

Sensitivity of the Segmentation Step in Digital Rock Physics Workflows

EAGE-SCA International Symposium on
Digital Rock Physics and Applications

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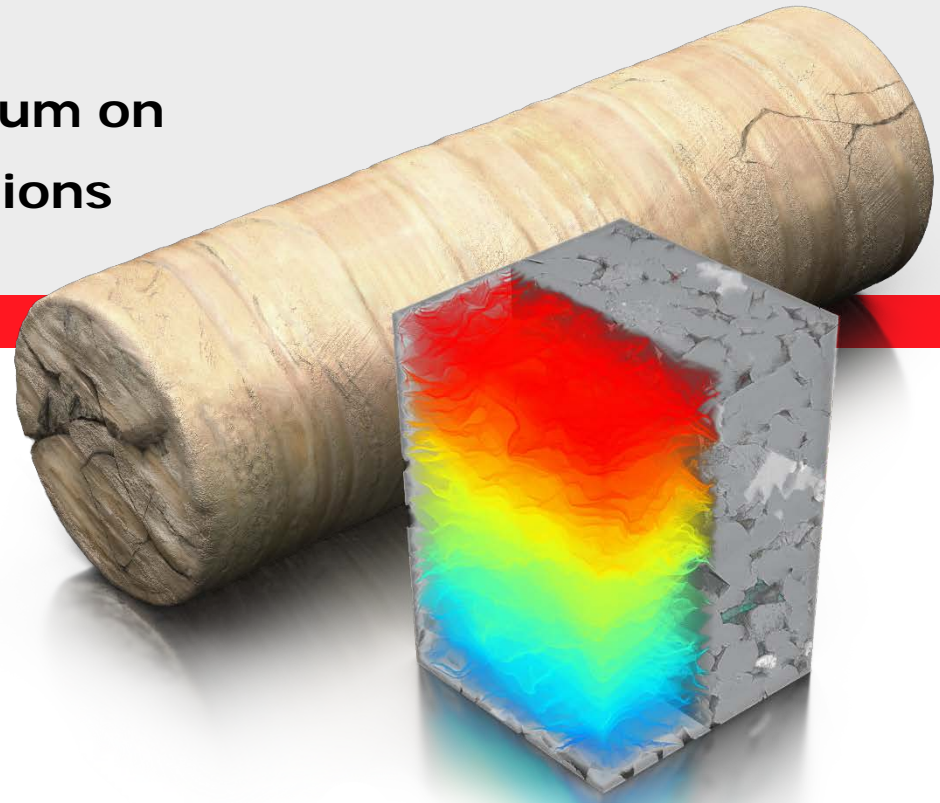
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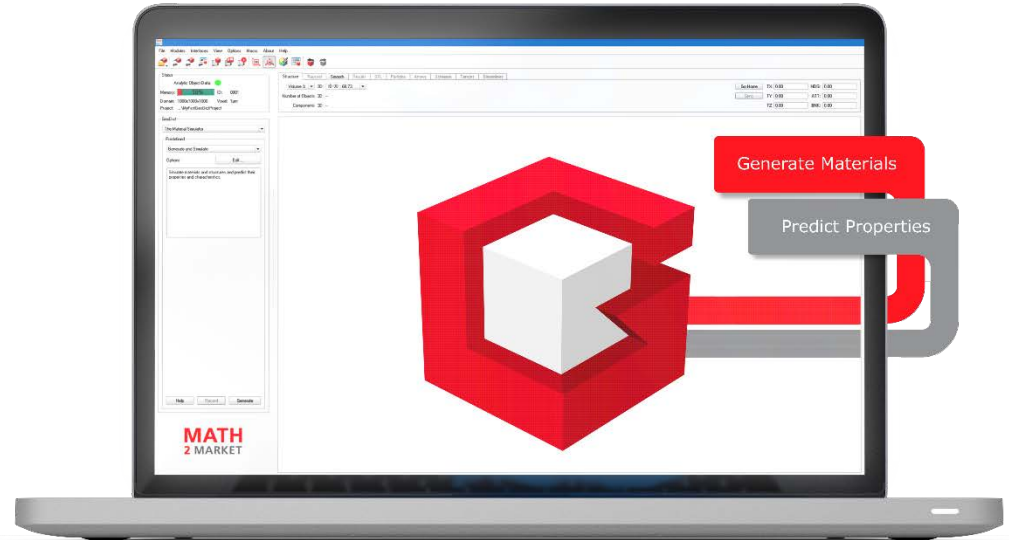
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Company Overview

Math2Market GmbH



Math2Market GmbH

Corporate Information

The Math2Market GmbH is a society of limited liability.

Math2Market GmbH spun-off in September, 2011 from Fraunhofer Institute for Industrial Mathematics, ITWM.

