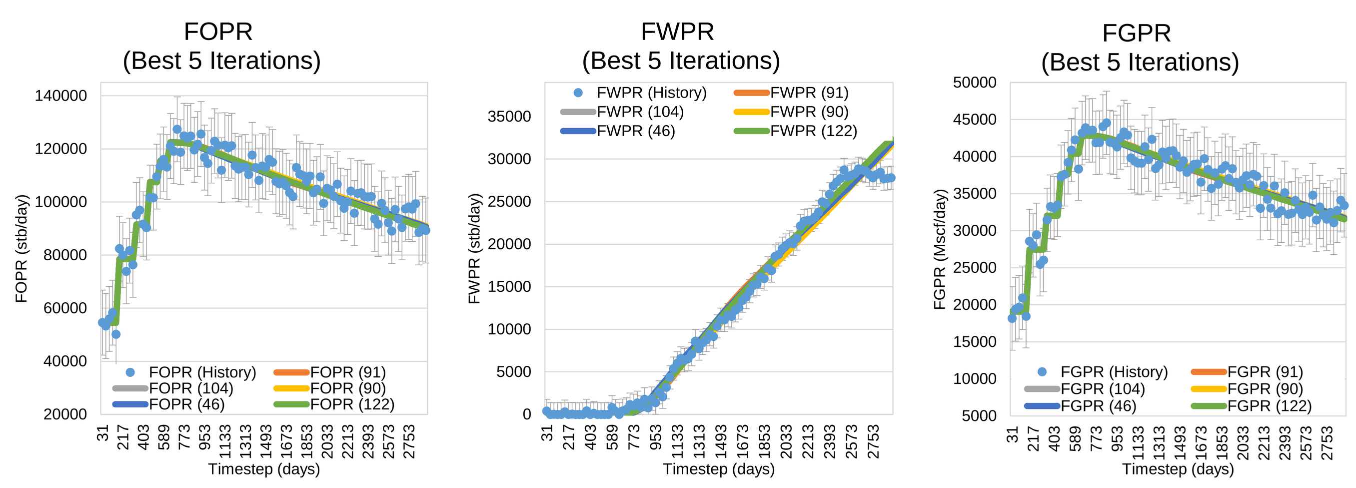


Fig. 4: Top – Misfit Evolution over iterations; Bottom – Best 5 iterations Field Oil(left), Water(middle) and Gas(right) Production Rates.

6. Conclusions:

Geostatistical History Matching with zonation–based approach

- Addresses local matching of the well data;
- Using a zonation-based methodology, explores the value in fault and fluid flow pattern zonation;
- Avoids geological and dynamic unrealistic solutions;
- Iterative model update through conditional assimilation constrained to the production data.

+

Adaptive Stochastic Sampling

- Addresses global matching of the well data;
- Calibration of geological uncertain parameters (i.e. variogram parametrization, histograms) or relevant engineering parameters (i.e. fault transmissibilities).

TÉCNICO LISBOA

L. Azevedo[1], V. Demyanov[2]
Instituto Superior Técnico[1] | Heriot-Watt University[2]

Ph.D. in Petroleum Engineering