Using pressure transients in assisted history matching

Feasibility study

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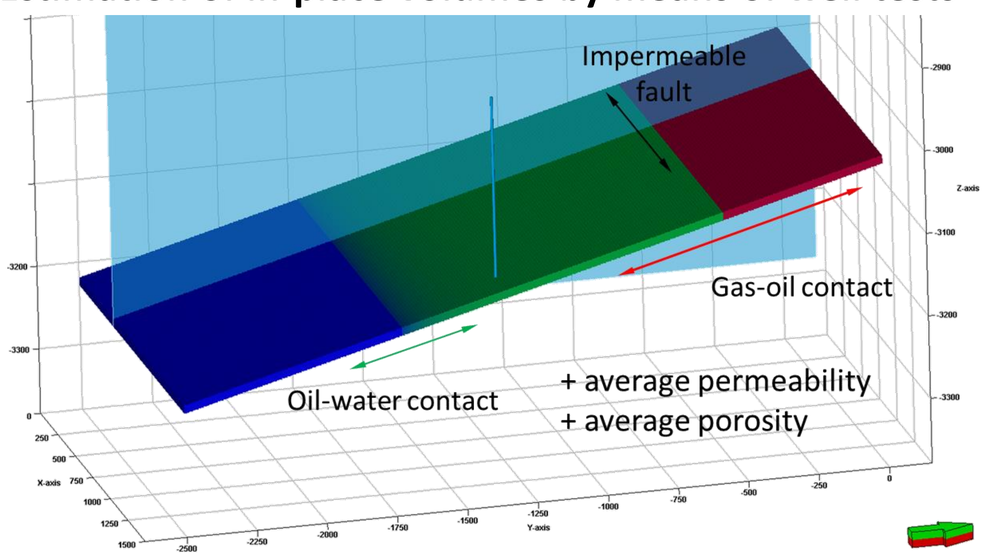
Introduction

Currently downhole pressure gauges are installed on the most of NCS fields gathering a lot of data. Pressure transient analysis (PTA) is standard tool to turn this data into knowledge. PTA helps identifying reservoir boundaries, characterizing near wellbore flow (skin and damage), clarifying cross-well communication and estimating reservoir properties and heterogeneity. However, pressure transients are seldom used in traditional full-field history matching activities. In the study we confirmed on mechanistic reservoir models that application of Ensemble Smoother to the pressure transients improves characterization of sealing faults, fluid contacts and permeability distribution.