Math2Market GmbH is privately owned by

- 3 operative founders
- 2 others



Math2Market GmbH

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Math2Market GmbH

Services provided to our clients



Software



Client



User Guide

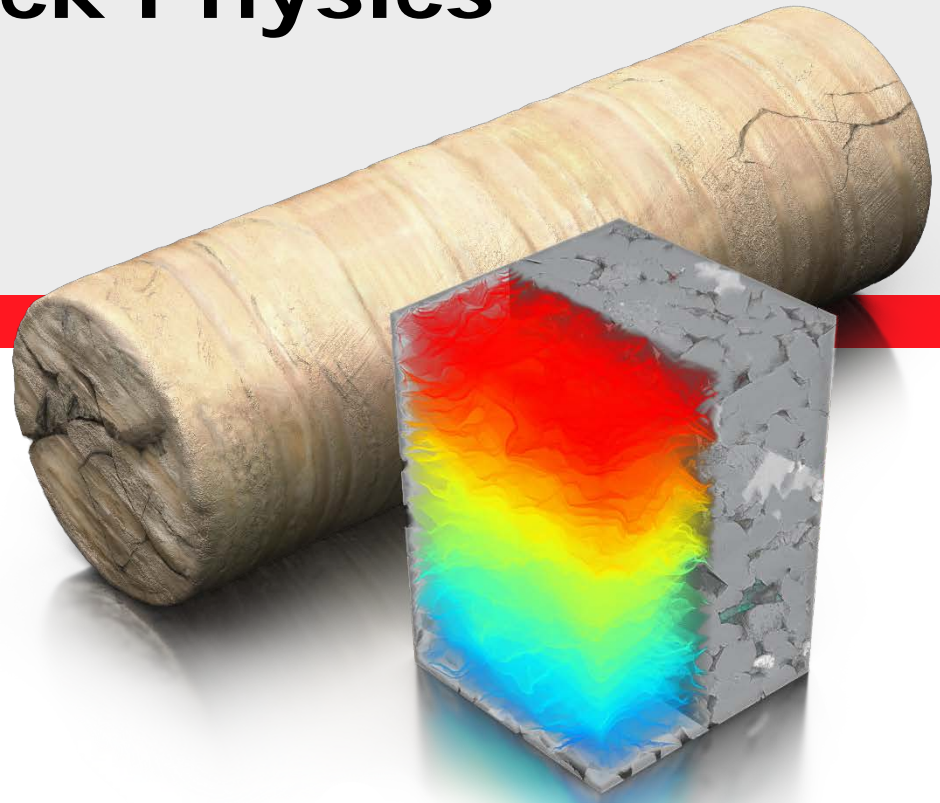


Support & Training



Consulting & Projects

Digital Rock Physics



(Reservoir) Rock Physics

Sources for physical properties of reservoir rocks



Analog outcrop



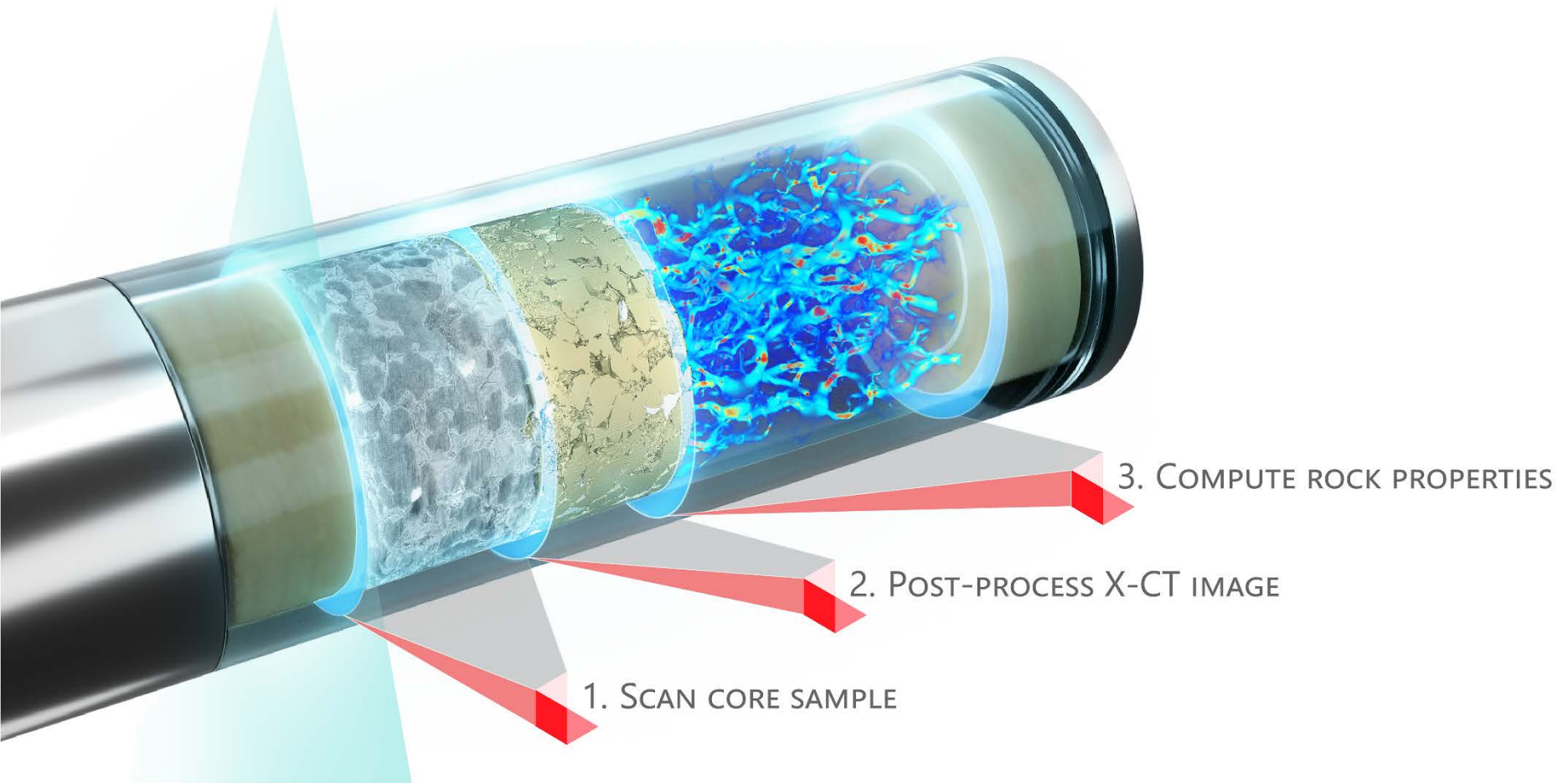
Well logging



Core analysis

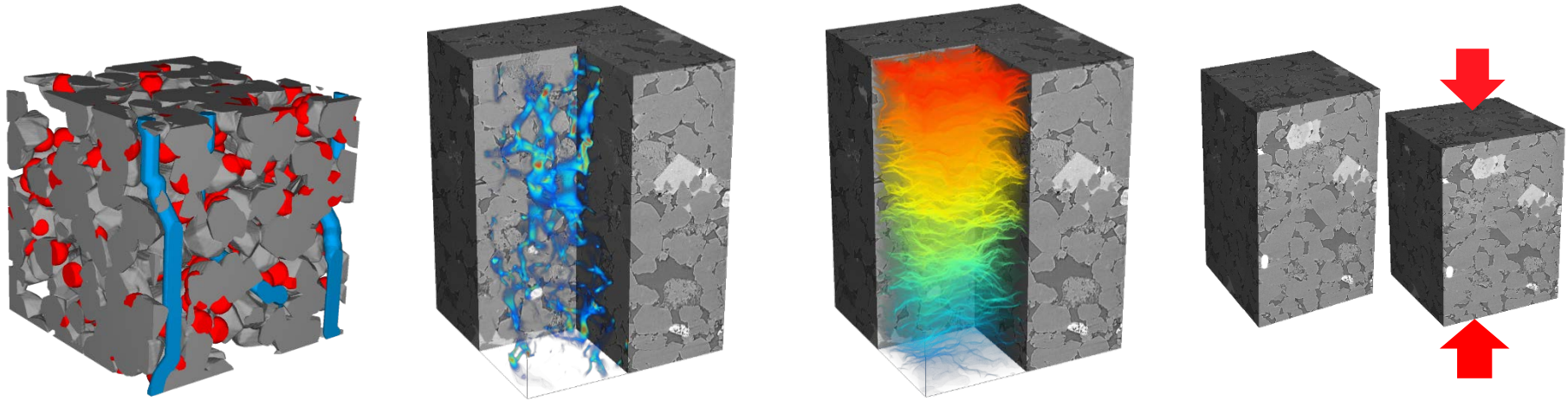
Digital Rock Physics (DRP)

