thermoscientific

WormHole characterization

1. Introduction

This tutorial is part of the PerGeos Training course, and will detail how to characterize a wormhole in a CT core sample.

Depending on the acidization of the rock sample, defining a recipe with the entire workflow (pre-processing, wormhole segmentation, wormhole characterization) will allow us to simply re-apply the recipe when changing the input data.

The wormhole segmentation is based on a Watershed transform, thus can be easily automated with limited user interaction.

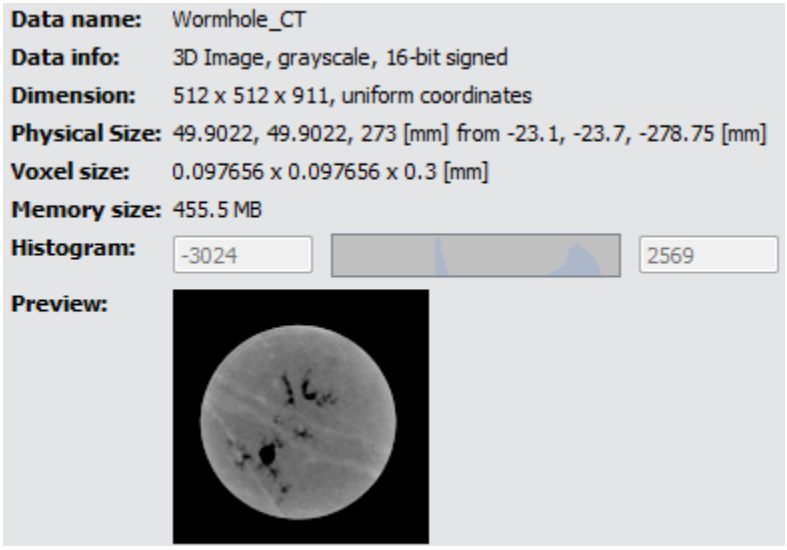

Figure 2 WormHole sample

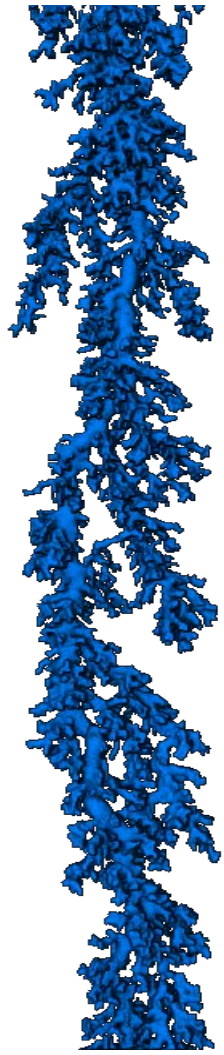

Figure 1 WormHole in 3D

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2. Playing the recipe

The <WormHole_segmentation> recipe, responsible of the wormhole extraction, contains the following steps :

