Application of multiple-point geostatistics on modelling pumping tests and tracer tests in heterogeneous environments with complex geological structures

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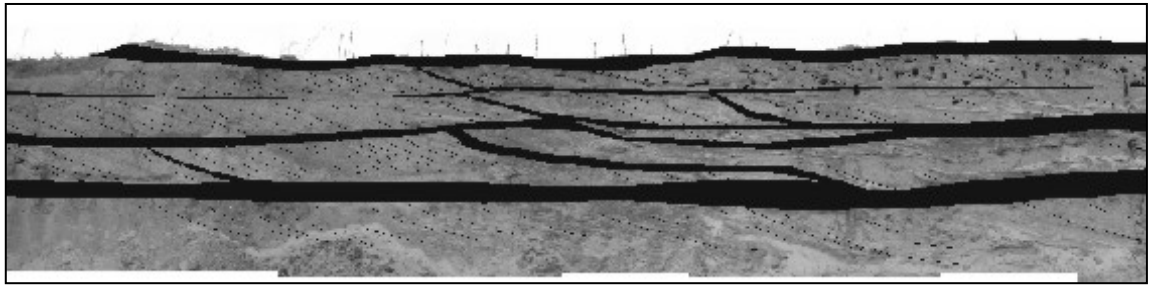
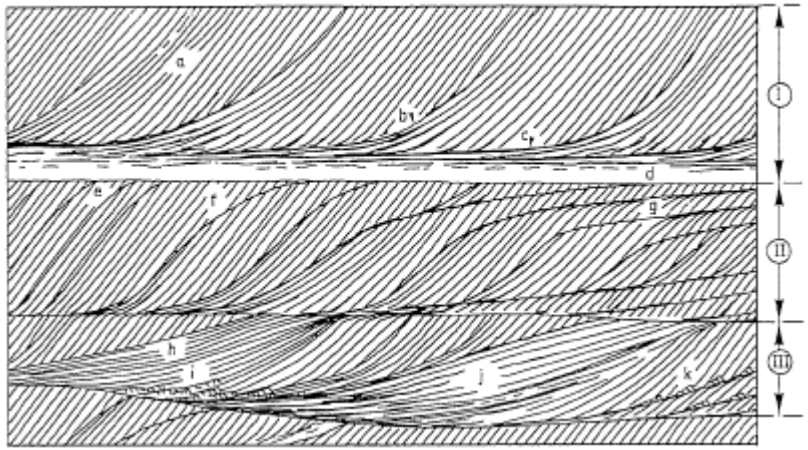
Problem setting