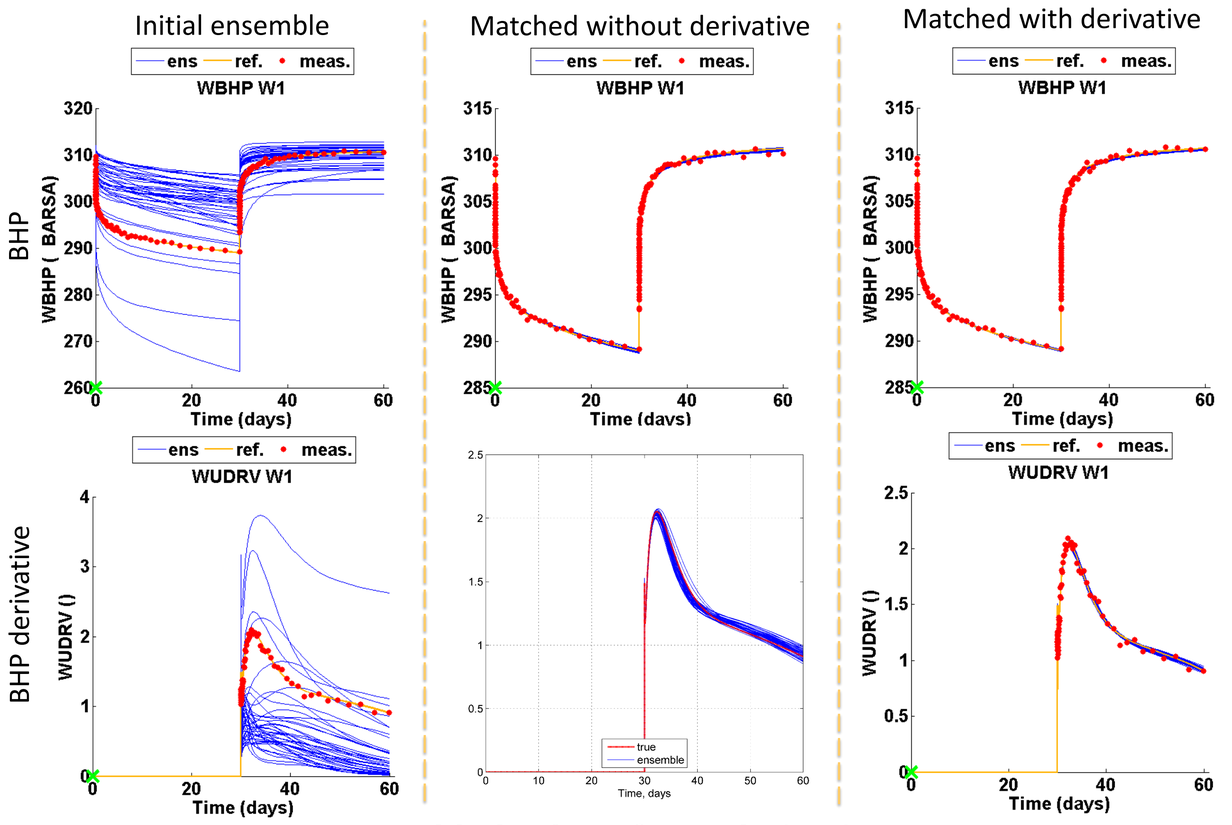
Case 1. Estimation of in-place volumes by means of well tests



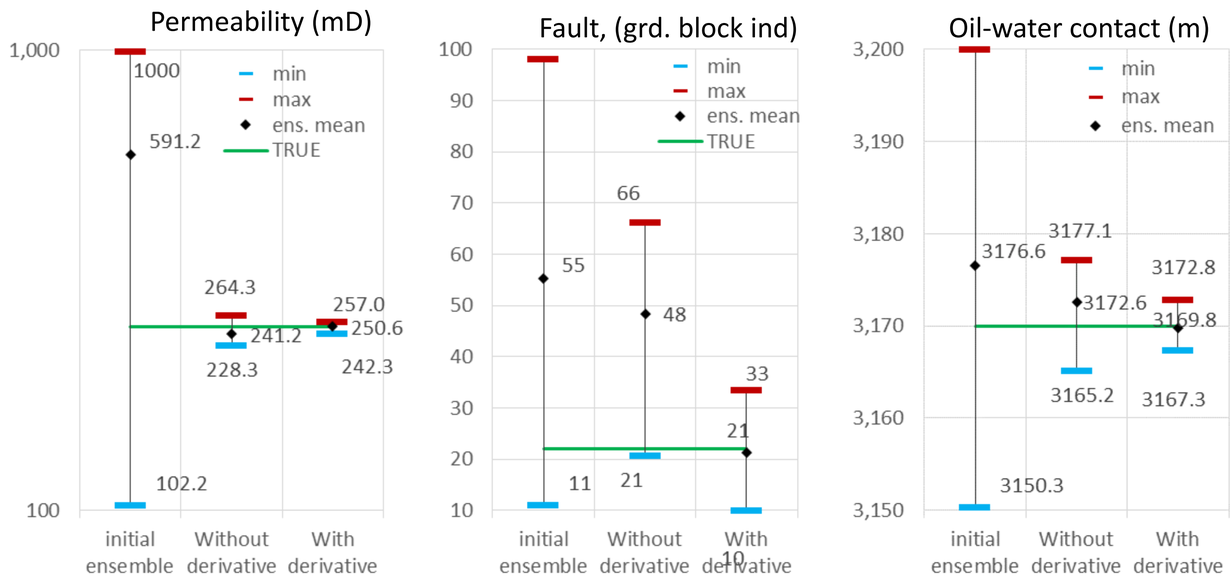
Purpose:
to estimate STOOIP/OGIP and res. parameters
Method: Ensemble Smoother
Number of estimated parameters: 5
Measurements :
Case 1.1. BHP, LRAT
Case 1.2. BHP, LRAT, BHP derivative d(ΔP)/d(ln(Δt))

