High-resolution characterization of the induced fracture network around galleries in the Callovo-Oxfordian Clay using discrete fracture network inversion

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1. Context and objectives

The Meuse / Haute Marne Underground Research Laboratory (URL) provides the location for an experiment designed to investigate the induced fracture network around open or sealed drifts.

- One of the aims of this experiment, called the OHZ-experiment, is to study the hydraulic properties of the induced fracture network in order to improve and validate the conceptual model of the fracture network as a function of the stress field.
- In the context of this experiment, many gas permeability tests were performed between nine closely spaced wells.

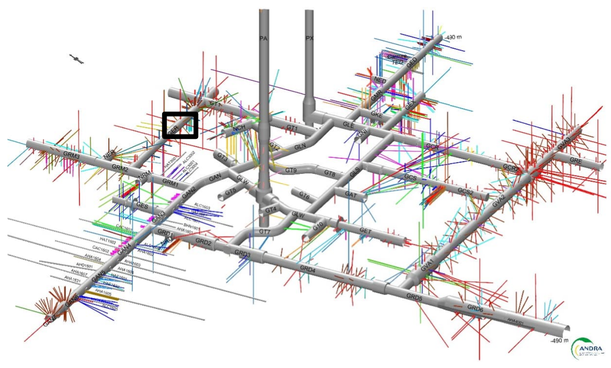


Figure 1: The Meuse / Haute Marne Underground Research Laboratory (de la Vaissière et al., 2015, J. Hydrol)

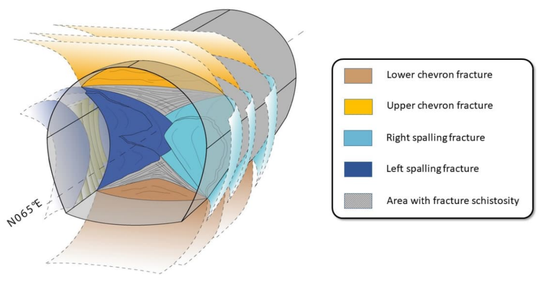


Figure 2: Conceptual model of the induced fracture network parallel to the horizontal minor stress direction (de la Vaissière et al., 2015, J. Hydrol)

2. Experiment

Figure 3: Photocraph of the tested boreholes

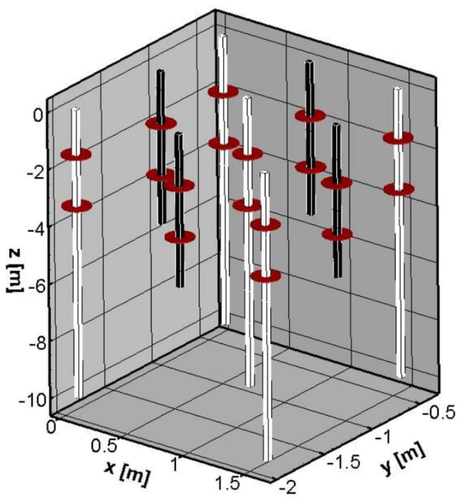


Figure 4: Relative position of the boreholes. The red discs indicate the interval midpoints

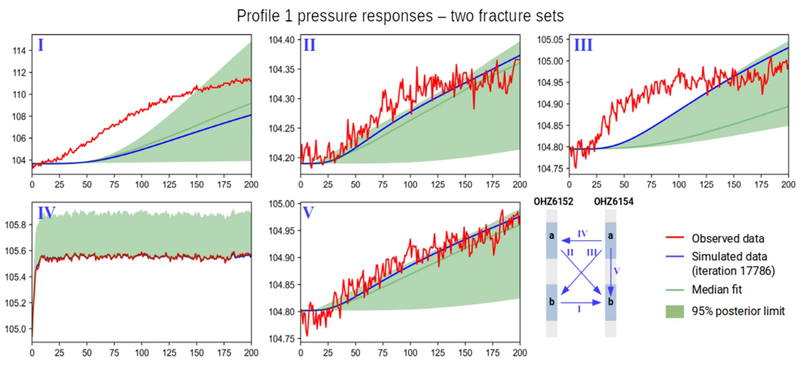


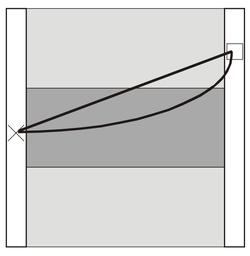
Figure 5: Example for measured and simulated interferences

