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Universidade Federal Fluminense

Using computational heuristics to recover a variable surface relaxivity from tomographic images for NMR logging

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Agenda

- NMR deliverables
- NMR simulation workflow
- Our problem
- Our proposal
- Software

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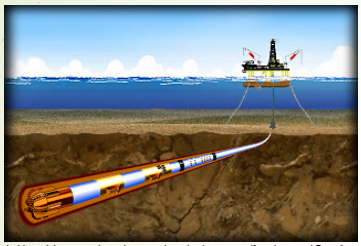
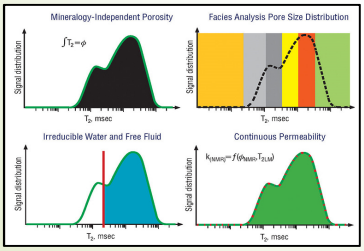


http://accutech.metadot.com/index.pl?r=1



www.spe.org/jpt/article/10327-technology-update-24

Formation evaluation by NMR

- Deliverables
  - Mineralogy independent porosity
  - Pore size distribution
  - Irreducible water saturation
  - Formation Permeability
- Advantages
  - Does not need to wait for laboratory results
  - Continuous record of formation's rock properties
  - Available in logging while drilling (LWD)

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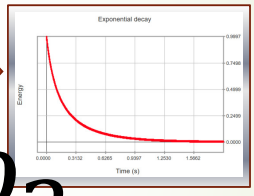
NMR simulation to produce a PSD

Digital rock

NMR decay

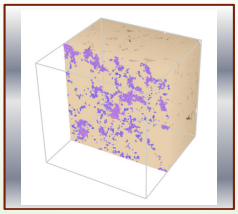


ρ_2

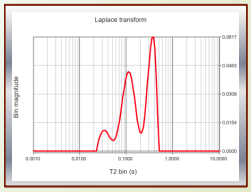
Pore size distribution

$$\frac{1}{T_{2,S}} = \rho_2 \frac{S}{V}$$

Random Walk



T2 Distribution



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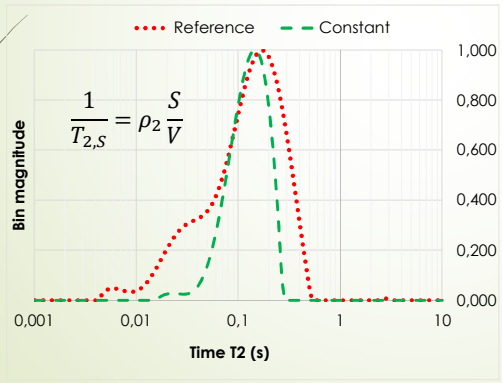
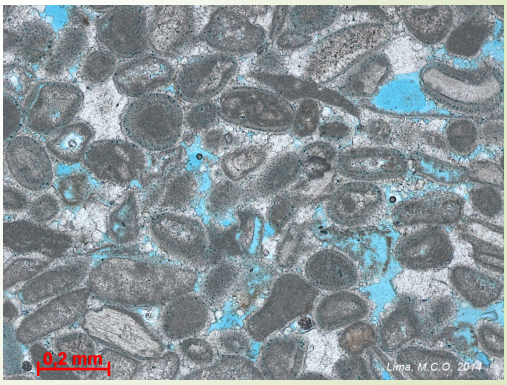
Our problem

- A mismatch between laboratory measurements and simulated results (RW method)



Petrographic thin section



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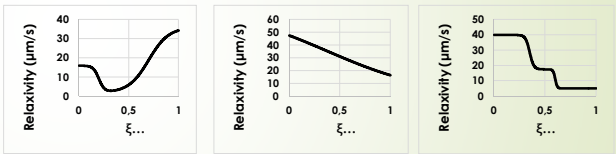
Our proposal

- Surface relaxivity varies with pores size
- Pore size is associated to the collision rate ξ of the fluid molecules saturating the porous media
- $\rho_2(\xi)$ can be expressed as a combination of sigmoid functions



- Pore size can be recovered from the collision rate

$$S_v(\xi) = \frac{4\xi}{\Delta}$$

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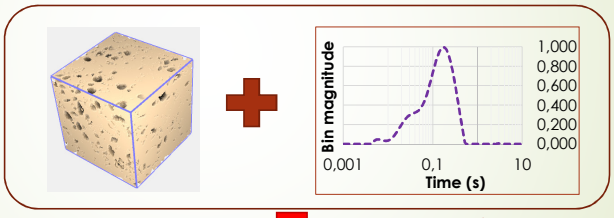
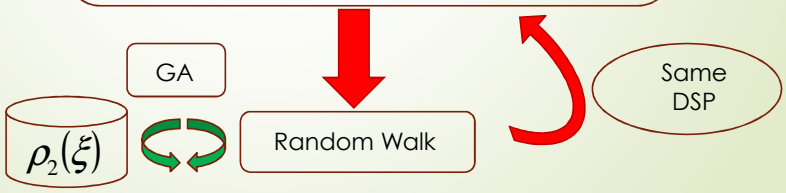
Iterative computational heuristics

- A genetic algorithm optimization
- A large set of RW simulations must be performed