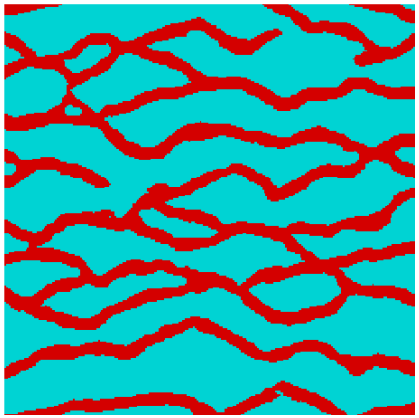
- Complex geological heterogeneity



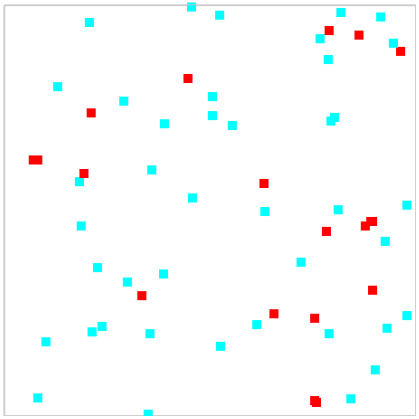


Problem setting

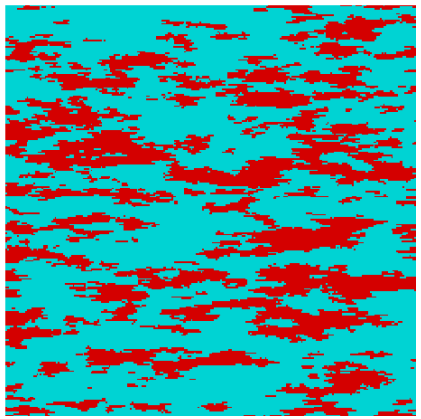
True distribution



Sample data

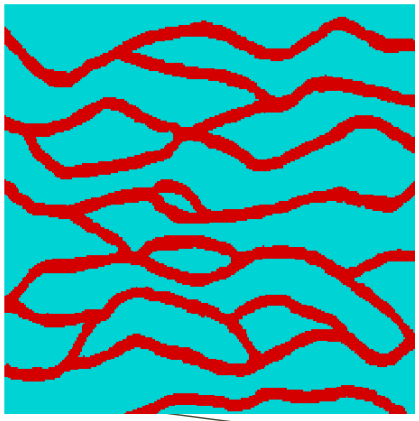


Variogram based simulation

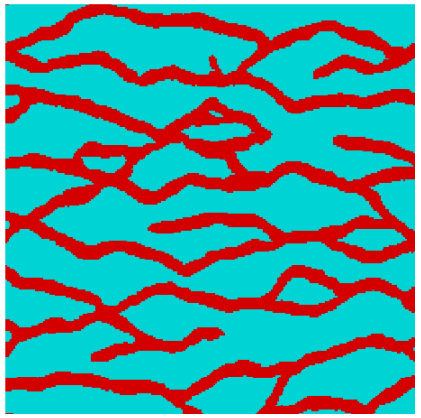


Multiple point geostatistics

Training image

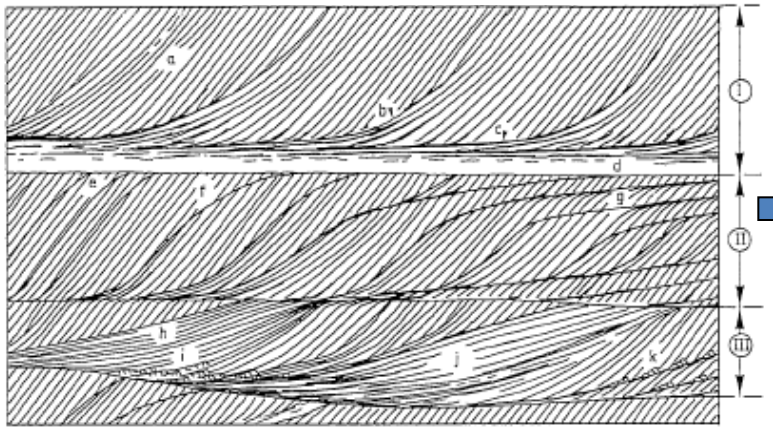


Multiple-point simulation



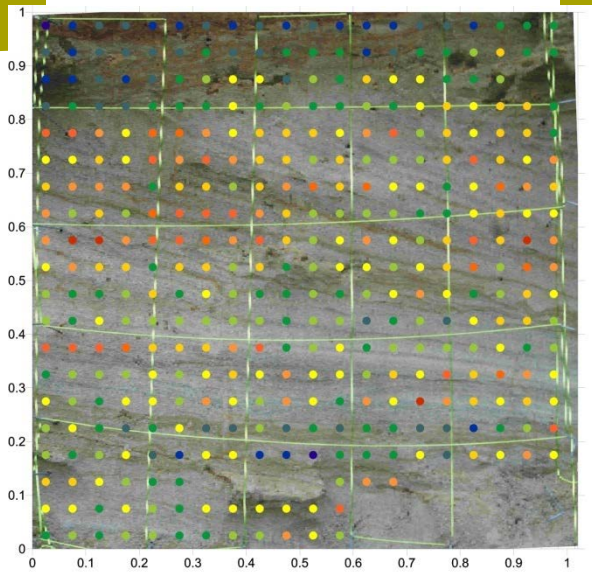
Problem setting

Complex geological heterogeneity