Basic Workflow



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Digital Rock Physics Portfolio



Geometrical parameters

- Porosity
- Pore size distribution
- Percolation
- Surface area
- Tortuosity

Flow parameters

- Absolute permeability
- Multi-scale flow
- Multi-phase flow
- Relative permeability
- Cap. pressure curve

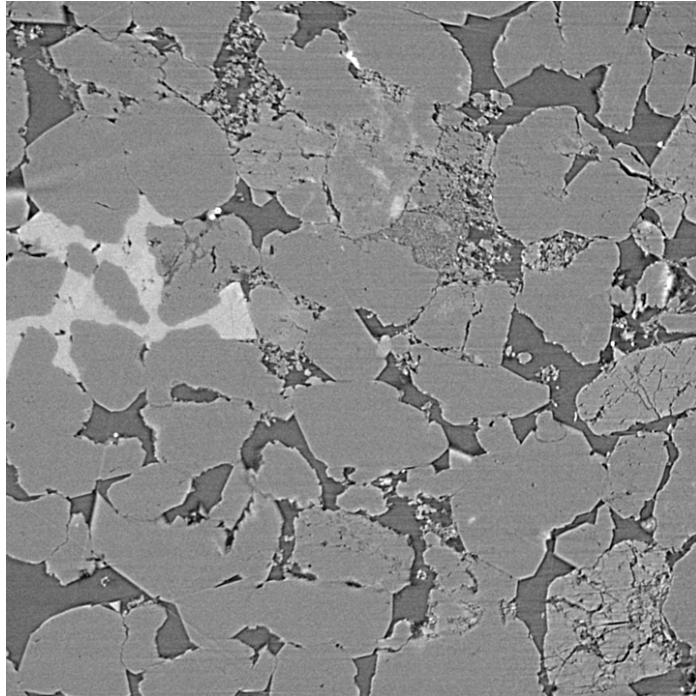
Electrical Parameters

- Formation factor
- Resistivity index
- Saturation exponent
- Cementation exponent