Crop Core

This step will re-center and re-align the core sample

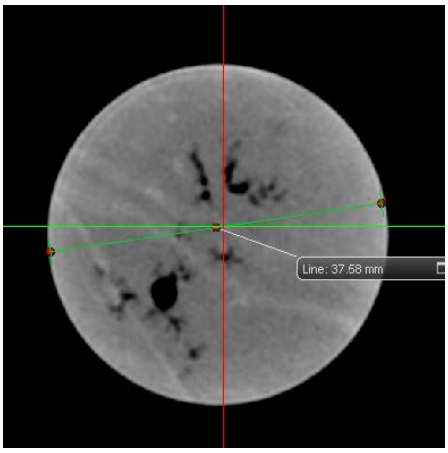

Figure 3 Core Sample before Crop Core

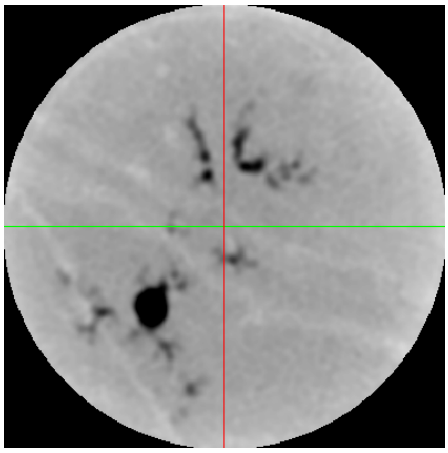

Figure 3 Cropped Core sample

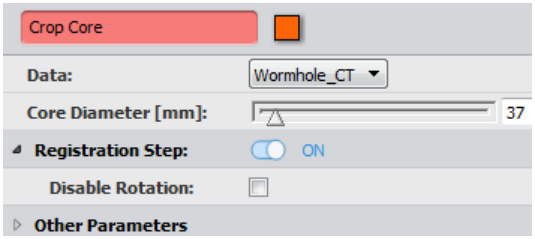

Figure 4 Crop Core GUI

Beam Hardening Correction

This step will correct the beam hardening artifact of the CT sample, thus easing the segmentation of the wormhole.

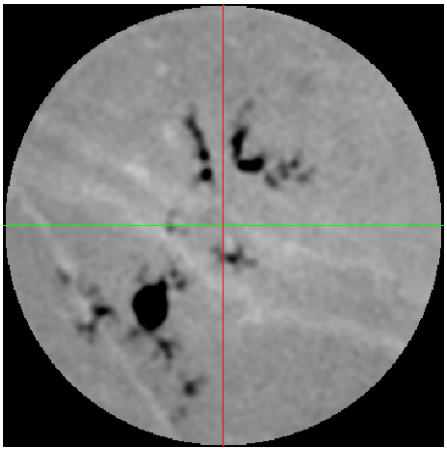

Figure 4 Beam Hardening Corrected Core

Wormhole segmentation

The WormHole segmentation is a classical pore space segmentation based on a Watershed Transform (markers with threshold + topHat) applied on the 3D gradient image.

Remaining unconnected pores are removed by applying a *Connected Pore Space* module.

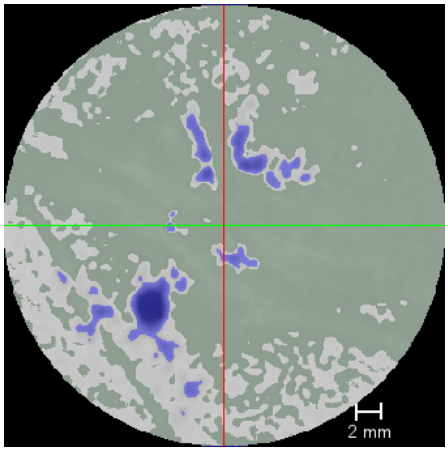

Figure 6 Wormhole (Threshold + TopHat) and rock markers (Threshold)

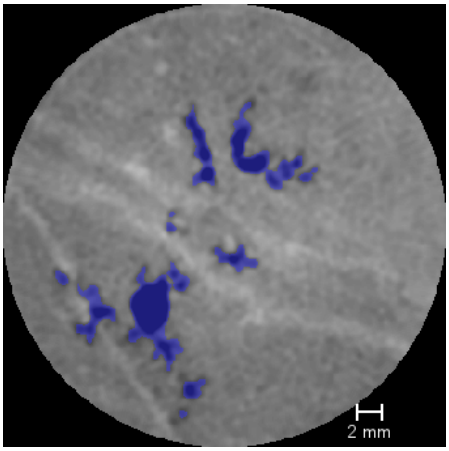

Figure 5 WormHole after the Watershed (XY)

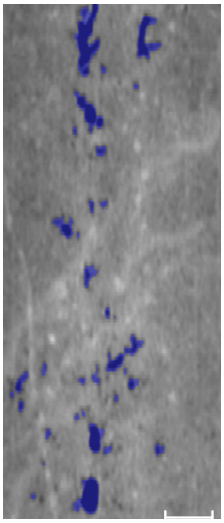

Figure 7 Wormhole after the Watershed (XZ)

Mask creation

The bulk volume of the core is also computed in the recipe, and extracted as an additional output(new feature of PerGeos 1.7).