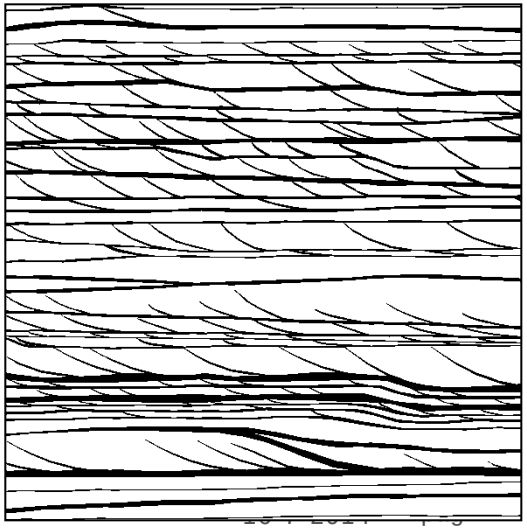


Field work

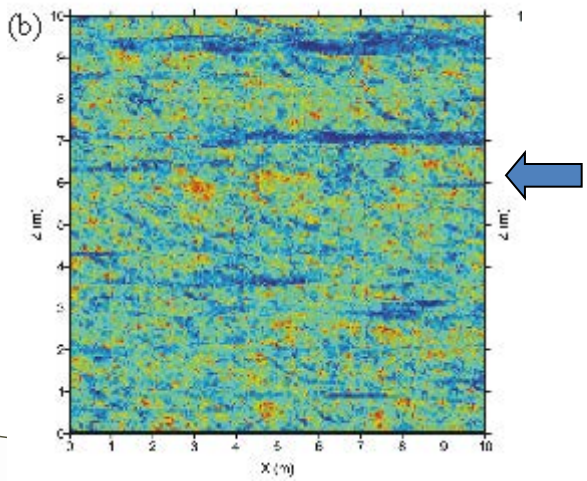
2750 air permeability measurements



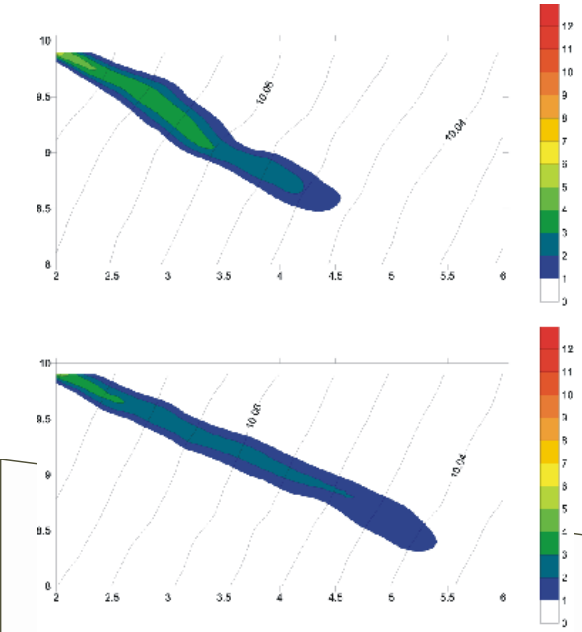
Training image



Permeability simulations

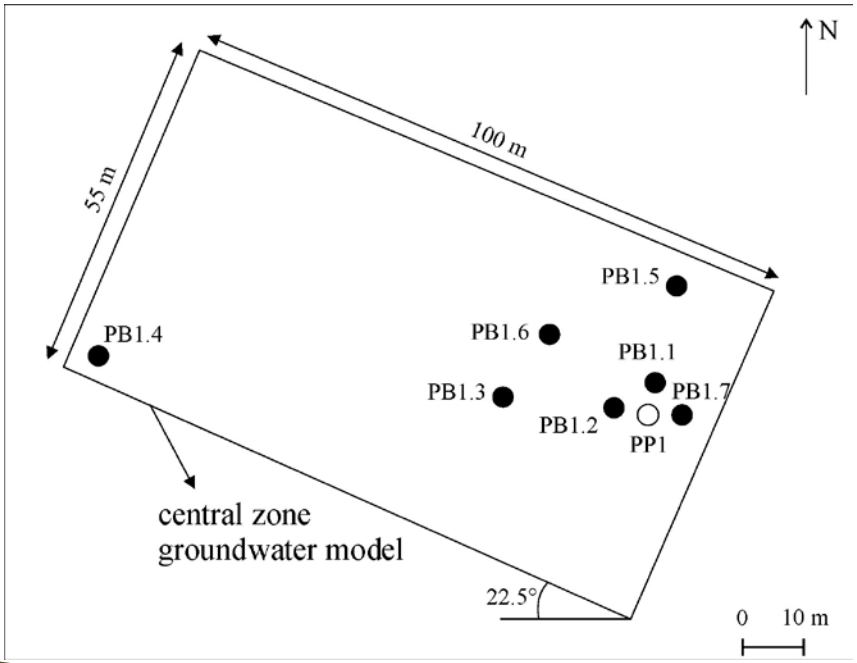


Groundwater modelling



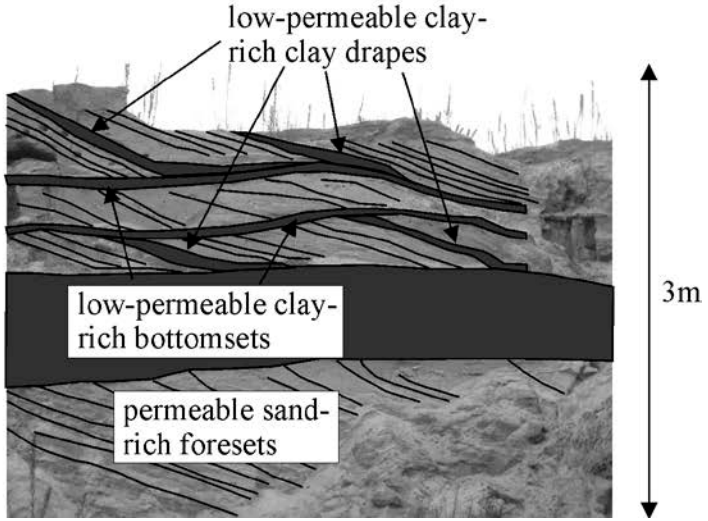
Problem setting

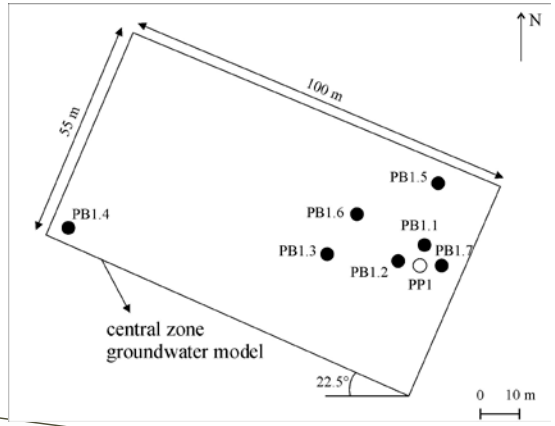
- Validation of the approach of combining field measurements, multiple-point geostatistics, upscaling and groundwater flow and transport modeling
- Pumping test

