

Experimental report

03/09/2021

Proposal: UGA-108

Council: 4/2020

Title: BIOTOM

Research area:

This proposal is a new proposal

Main proposer: Pascale SENECHAL

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Samples: Sand (quartz) + water + biofilm no pathogenic (desulfotomaculum profundum)

Instrument	Requested days	Allocated days	From	To
D50 T	2	2	21/09/2020	23/09/2020

Abstract:



UGA.108 EXPERIMENTAL REPORT

Context :

Our challenge is to characterize biofilm growth in a deep aquifer, identified as a potential future location for storing biogas. More precisely, we want to evaluate the impact of biofilm growth on the porosity by means of high-resolution X-ray and neutron tomography without using artificial contrast agents as these substances could affect the phenomenon of interest.

Objectives :

According to the first results obtained during the test day (UGA.95), we will use high resolution neutron tomography to observe biofilms in micro capillaries of 2 millimeters outer diameter and of 10 cm height which are filled with sand and saturated by water + microorganisms.

The tests aim to explore:

- the possibility to visualize biofilms/microorganisms by neutron tomography
- 2 days to perform tests on 4 samples.

List of participants :

Pascale Sénéchal, DMEX, UPPA, main proposer (IR)

Configuration for neutron experiment :

Volume height/diameter: 14,6 mm / 14,6 mm
Detector size: 2048 x 2048 pixels
Voxel size: 7,15 μm (set pixel size Neutron Cam)
Pinhole diameter: 30 mm
Field of view : 14,6 mm
Binning: 1
Exposure: 5s
Number of frame=6

Calibration : 36
Number of projections : 1056

List of the samples scanned and their distinctive features :

A complete list of sample scanned is provided in Table 1.

Table 1: Sample description

Sample number	Capillary type	Composition	Experiment type	Acquisition type
1	Quartz	H ₂ O + biofilm + sand	Centrifuge	Tomography
3	Quartz	H ₂ O + biofilm + sand + Iron	Centrifuge	Tomography
5	Quartz	H ₂ O + biofilm + sand	Cultivation	Tomography
7	Quartz	H ₂ O + biofilm + Iron + Sand	Cultivation	Tomography

Results obtained with neutron tomography.

During the scan of Sample 1, the sample has touched the detector and therefore the corresponding data are unusable.

Concerning the samples 3, 5 and 7, the analyses of data show clearly 2 phases corresponding to grains+gas and water. The water generates an important scattering which appears on the images as a phase with an intermediate range of grey values located around the grains, the bubbles of gas and along the capillary. After removing of the voxels corresponding to this scattering, the remaining water doesn't highlight the presence of microorganisms/biofilms. An hypothesis to explain this is that the scattering of water could also mask the presence of microorganisms/biofilm.

During the acquisitions, it was not possible to optimize as much as possible the strictly vertical position of the samples on the sample holder. Consequently, the detector-sample distance could not be reduced to the minimum and has favored the scattering.

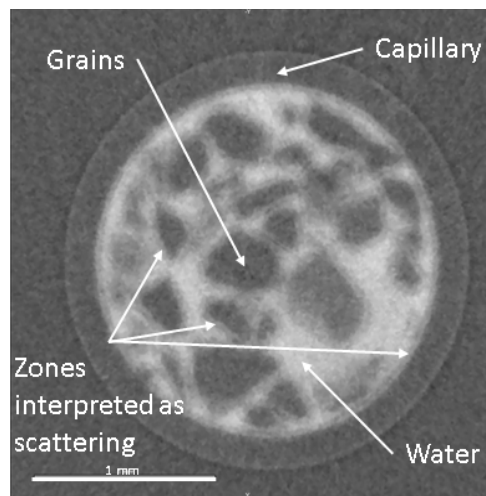


Figure 1: Raw neutron image obtained for sample 7

Conclusions:

The scattering due to the water is too important to observe the presence of biofilms.

New Acquisitions could be considered to avoid this and increase the quality of images:

- Use of sample with water and high resolution imaging with a strictly vertical position of the sample. This configuration will optimize the dynamic of images, will permit to minimize the detector-sample distance and consequently the scattering due to the water.
- Use of sample with heavy water and high resolution imaging with a strictly vertical position of the sample. This configuration will reduce the scattering but also the dynamic of images.