Mechanical parameters

- Elastic moduli
- Stiffness
- In-Situ conditions

Post-Process X-CT image Berea Sandstone



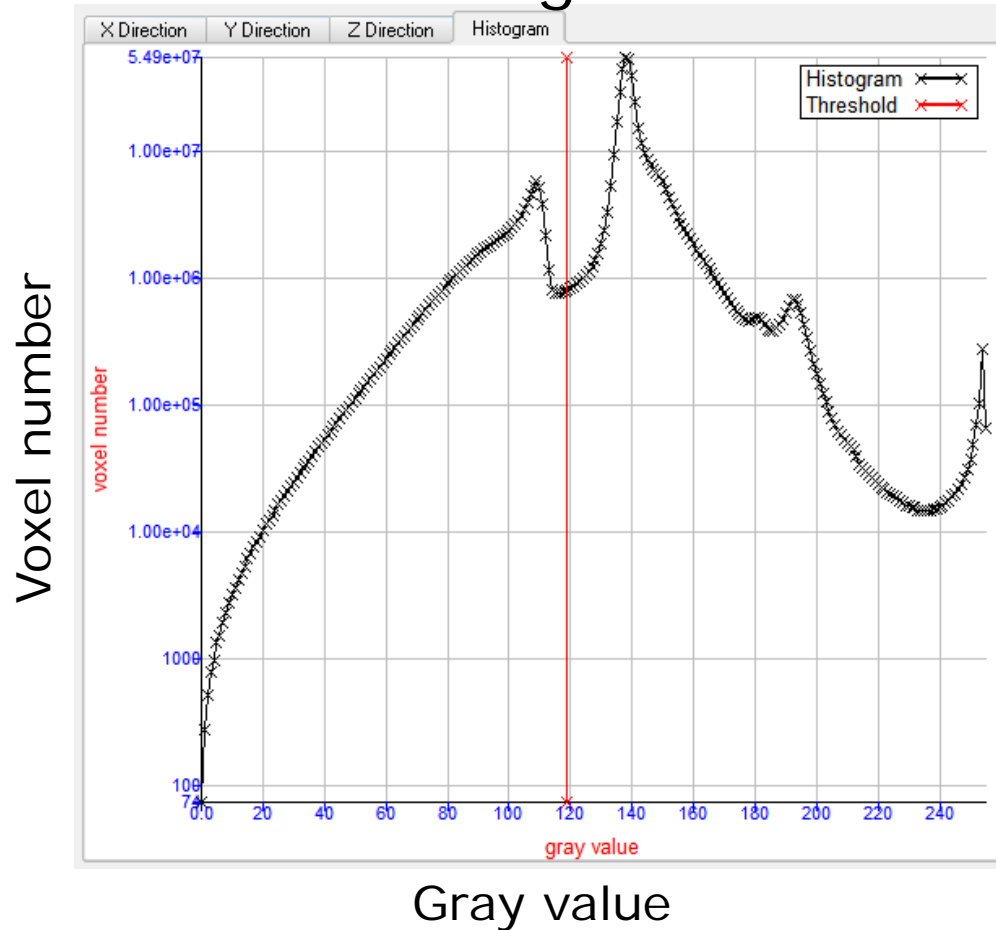
CT scan



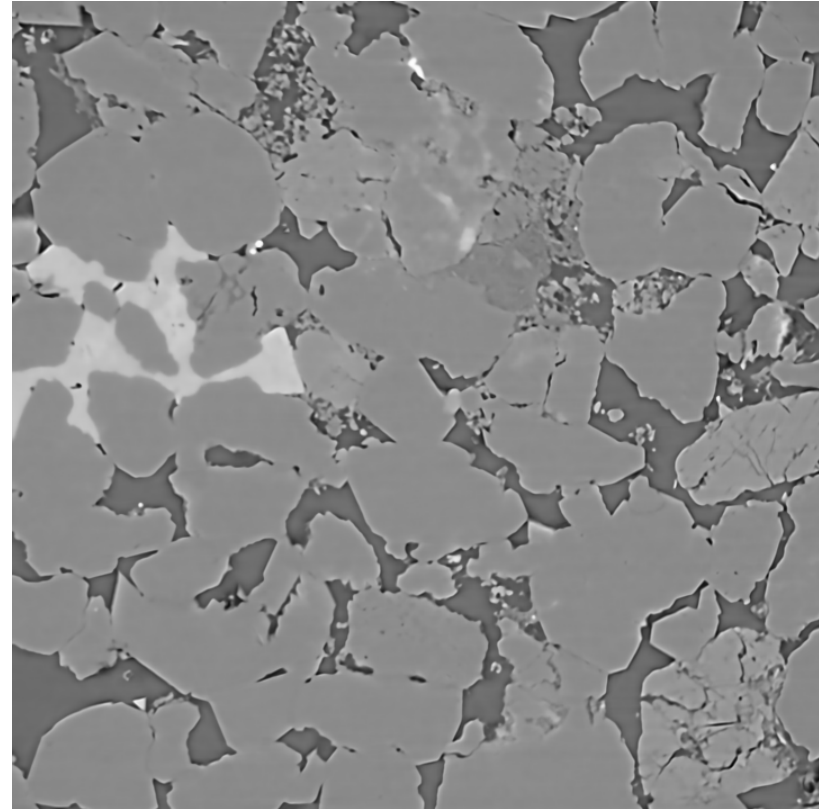
Segmented image

Threshold Segmentation

Histogram

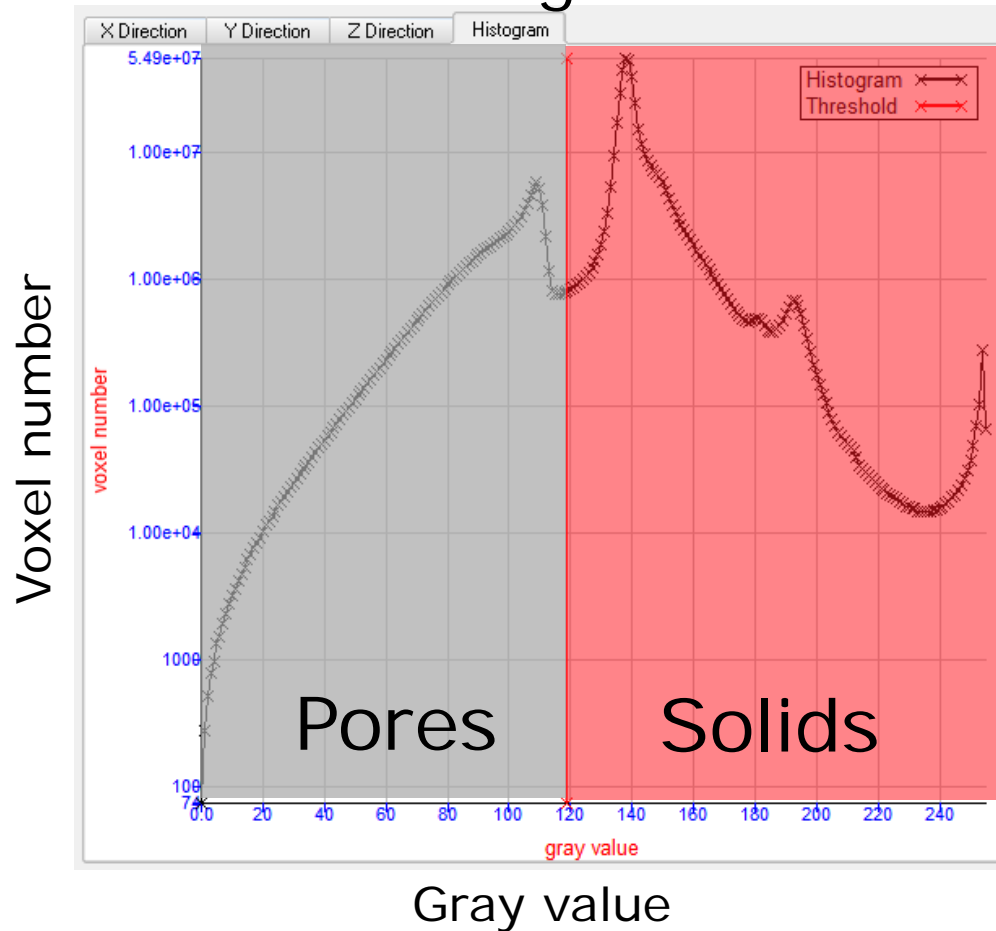


Filtered CT image

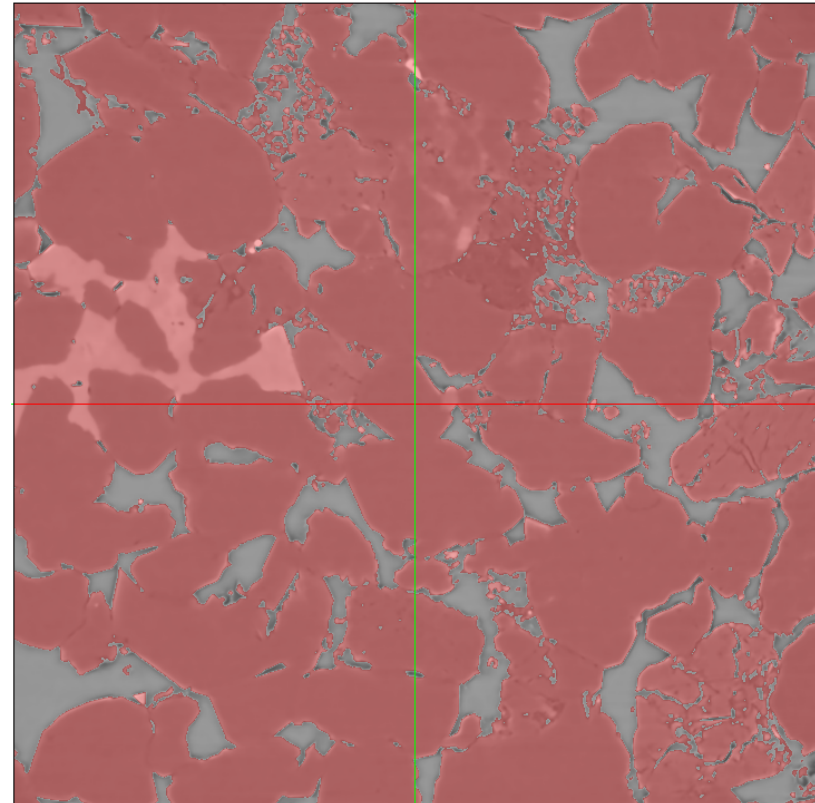


Threshold Segmentation

Histogram

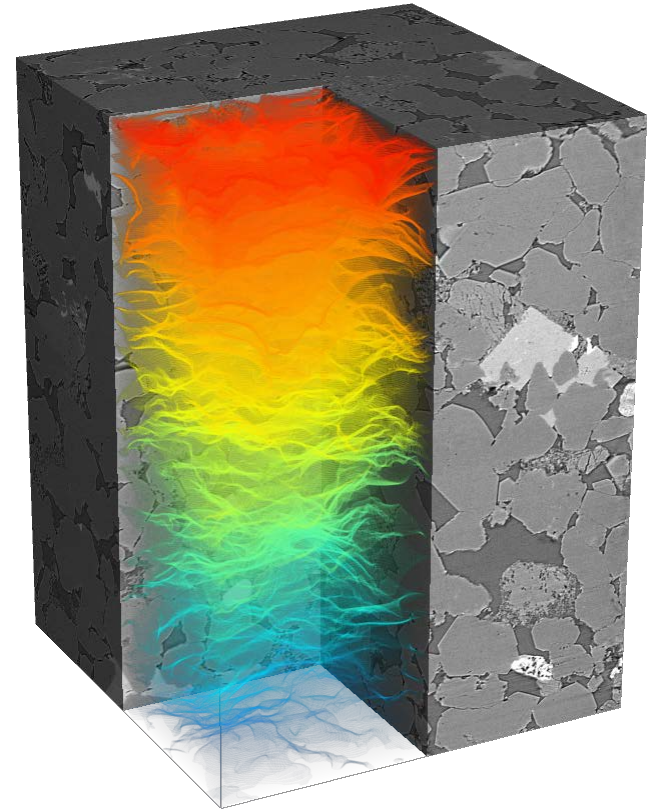


Thresholded image



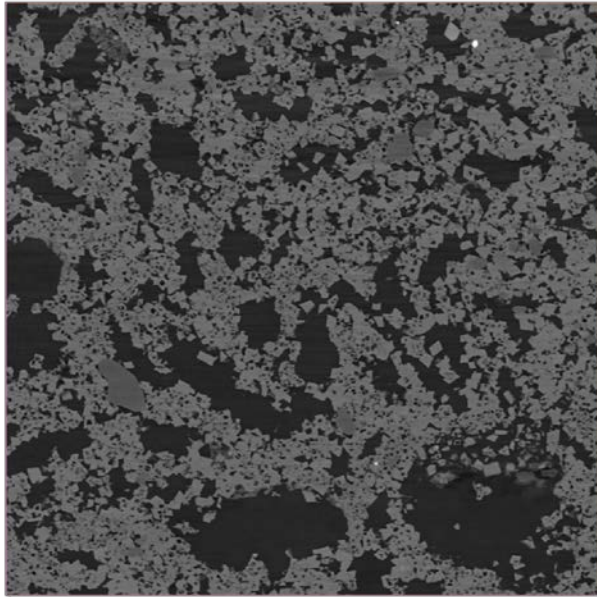