#	Parameter	Min	Max	True
1	aver. perm., mD	100	1000	250
2	aver. poro, fr.	0.15	0.35	0.24
3	fault location	10	100	22
4	OWC depth, m	3150	3200	3170
5	GOC depth, m	3010	3100	3055

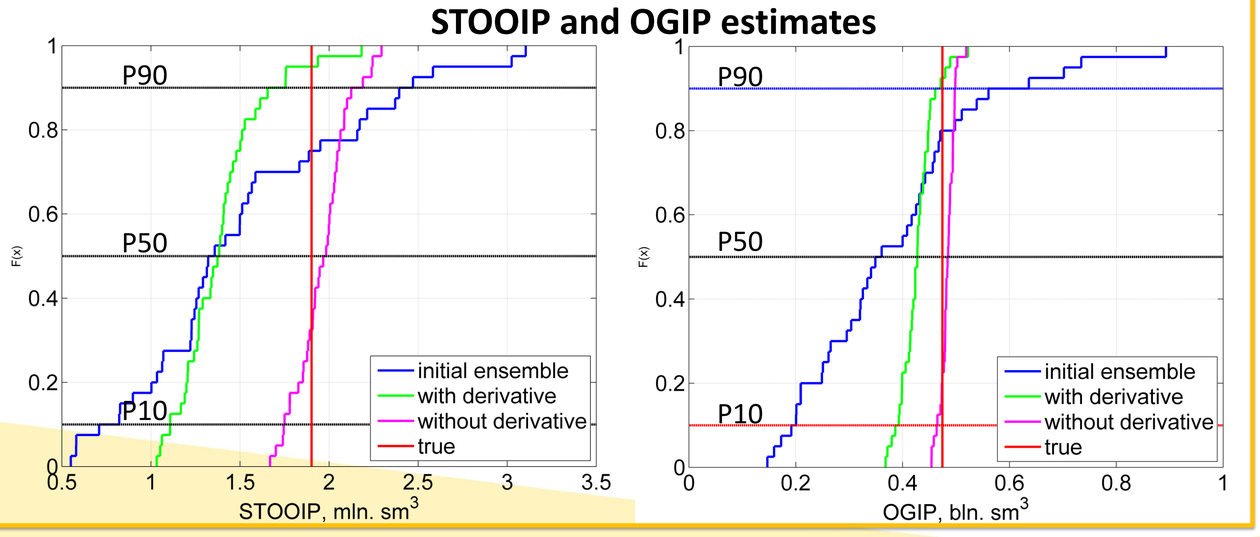
Results



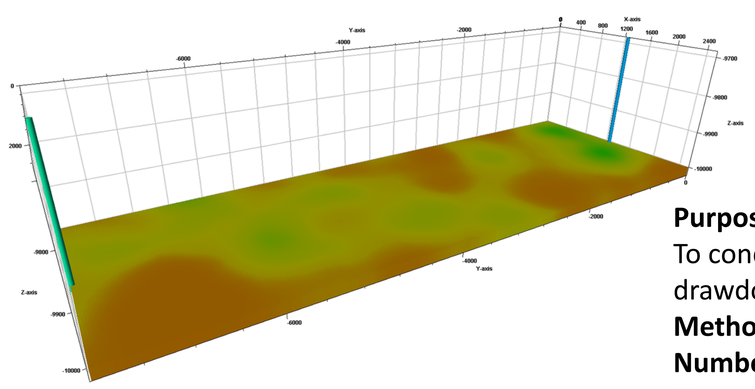
Added value of BHP derivative



STOOIP and OGIP estimates



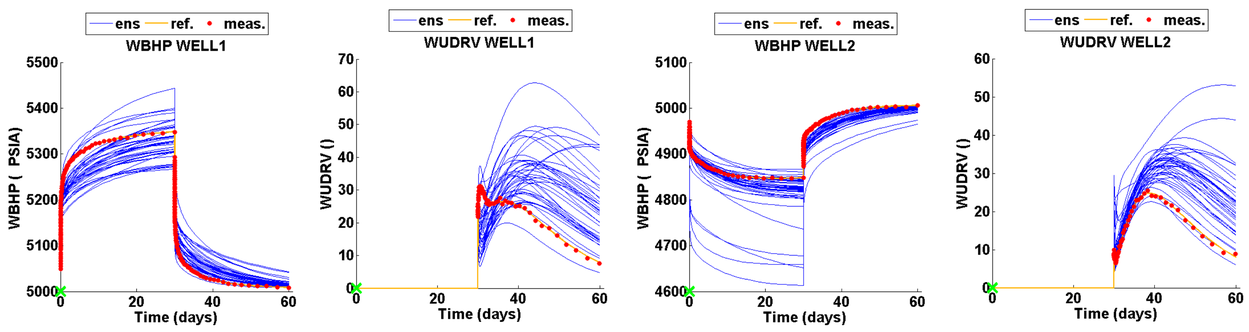