3. Deterministic Inversion

line integral (geophysical travel time tomography):

$$t = \int_{x_1}^{x_2} \frac{ds}{v(s)}$$

eikonal solver + ray tracing



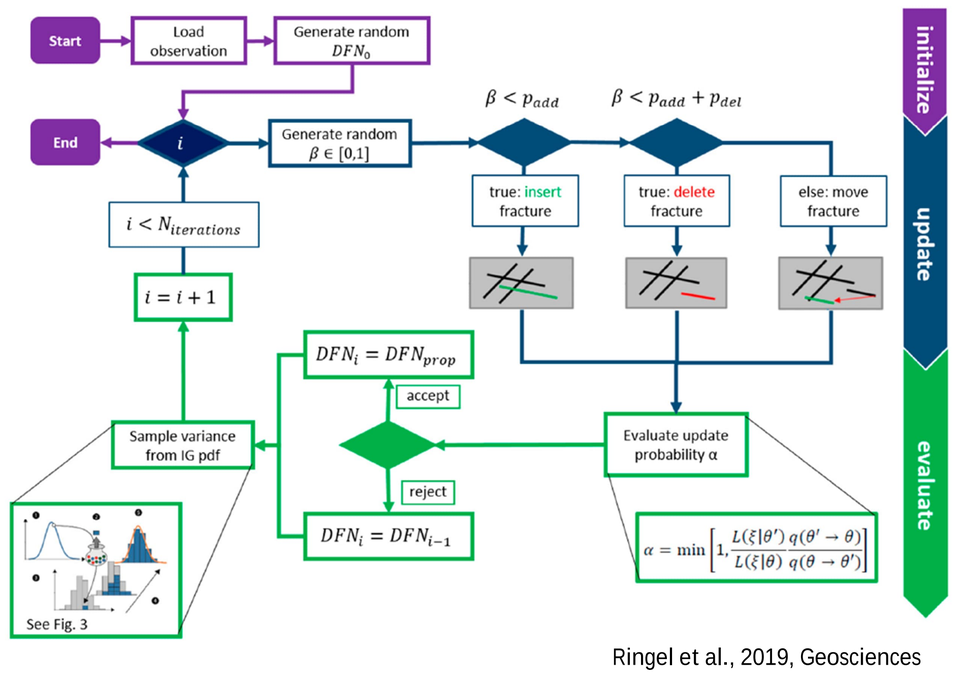
line integral (hydraulic travel time tomography):

$$\sqrt{t_{peak}(x_2)} = \frac{1}{\sqrt{6}} \int_{x_1}^{x_2} \frac{ds}{\sqrt{D(s)}} \qquad \sqrt{t_{\alpha,d}} = \frac{1}{\sqrt{6\, f_{\alpha,d}}} \int_{x_1}^{x_2} \frac{ds}{\sqrt{D(s)}}$$