Workflow for Threshold Sensitivity Tests

- X-CT Scanning of samples with different resolutions
- Non-local means filtering
- Registrations of the scans with different resolutions
- Segmentation of pore space with different settings
- Computation of physical properties



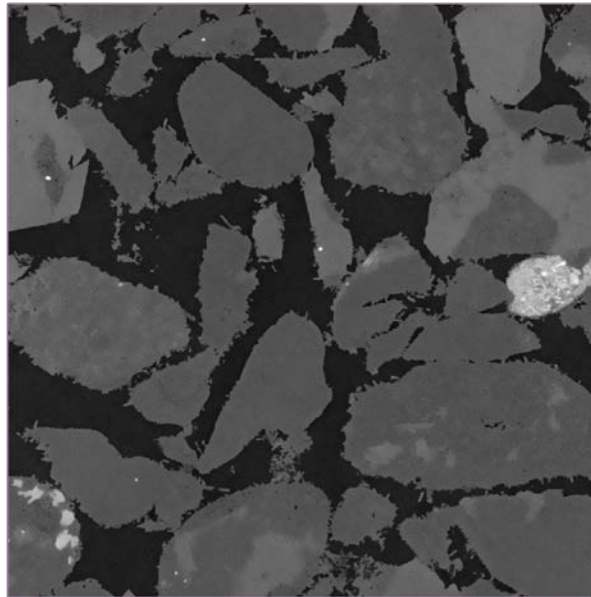
Rock samples

Carbonate (EBK)



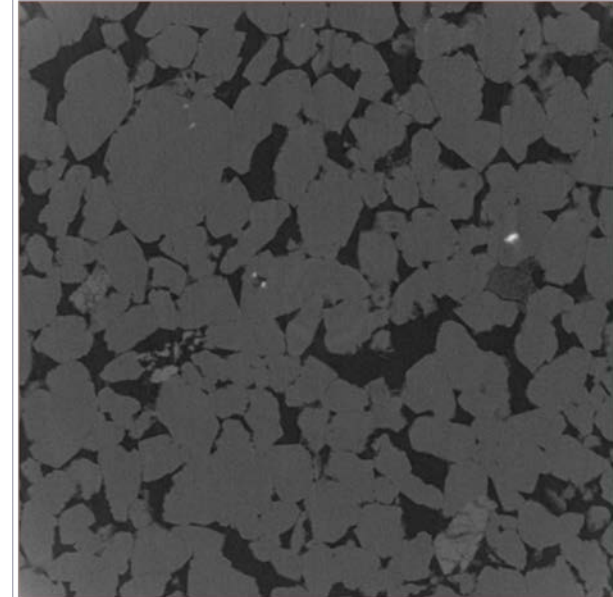
- Porosity up to 48%
- Inter- and intragranular void space

Young sandstone (IG)