Case 2. Conditioning permeability distribution to well tests



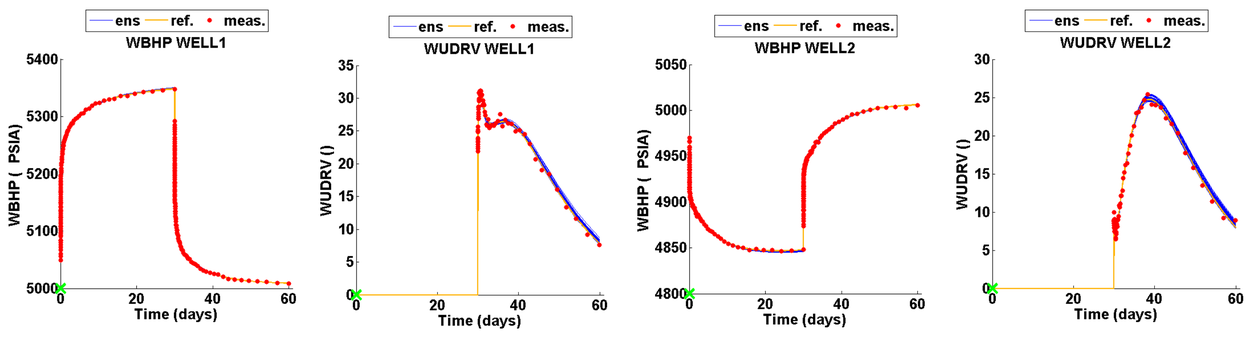
- single phase (water)
- dimensions: 303×101×1
- 2300×768×7.6 m
- producer-injector pair

Purpose:
To condition ensemble of permeability to drawdown, build-up/fall-off tests
Method: Ensemble Smoother
Number of estimated parameters: 30603
Measurements: BHP, LRAT, d(ΔP)/d(ln(Δt))