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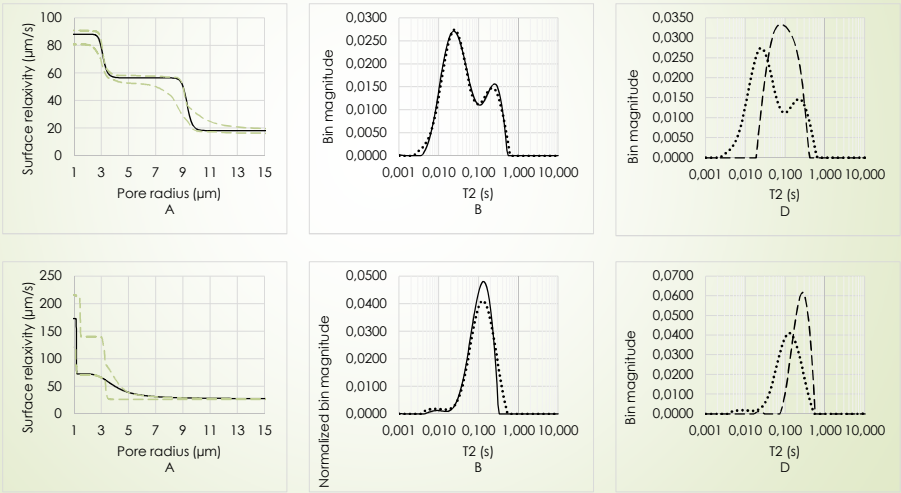
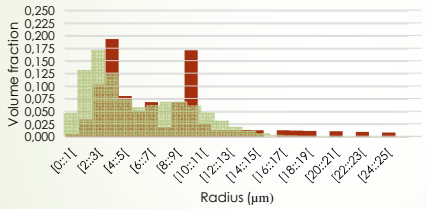
Experimental results (AC, DP)

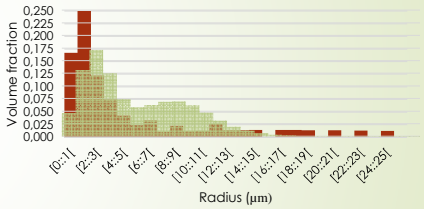


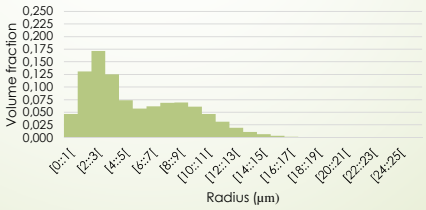
Pore size distributions

- Varying surface relaxivity

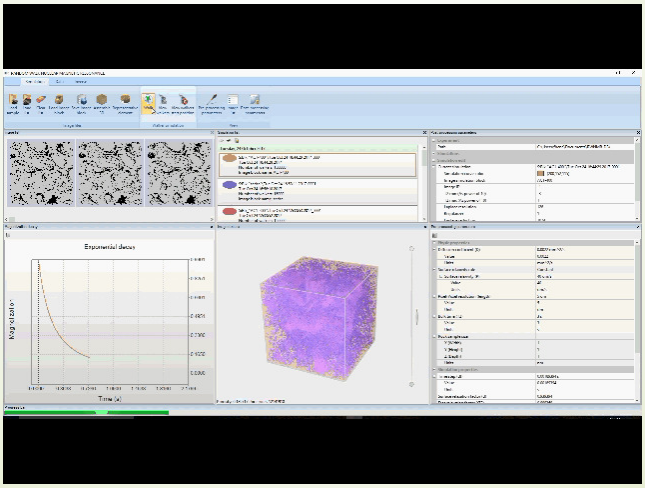


- Constant surface relaxivity





Simulation software



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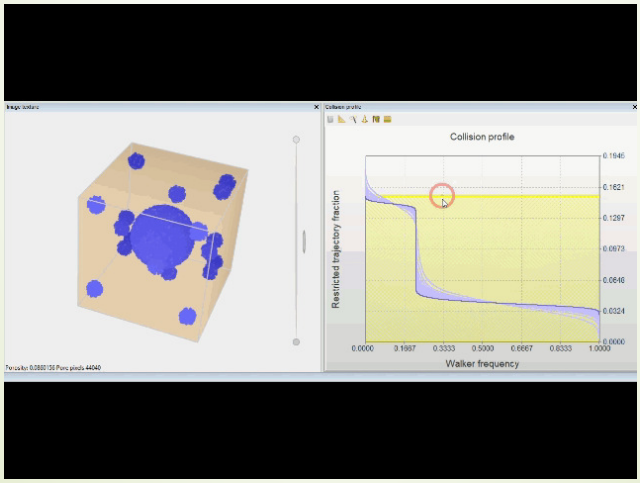
Collision rate distribution



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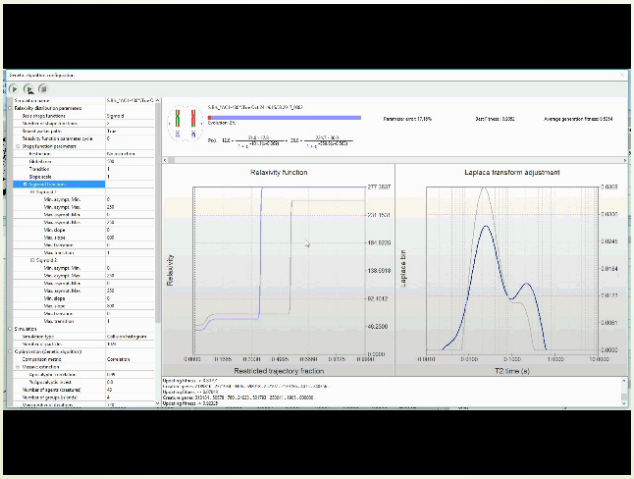
Computational heuristics



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Research paper

Estimating the surface relaxivity as a function of pore size from NMR T2 distributions and micro-tomographic images

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Conclusions

- A new varying surface relaxivity concept was introduced
- This approach produces a more precise PSD from a rock sample
- The oil industry can apply this approach on the formation evaluation by NMR
- A new Software Tool specialized in NMR: https://www.youtube.com/watch?v=kR7FmL6KSII

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