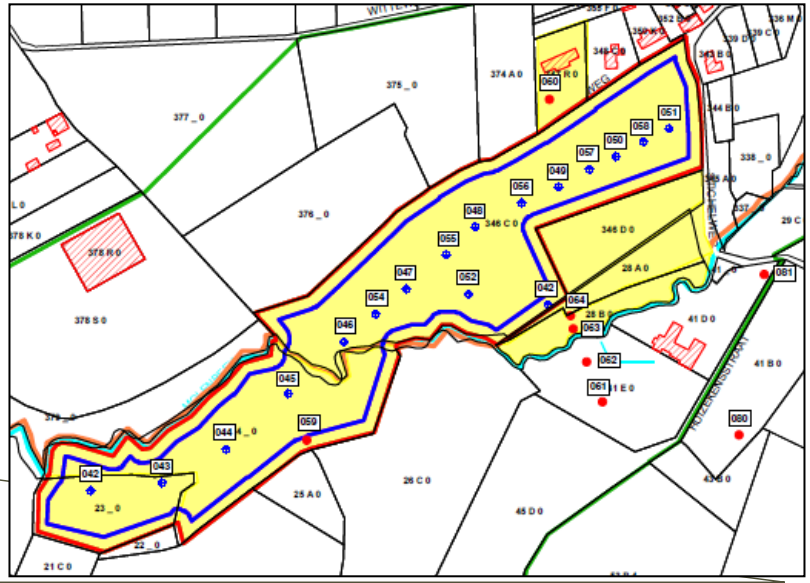


- Groundwater tracer test

Methodology: field work







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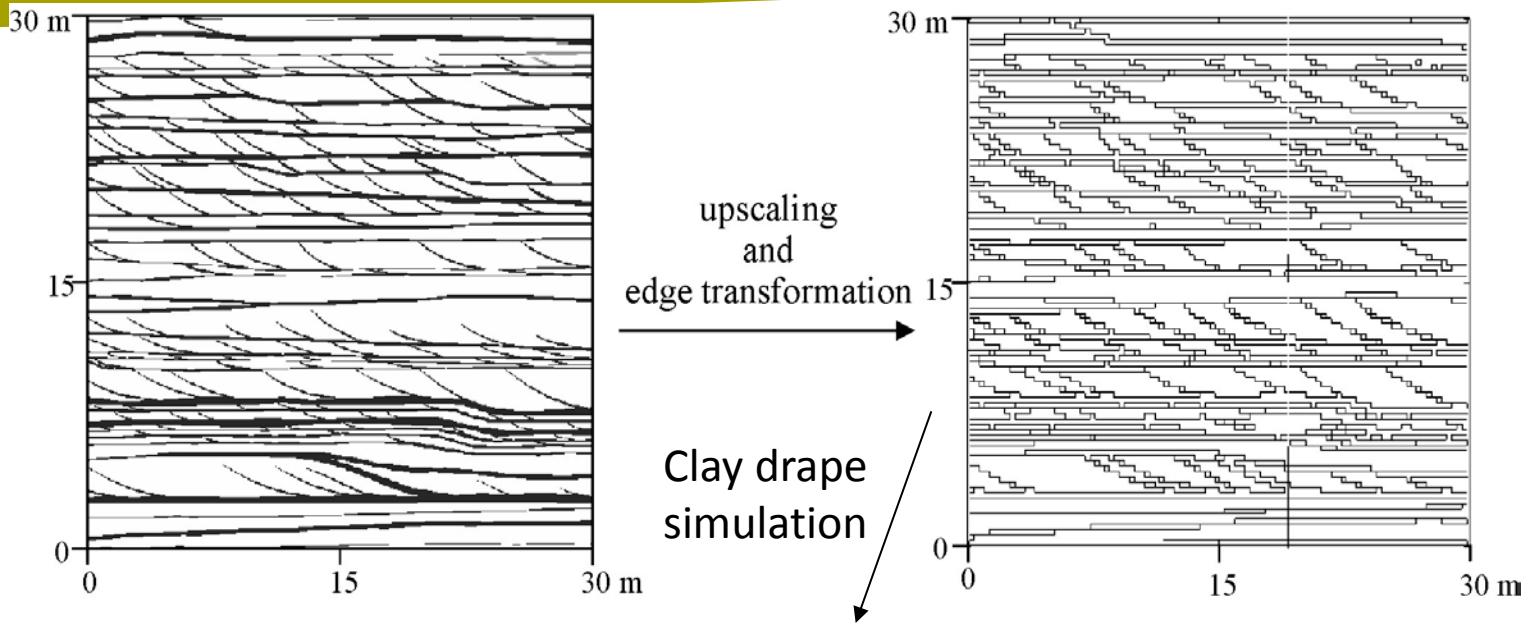