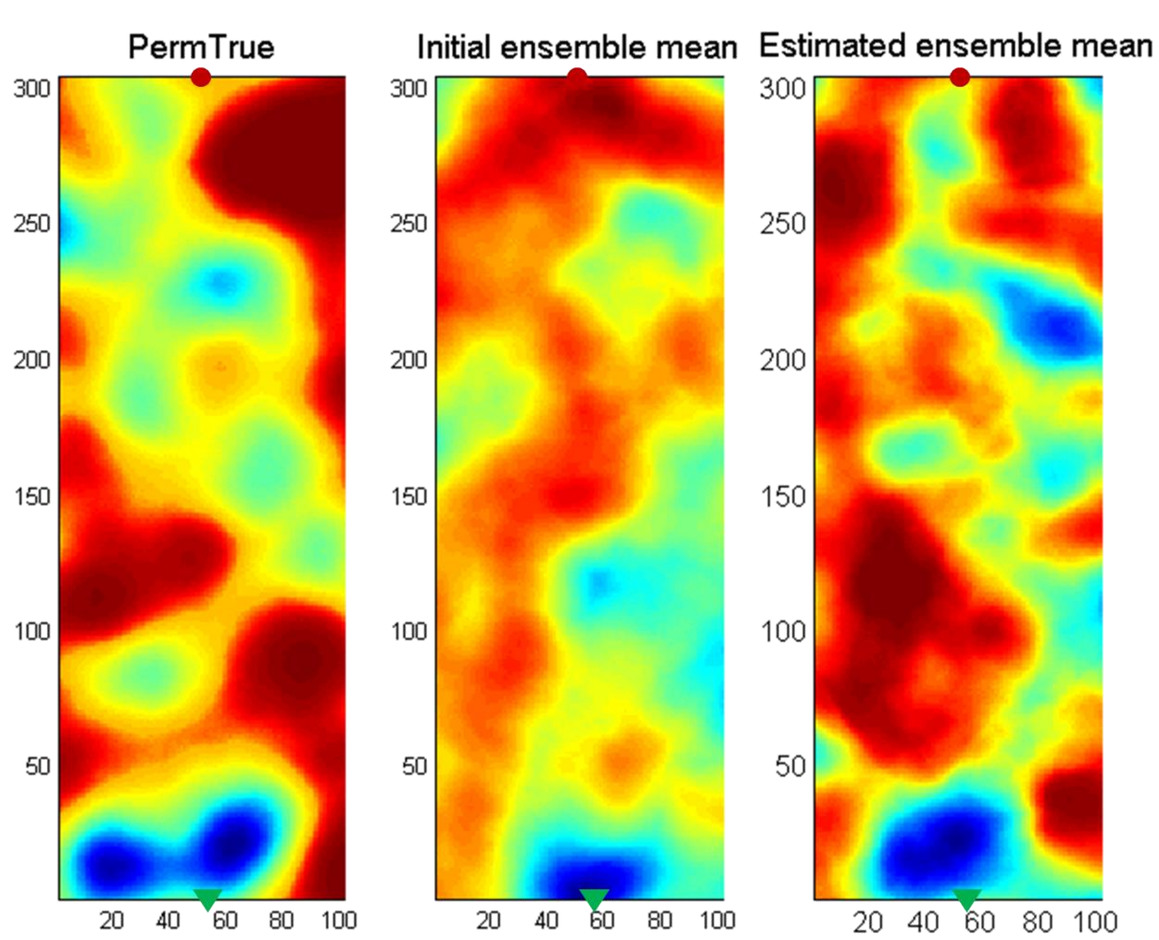
Initial ensemble



Estimated ensemble



Results of permeability estimation



Conclusions

1. The mechanistic case studies demonstrated added value of using the pressure transients in assisted history matching. Reducing uncertainties by means of readily available data (like BHP derivative) is even more valuable for field studies.
2. Generally a reasonable match was obtained both with and without usage of BHP derivative (especially for porosity and permeability), though implementation of BHP derivative in assisted history matching workflow allows for better estimation of sealing faults and fluid contacts.
3. The results of case 1.1 showed that ensemble methods may overcome local optimums, as few models with good match were retained within the ensemble in spite of the drift of ensemble means far from the true values.

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