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Statistical Characterisation of Porous Media at the Pore Scale

Progress Report I

Student:
Lukas Mosser

Supervisors:
Professor Olivier Dubrule
Professor Martin Blunt

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Report Outline

- **Current Status**
- **Next Steps**
- **Meeting Summaries**

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Current Status

- Preliminary Critical Literature Review summary
  - ~ 20 Relevant Papers
  - Topics:
    - » Image Morphology
    - » Minkowski Tensors
    - » Permeability estimation from X-Ray Micro-CT images
    - » Applications of Micro-CT imaging
- Scoping out the project:
  - Built Python Framework to apply Minkowski tensors to M-CT images
  - Uses unsmoothed marching cubes mesh
  - Preliminary results are promising but need to be double checked
  - Interpretation of results open question
- EAGE conference:
  - Introduction to Avizo by FEI product manager
  - Demonstration of surface extraction functionalities.

Next Steps

- Interpretation of Minkowski Tensors
- Investigate relation of tensors to scalar Minkowski functionals
- Extract isosurfaces using Avizo
- Investigate variation of tensors with smoothing
- Compute Minkowski functionals on simple geometries
  - => better understanding of behavior under varying parameters
- Compute scalar Minkowski functionals on same images/sub-volumes
- Find a good way to visualize eigenvectors of tensors and compare different samples
- Next Meeting: 08/06/2016
  - Attendants: Prof. Martin Blunt, Lukas Mosser

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Meeting 1:

- Date: 22/03/2016
- Attendants: Prof. Martin Blunt, Prof. Olivier Dubrule, Lukas Mosser
- Discussed Topics:
  - Project Outline
    - » Statistical Correlations applied to Micro-CT Images
    - » Minkowski Functionals
    - » Different Length scales
    - » Cross Correlations
    - » Distance Maps
  - Collect Micro-CT images, available at Imperial College

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Meeting 2:

- Date: 28/04/2016
- Attendants: Dr. Branko Bijeljic, Lukas Mosser
- Discussed Topics:
  - Review of proposed Project Outline
  - Discussion of individual Micro-CT images
  - Recommendation by Dr. Bijeljic to start with “homogeneous” samples
    - » Ketton most similar to bead pack
  - Discussed difficulties of measuring permeability from Micro-CT
  - Recommendation of complementary papers

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Meeting 3:

- Date: 16/05/2016
- Attendants: Prof. Olivier Dubrule, Lukas Mosser
- Discussed Topics:
  - Time Schedule:
    - » Olivier away: July and August
    - » Available in May and June
  - Preparation of slides for presentation
  - Set up meeting with Claire Veillard
  - Look at possibility to differentiate between different characteristics:
    - » Different Porosity types, depositional effects
  - Problem of single samples per category
  - Binary vs. multi-colored images

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Meeting 4:

- Date: 24/05/2016
- Attendants: Claire Veillard, Lukas Mosser
- Discussed Topics:
  - Discussion on Claires PhD topic
  - How segmentation has been performed on multi-colored image
    - » Visual estimation of what is dolomite, what is calcite.
    - » Proper way by using back scattering energy
  - Explanation of fundamental X-Ray Micro-CT principles
    - » Sample preparation
    - » Attenuation Coefficient
    - » Attenuation Coefficient contrast as function of beam energy

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Meeting 5:

- Date: 25/05/2016
- Attendants: Prof. Martin Blunt, Prof. Olivier Dubrule, Lukas Mosser
- Discussed Topics:
  - Review of proposed Project Outline
  - Computation of permeability has already been done, needs to go beyond this
  - Shift focus towards Minkowski Tensors
  - Needs to be scoped out
    - » Can we apply it to our datasets?
    - » What software/tools do we need?
    - » Is it doable in 3 months?
  - Definitely in 3D, 2D is insufficient
  - Get access to Avizo and compare to python tools, better suited?
  - Martin available: June, July
  - Olivier available: May, June