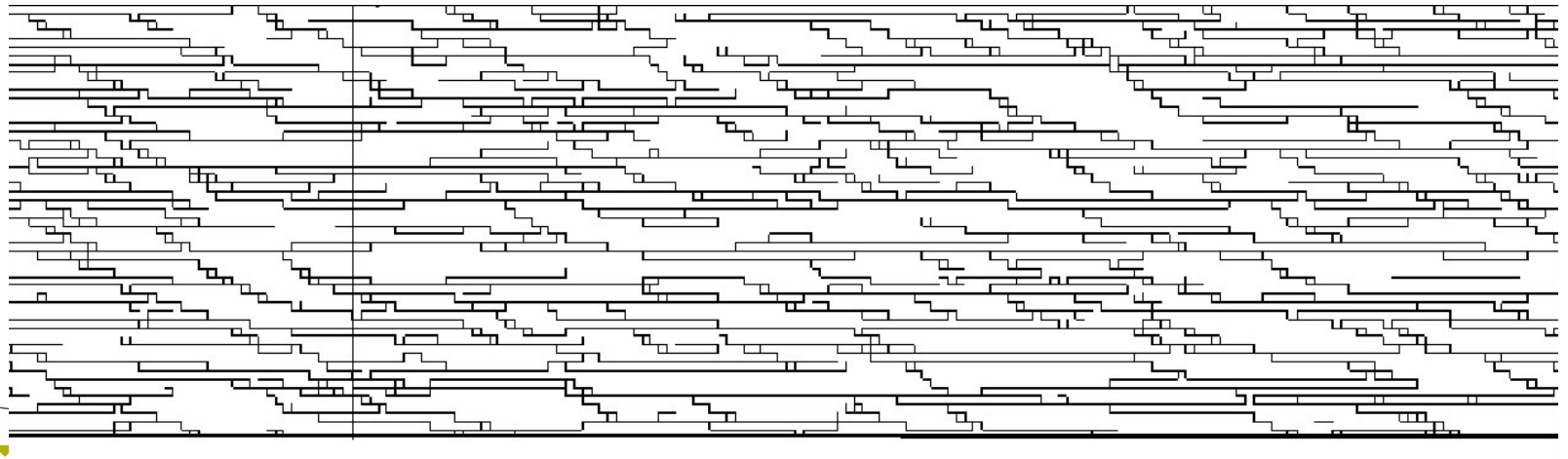
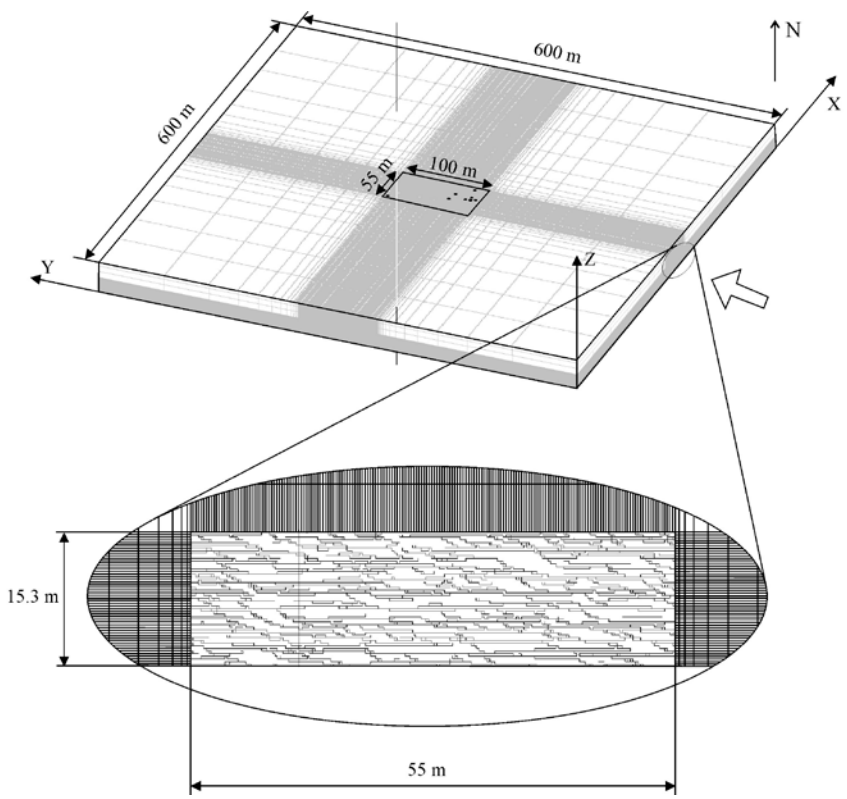
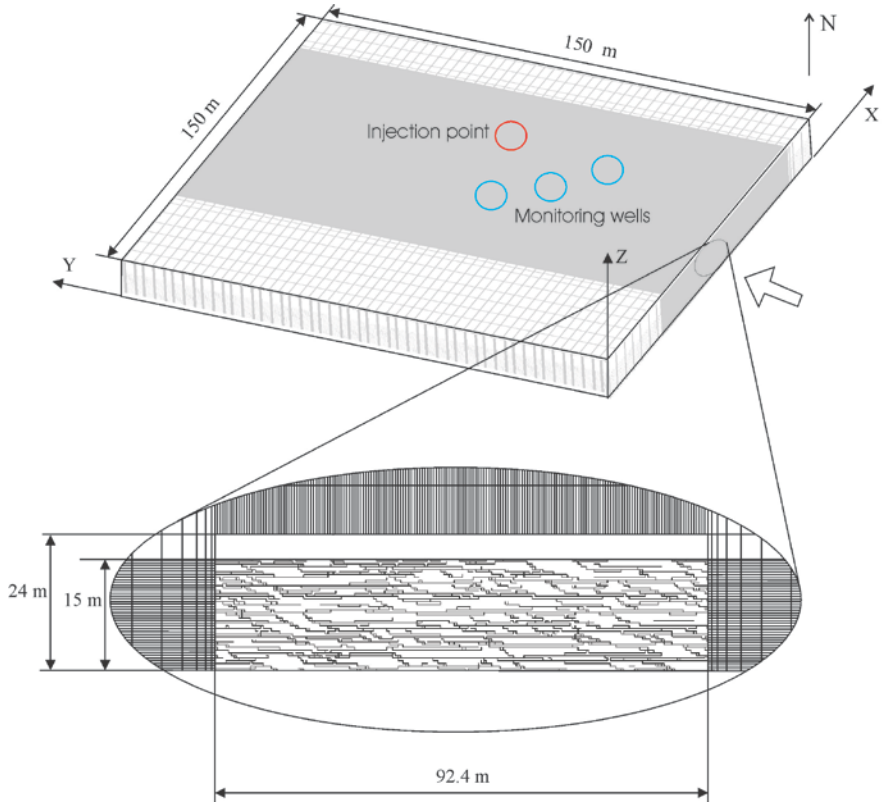
Methodology: training image construction and upscaling