Vasco et al., 2000, WRR

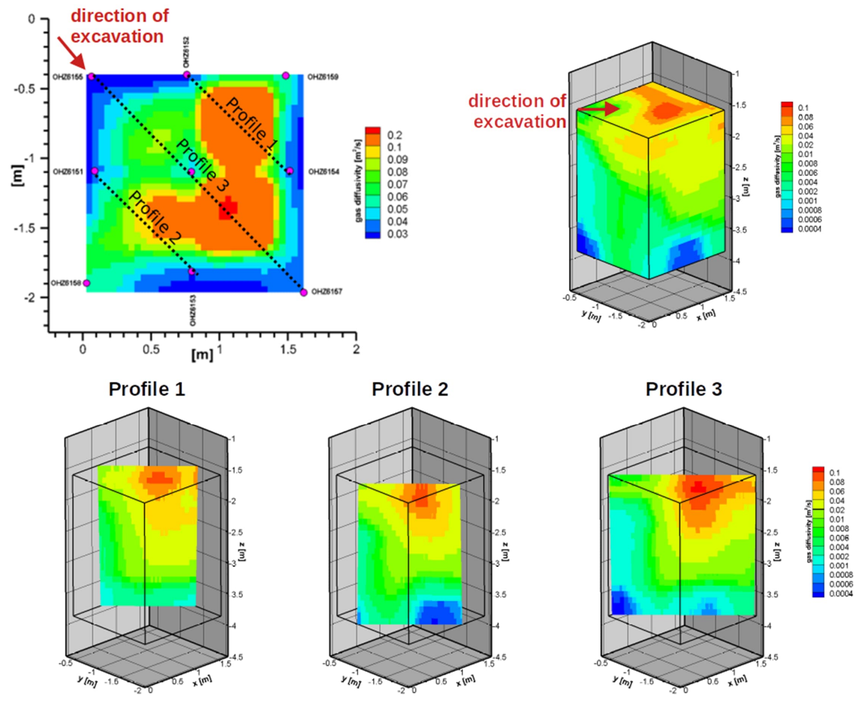
Brauchler et al., 2003, WRR

4. Stochastic DFN Inversion

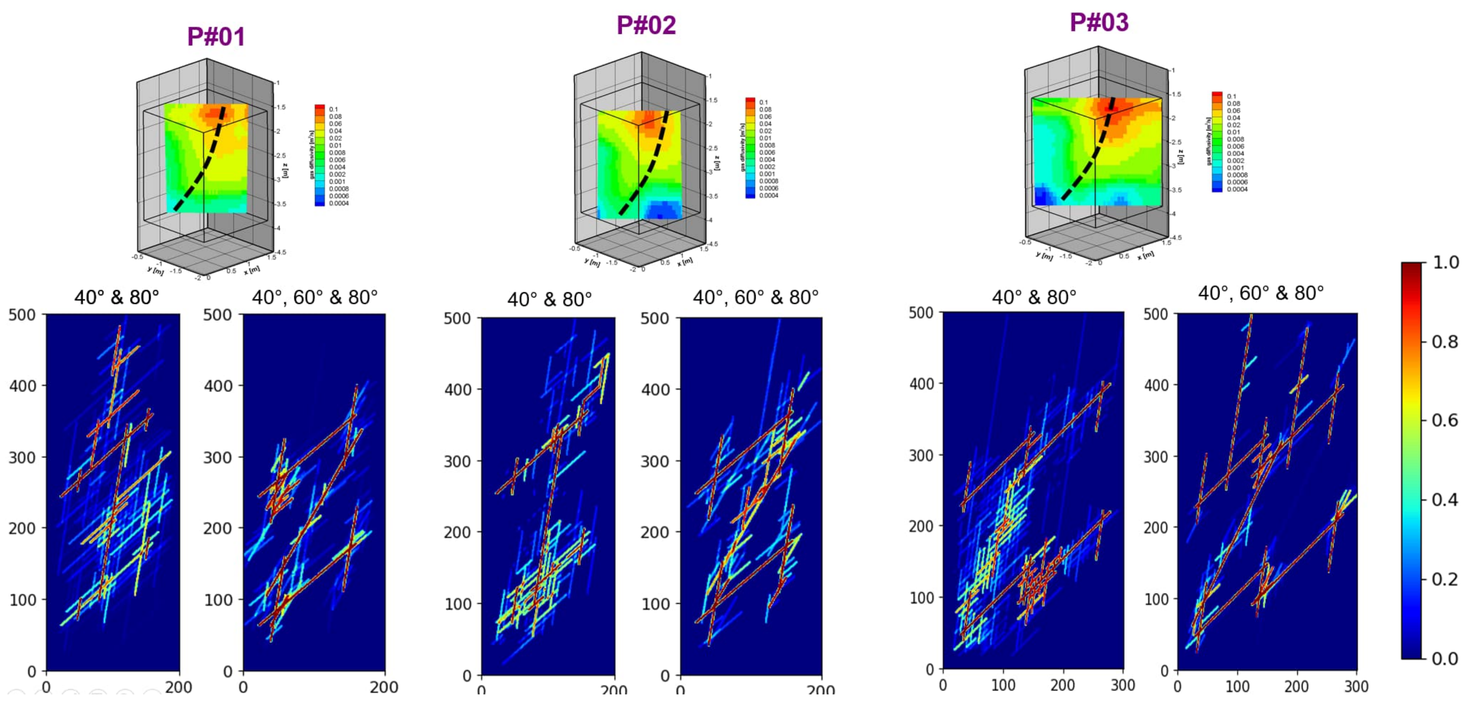


Ringel et al., 2019, Geosciences

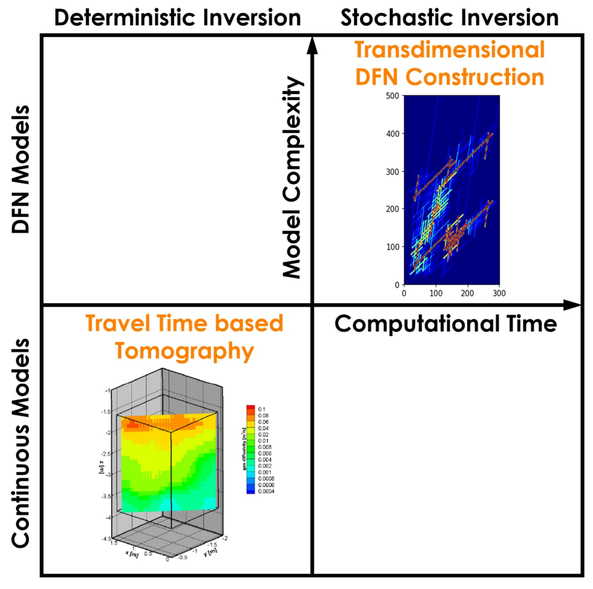
5. Deterministic results



6. Stochastic results



7. Conclusions



6. References

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Vasco, D. W., Keers, H., & Karasaki, K. (2000). Estimation of reservoir properties using transient pressure data: An asymptotic approach. Water Resources Research, 36(12), 3447-3465.
Ringel, L., Somogyvári, M., Jalali, M. & Bayer, P. (2019). Comparison of Hydraulic and Tracer Tomography for Discrete Fracture Network Inversion" Geosciences 9, no. 6: 274. https://doi.org/10.3390/geosciences9060274

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