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

Training image

Multiple-point simulation

Multiple point geostatistics
Problem setting

Complex geological heterogeneity

Field work

2750 air permeability measurements

Groundwater modelling

Permeability simulations

Training image
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

low-permeable clay-rich clay drapes

low-permeable clay-rich bottomsets

permeable sand-rich foresets

3 m
Methodology: training image construction and upscaling

Clay drape simulation

upscaling and edge transformation

55 m

15.3 m

15 m
Methodology: groundwater flow and transport modeling
Results: pumping test

- Homogeneous and horizontally isotropic model
- Edge model
Results: pumping test

- Error variance = $1.06 \times 10^{-2}$
- Homogeneous and isotropic model

- Error variance = $7.29 \times 10^{-3}$
- 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

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