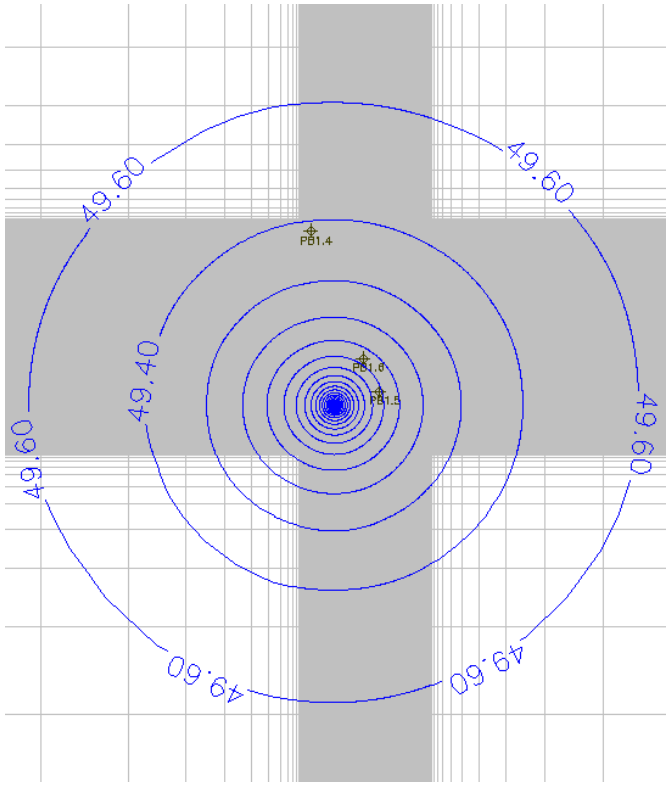


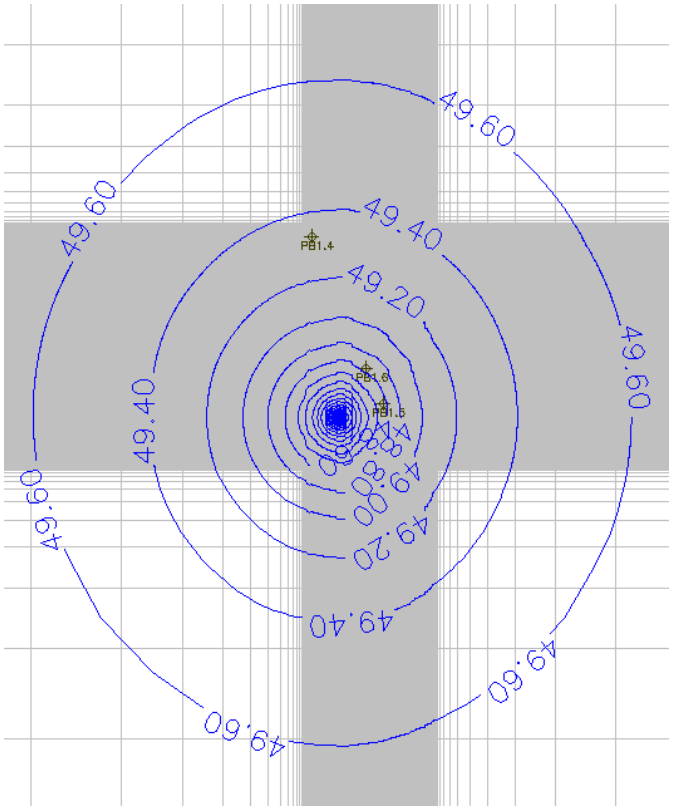
Methodology: groundwater flow and transport modeling