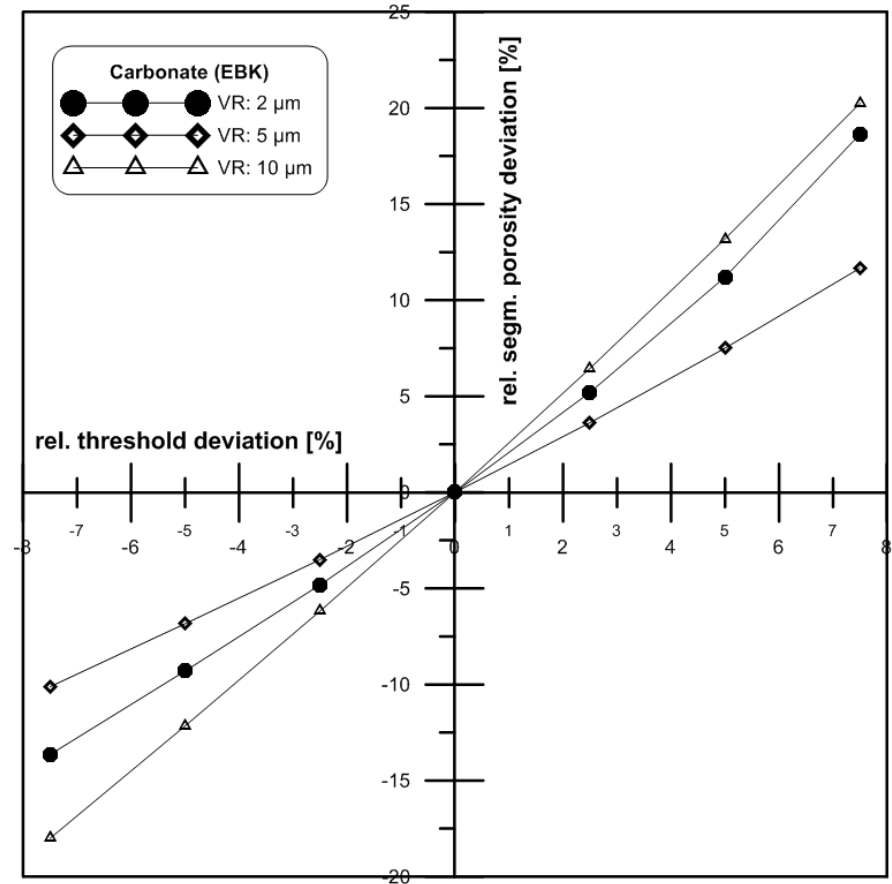
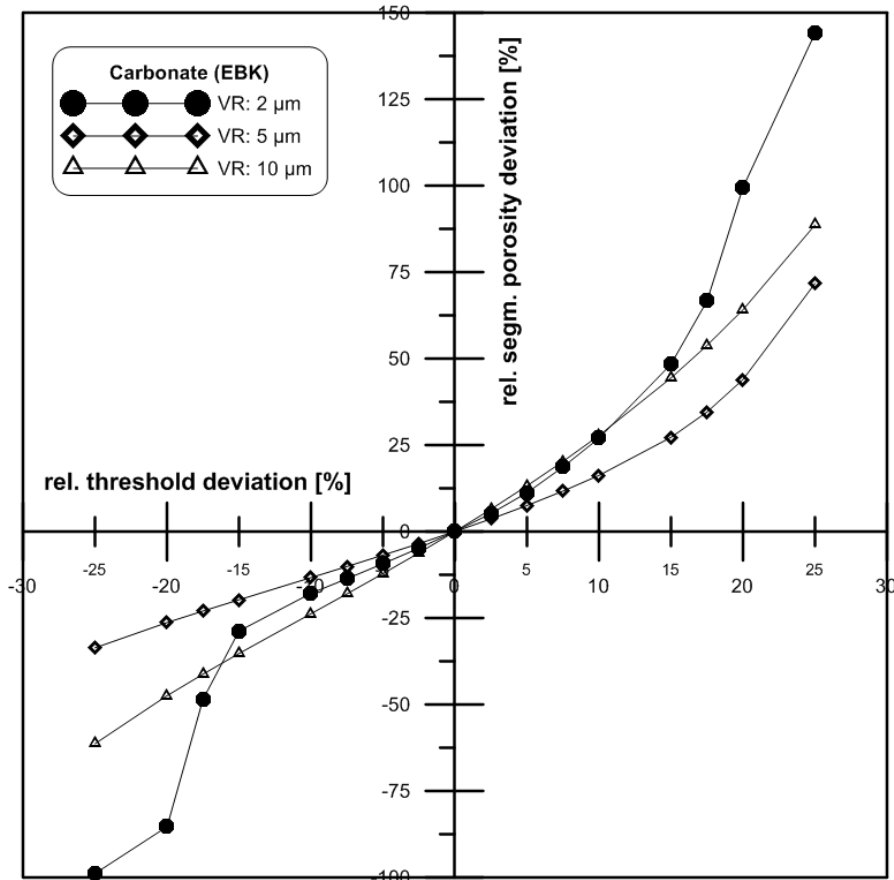
- Porosity up to 37%
- intergranular void space

Reservoir sandstone (BE)

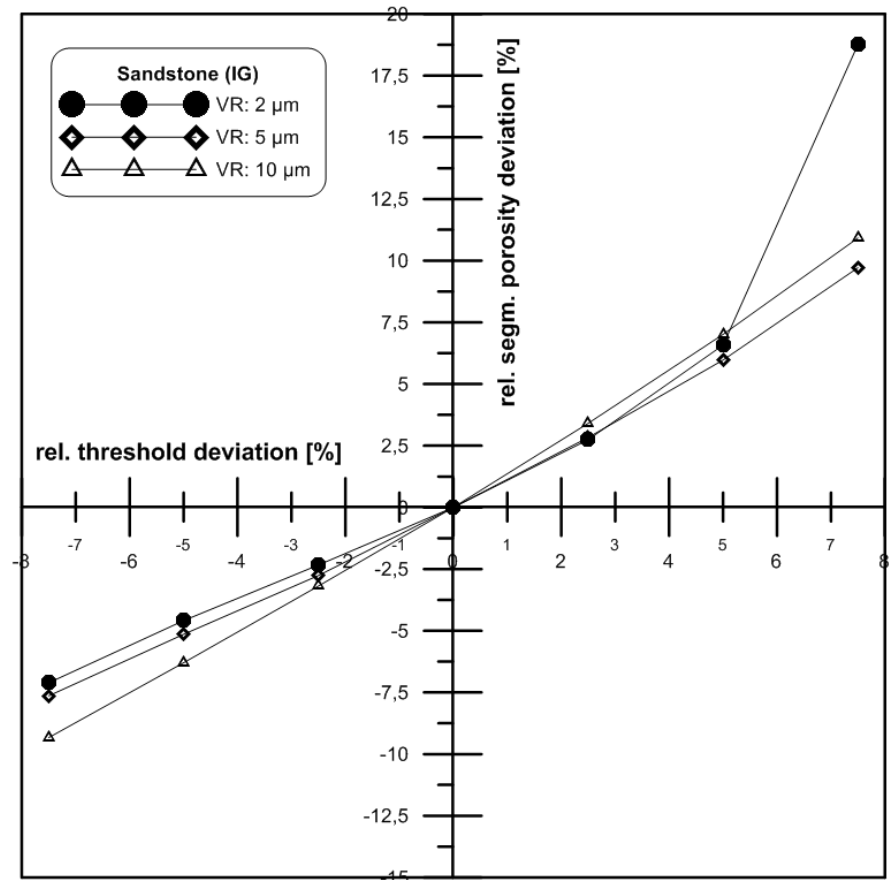
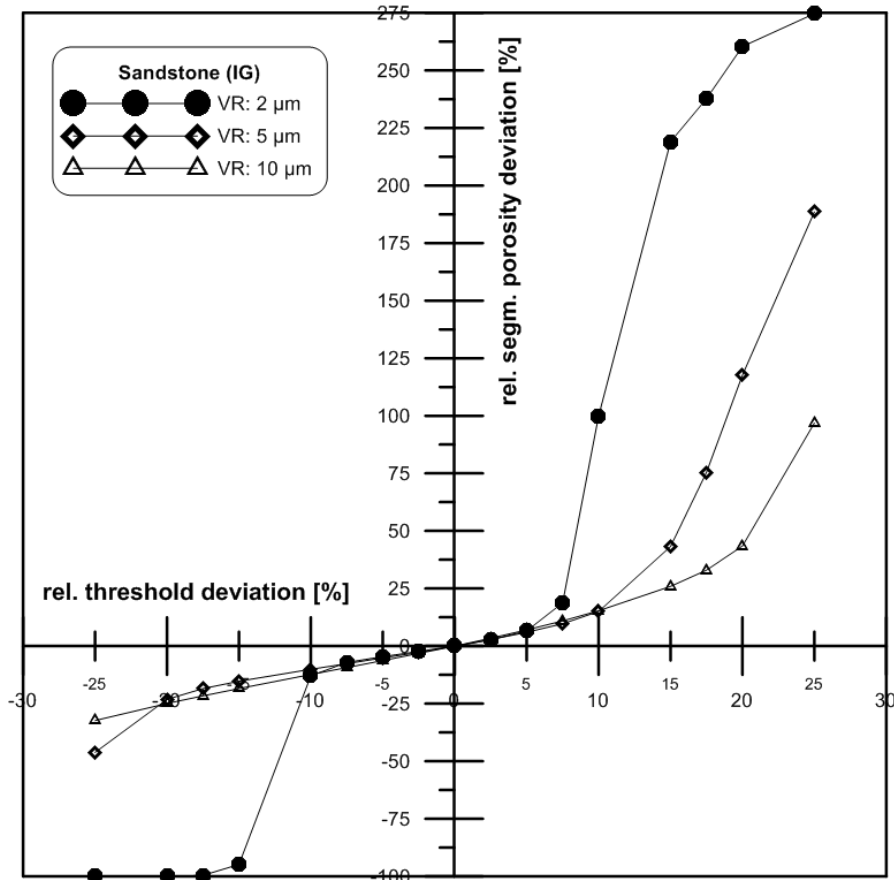