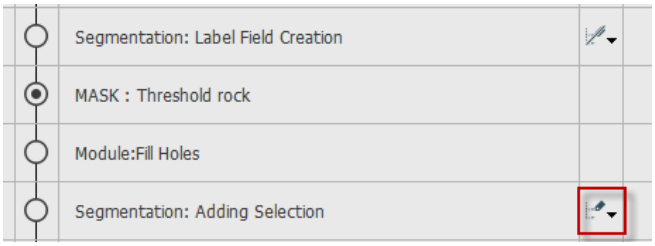

Figure 8 Portion of the recipe computing the Mask

It is computed with a high intensity Thresholding followed by a *Fill Holes* operation.

3. WormHole analysis

The wormhole fraction is computed with volume fraction.

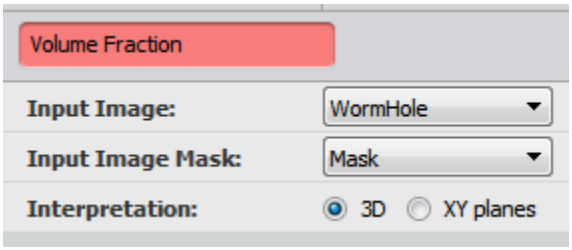

Figure 10 Volume Fraction module

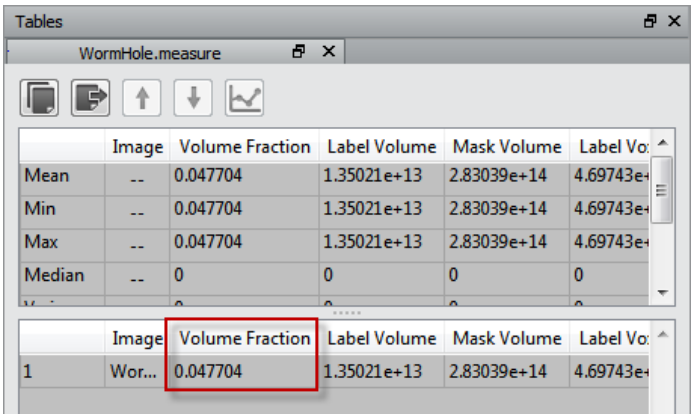

Figure 9 Volume fraction result (4.7%)

Further analysis possibilities include :

- Absolute permeability
- Separation into individual pore bodies
- Pore Network Modeling
- Detection of main and secondary branches (morphological operations or Pore Network Model filtering)
  Morphological recipe available : <mainBranchRecipe_morpho>
  PNM recipe : <mainBranchRecipe_PNM>
- Branch size analysis

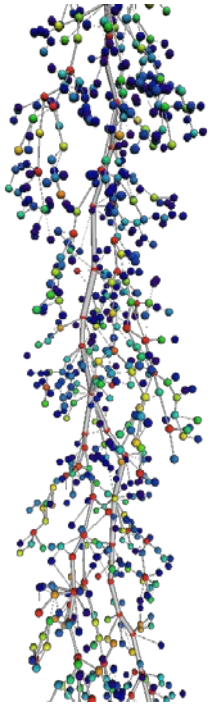

Figure 11 Pore Network Model

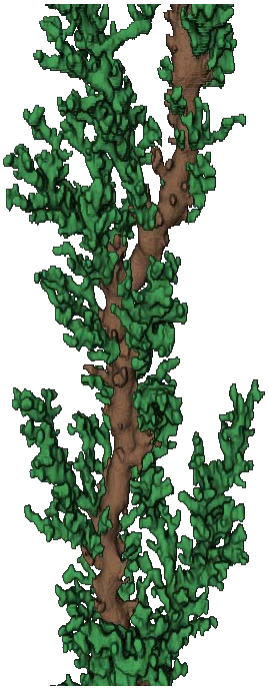

Figure 12 Main and secondary branches