

Extended characterization of pore structure in sandstone

Lisa Falco and Markus Burkhardt
 SCANCO Medical AG
 Brüttisellen, Switzerland
www.scanco.ch

Customer need

Information about the porosity and permeability is often of high importance for characterizing a material. The descriptive parameters obtained by the standard SCANCO morphometric analysis are the porosity, average pore thickness and pore size distribution. We will here show that a further characterization of the structure is possible in order to quantify the penetrability of the material and to obtain the inter pore connectivity by simulating the mercury intrusion method on the data.

In this example we have performed the analysis on sandstone but the same method is often used for many other applications such as biomaterials and scaffold characterization.

Materials and methods

A sample of sandstone was analysed using the SCANCO Medical μ CT 50 scanner.

The following settings have been applied by means of an easy configurable measuring protocol:

- Spatial Resolution: 2 μ m
- Beam energy: 90 kVp
- Beam Intensity 67 μ A
- Integration Time: 6 s
- Image Matrix: 3400 x 3400

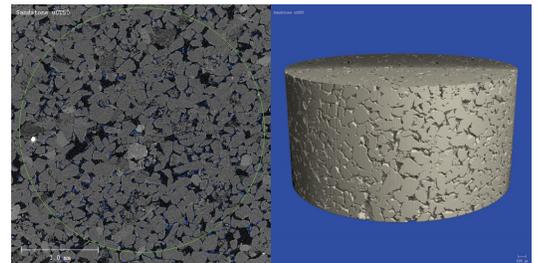


Figure 1: a) Cross-sectional slice image of the sandstone scanned with a micro computed tomography system. The region of interest used for the analysis is marked in green. b) The segmented volume of the sandstone sample.

After the automatic reconstruction of the data, a volume of interest is manually selected (Figure 1a). Then, a morphometric analysis using the SCANCO Evaluation Software is done. This first analysis segments the image and compute parameters such as total volume, object volume, object surface, wall thickness, pore diameter distribution, porosity, local wall thickness etc.

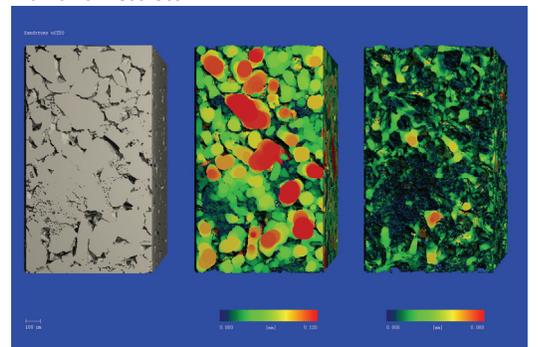


Figure 2: a) Segmentation of a part of the sandstone sample. b) Color coded wall thickness of the sample. c) Color coded pore diameter of the sample.

Customer need

Quantitative analysis of the porosity and the permeability of a material.

Materials and methods

SCANCO Medical μ CT 50 scanner was used to produce the images and SCANCO evaluation software for segmentation, 3D morphometric analysis and Accessible Volume Analysis simulating the Mercury Intrusion Method were used for the analysis.

Results

Quantitative information about the porous structure such as porosity, average pore size, pore size distribution, pore interconnectivity and accessible volume for various particle sizes.

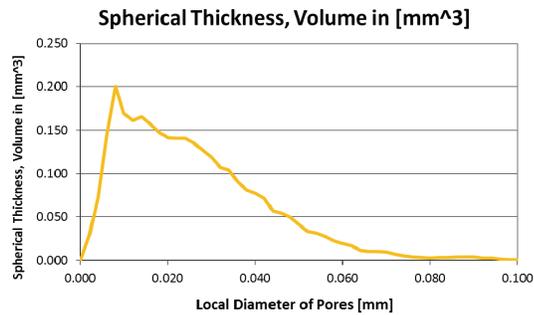


Figure 3: Local pore size distribution

We then run the mercury intrusion simulation that computes the volume of the pores that is accessible through pathways with at least a chosen parameter D . In other words: if a sphere with diameter D is taken, what is the total volume it can reach via the connected pores?