- Porosity up to 25%
- intergranular void space and micro-pores

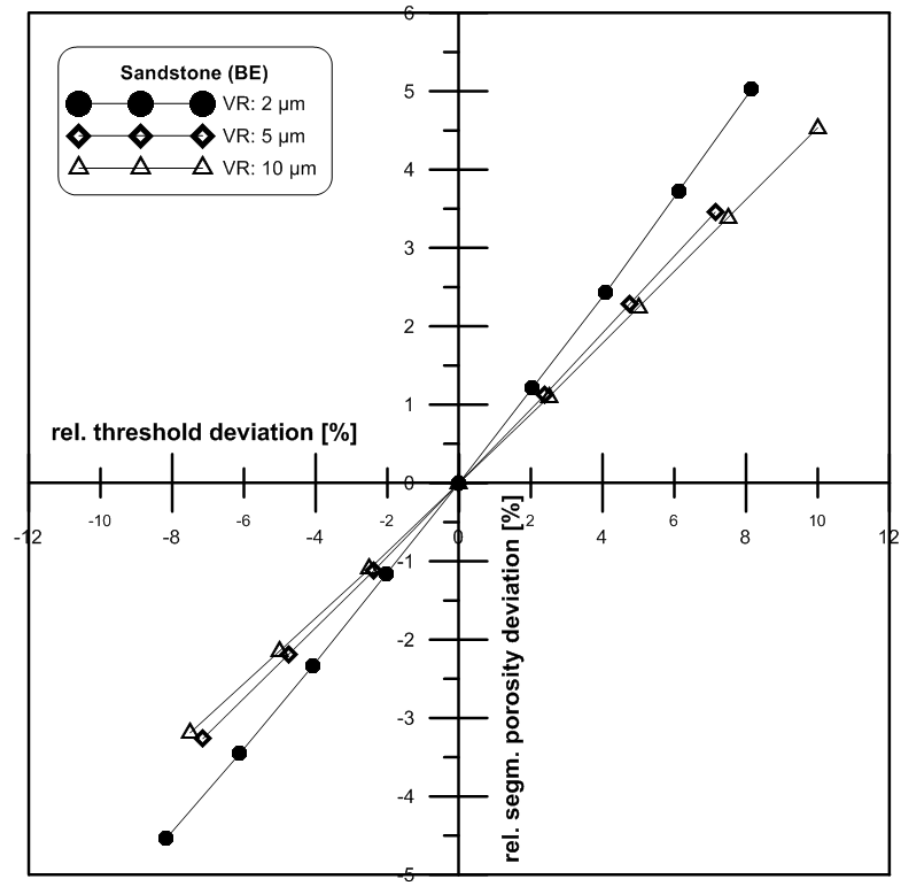
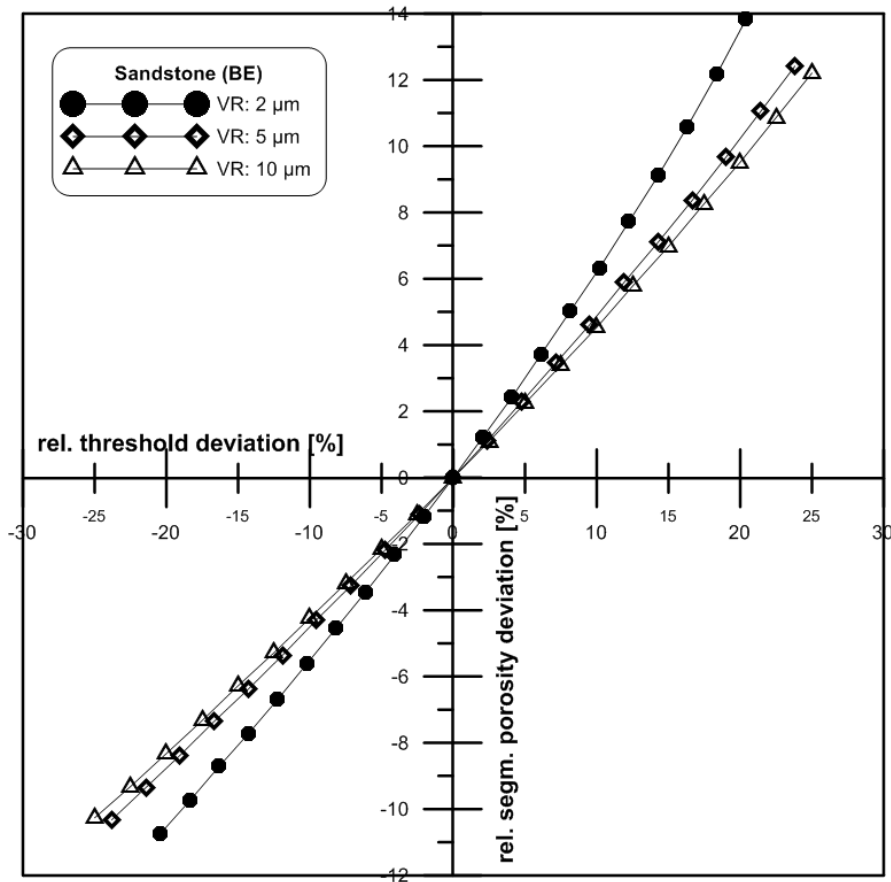
Results carbonate (EBK)