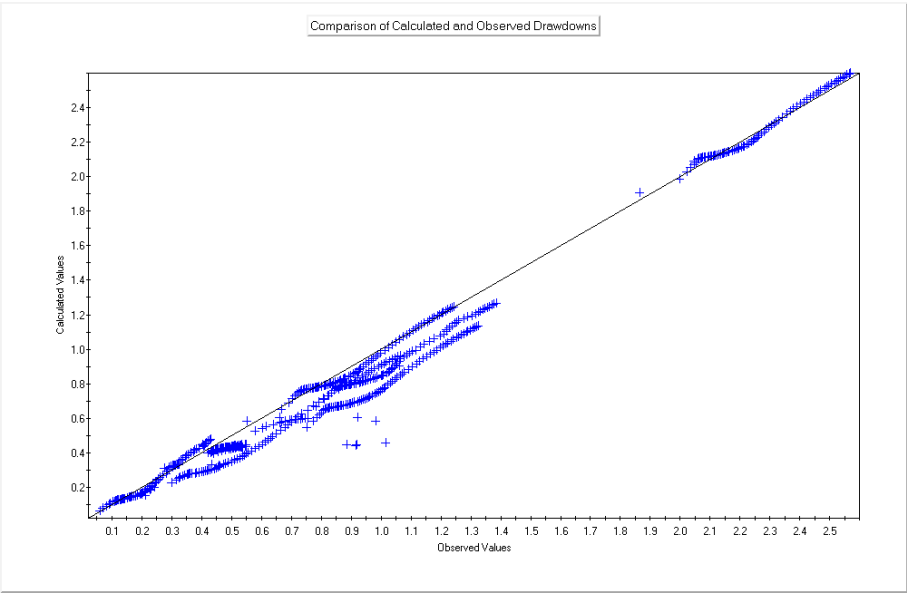
Results: pumping test

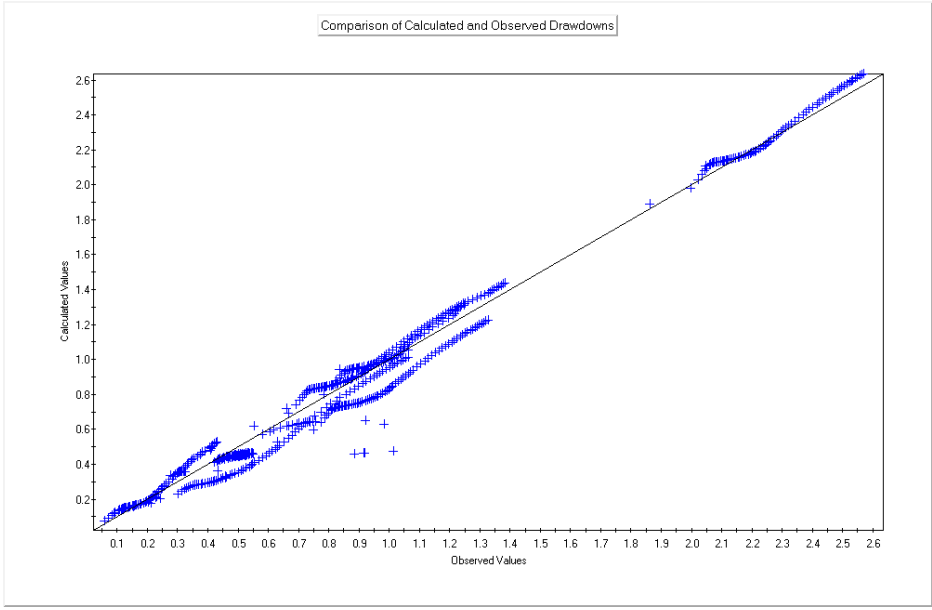




- Homogeneous and horizontally isotropic model
- Edge model

Results: pumping test

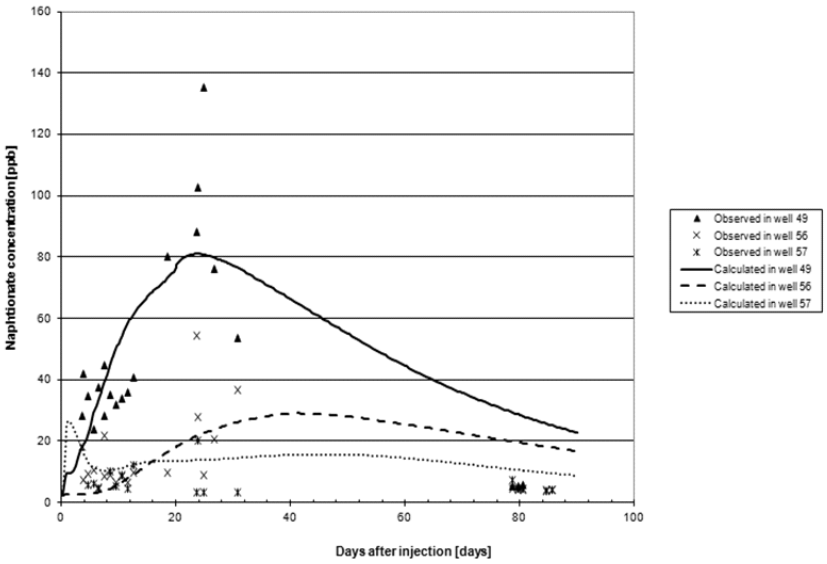


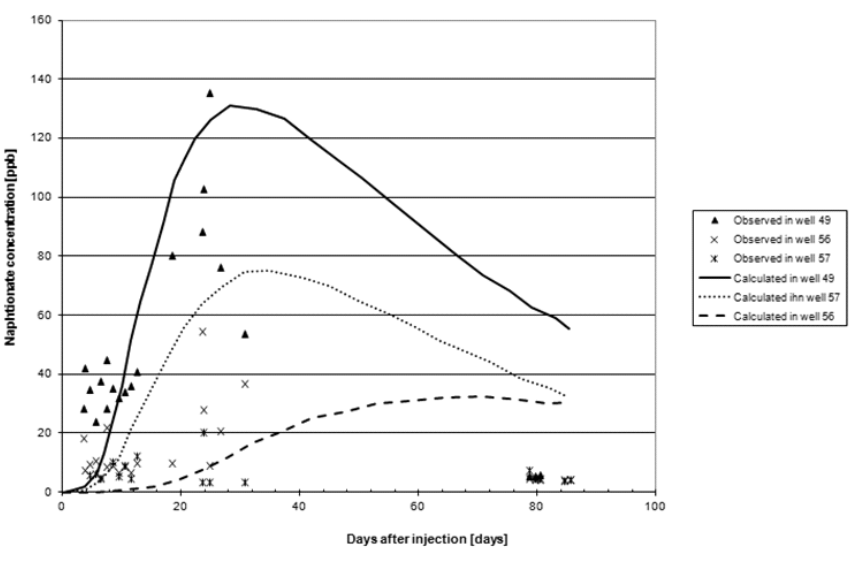


- Error variance = 1.06^{E}-2
- Homogeneous and isotropic model

- Error variance = 7.29^{E}-3
- Edge model

Results: tracer test





- Homogeneous and horizontally isotropic model
- Edge model

Discussion

- Extensive field campaign for heterogeneity characterization
- Very detailed information about fine-scale heterogeneity

- Multi-well pumping test + multi-injection tracer test

- Slight improvement of fit for pumping test and groundwater tracer test

Discussion

- Other features than fine-scale heterogeneity play an important role
  - Cm-scale geological heterogeneity versus field-scale models
  - Other heterogeneity features than clay drapes
  - Variations of pumping discharge rates
  - Wells screened in more than one geological layer
  - Boundary conditions, e.g. interaction with surface water features
  - Sampling issues

Conclusions

- Advantages
  - Incorporation of realistic geological heterogeneity
  - Efficient multiple-point geostatistical simulation
- Limitations
  - Computation time for fine-scaled groundwater flow and transport model
  - Other features than fine-scale heterogeneity play an important role

Thank you

Marijke Huysmans and Alain Dassargues