Results of the analysis

The result from the simulated mercury intrusion is a graph of accessible volume versus sphere diameter used to penetrate the porous rock (Fig. 6). A 3D rendering of the simulation can be seen in Fig. 4 and Fig. 5. Fig. 4 illustrates the entire sample volume simulated with the accessible pore volume for a test sphere diameter of $24\ \mu\text{m}$ shown in yellow. Fig. 5 shows a section of the sample is displayed with decreasing test sphere diameters.

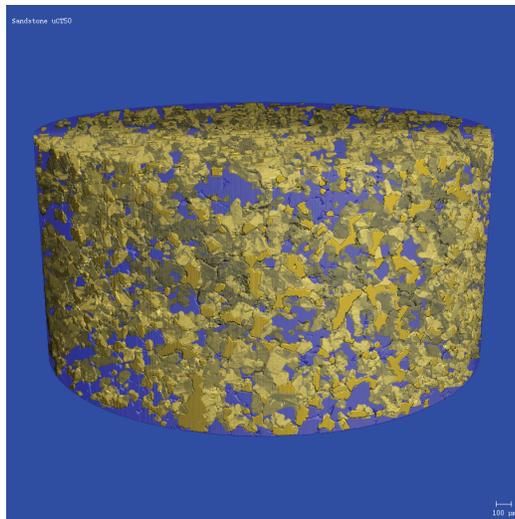


Figure 4: Sandstone sample. Accessible volume of a sphere diameter of $24\ \mu\text{m}$ is shown in yellow.

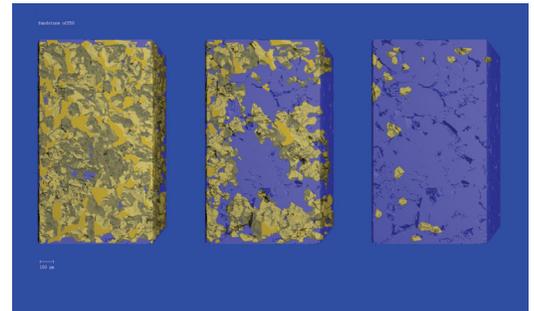


Figure 5: Part of sandstone sample. Accessible volume is shown in yellow. a) Left: accessible volume with sphere diameter of $16\ \mu\text{m}$. b) Middle: $24\ \mu\text{m}$. c) Right: $48\ \mu\text{m}$.

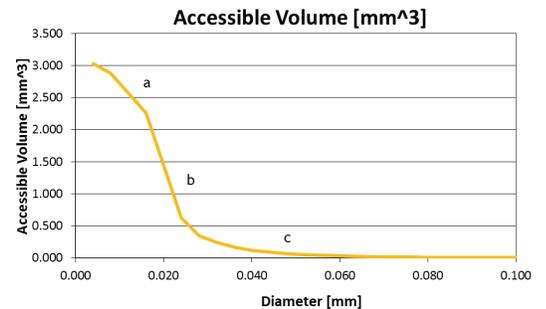


Figure 6: Accessible volume versus local pore diameter. Numbering a, b, c corresponds to Figure 5.

Conclusion

Accessible Volume (and in analogy accessible surface) can be calculated from microCT images using mercury intrusion simulation. This provides insights into structure and function of sampled rock. This quantitative analysis is accompanied by powerful 3D imagery.

SCANCO equipment

SCANCO Medical μCT 50 scanner

SCANCO software

Measurement program incl. Scout View

Reconstruction software

Evaluation program

- ✓ Segmentation
- ✓ 3D morphometric analysis
- ✓ Accessible Volume and Surface Analysis using a mercury intrusion simulation.

Visualization program