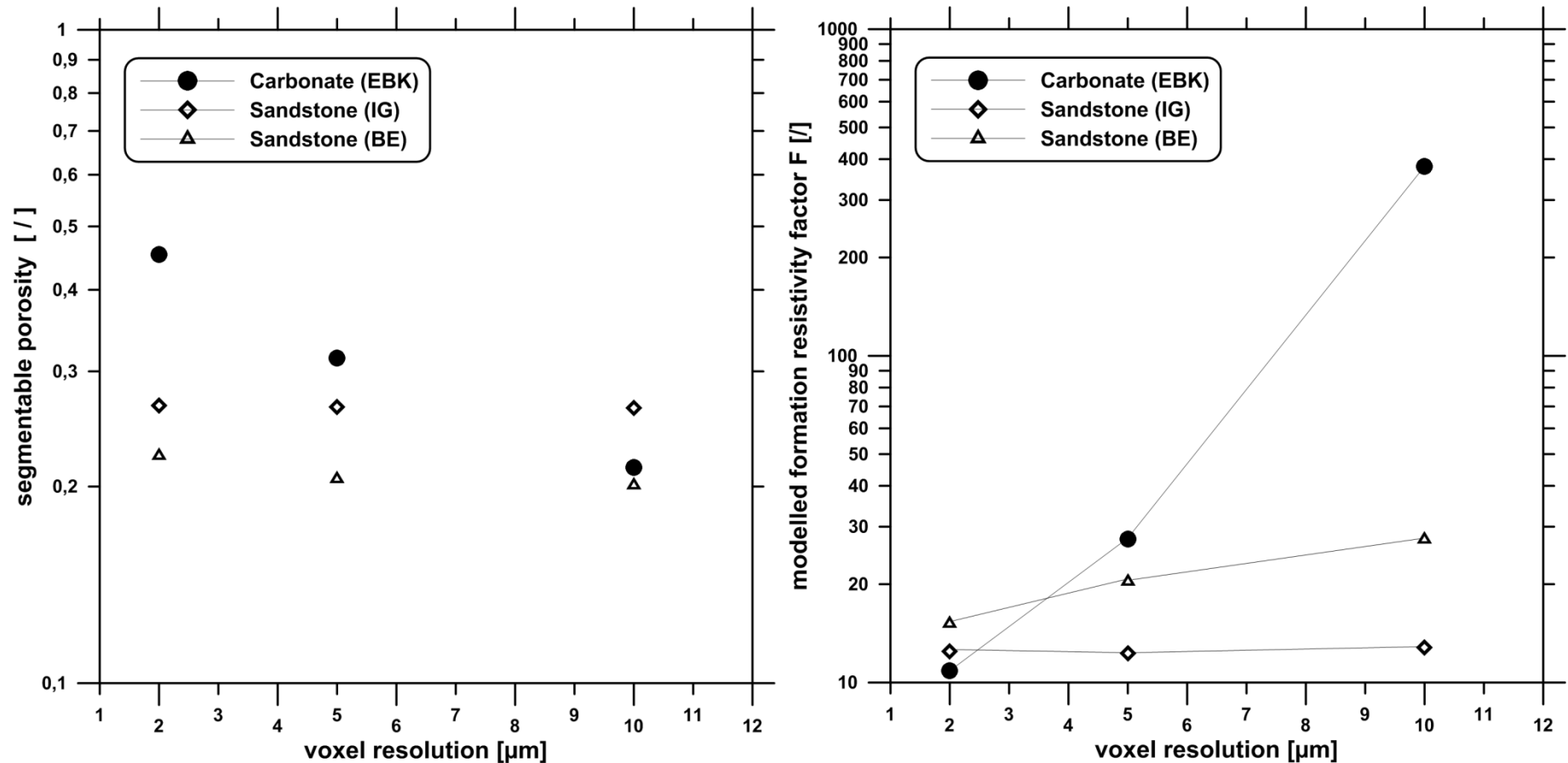
Results young sandstone (IG)



Results reservoir sandstone (BE)

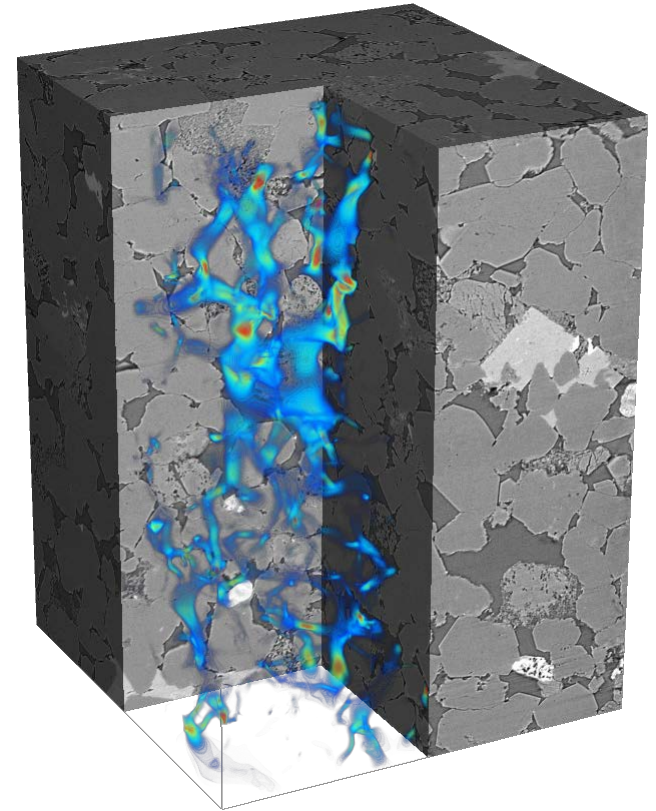


Results formation resistivity factor



Conclusions

- The segmented porosity is very sensitive to the chosen threshold value and the resolution of the CT scan.
- Changes in the threshold value may trigger more than ten times larger changes in the segmented porosity.
- The formation resistivity factor responds very sensitive to changes in the segmented porosity.
- Compute DRP parameters for multiple segmentations and provide error bar.
- Requires fast numerical solvers and an automatization of the calculations.



Thank you for your attention!

