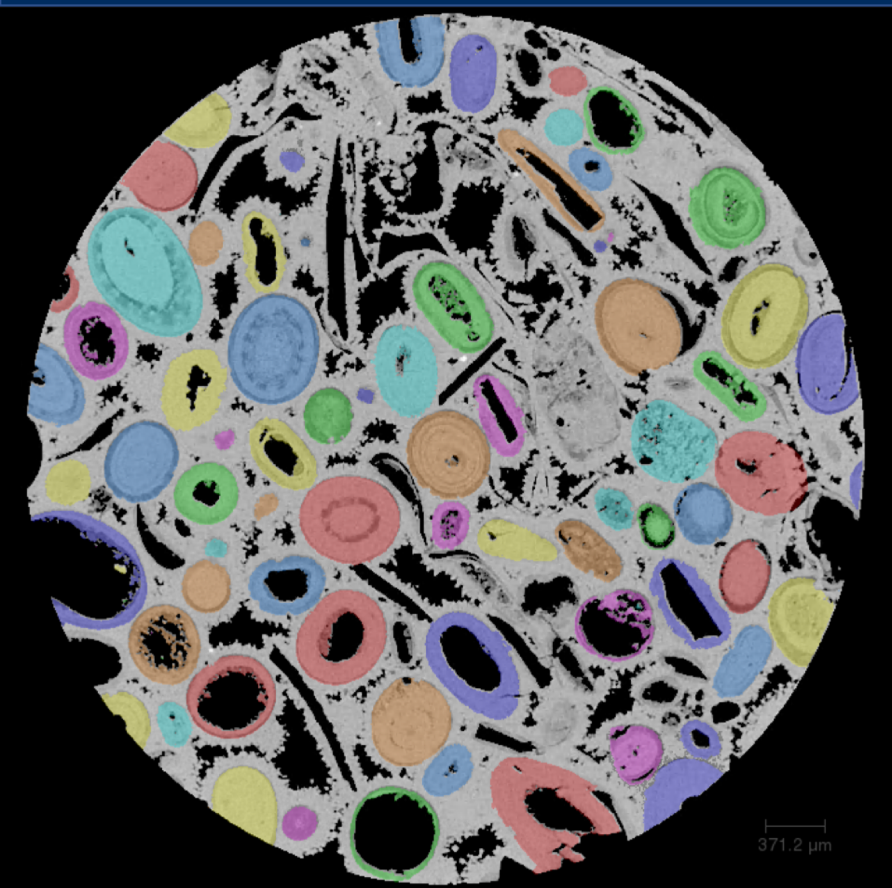
PennState

Porous Media Visualization and Data Reuse Challenge



Name
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Dataset
Savonnières carbonate (https://www.digitalrocksportal.org/projects/72)

Visualization Software Used:
Avizo 9.7.0

Entry:
2D Image

Description

The characterization of carbonate rock structures poses a bigger challenge compared to siliciclastic rocks. This is mainly due to the complex physical and chemical diagenetic processes taking place during their formation. Savonnières limestone is an oolitic limestone which is made up of almost spherical grains called ooliths that are held together by cement-like material known as lime mud.

Partitioning ooliths and lime mud as well as separating grains into individual ooliths can help in characterizing a variety of properties such as grain/oolith size distribution, as well as contribution of ooliths and lime mud to pore-wall roughness. When spatially correlated, the oolith size distribution can also give an idea about the formation and deposition of those rocks. Additionally, it can be used to correlate oolith sizes and lime mud thickness to the rock's geomechanical properties under different stress conditions.

The visualization steps followed in this entry include eliminating the jacket surrounding the rock sample and reducing the volume size to help in reducing computational time. The volume extracted is then filtered using anisotropic diffusion, followed by SNN filters to minimize noise while preserving the edges and image details. This step amplifies the difference between pores and solid, which is useful in binary segmentation, where solids are labelled 1 and pores are labelled 0. Next, the original micro-CT images are multiplied by the binary segmented images to remove variation in pore spaces and show a stronger signal on the gradient image used in the watershed segmentation protocol. Watershed segmentation is used to separate ooliths from lime mud. Finally, a grain partitioning module is used to individually label each oolith, making the dataset ready for further rock structure analysis.

Link to files:

https://drive.google.com/drive/folders/1qq15rufVdUq2jttrd0TQlNDcSrJ3R-wQ?usp=sharing

Steps:

1- Use Volume Edit Module: to remove (i.e.: zero out) the jacket and dead space around the rock sample.
2- Use Extract Subvolume Module:
- To remove excess dead space outside of the core, which reduces computational time
- To remove top and bottom slices which have CT image artefact.

3- Apply 3D anisotropic diffusion filter onto dataset generated in step 2
4- Apply 3D SNN filter onto dataset generated in step 3
5- Apply Simple thresholding of the filtered dataset to get a dataset where pores = 0 and solid = 1 by visually inspecting the histogram of CT numbers and where a good threshold can be drawn to separate the pores from the solid rock voxels.
6- Use arithmetic module to multiply the filtered dataset from step 4 by the labels generated in step 5 to enhance the gradient at pore-rock interfaces.
7- Calculate the gradient dataset to be used in step 8.
8- Use the dataset generated in step 6 to apply watershed segmentation.
- Provide markers until a decent segmentation between the pore, lime mud and ooliths is achieved (The focus is on slice 841).

9- Use extract subvolume module to extract the slice of interest (slice 841) from the filtered dataset as well as the same slice from the segmented dataset
10- duplicate the segmented slice and remove the labels, keeping the ooliths labels only.
11- Use separate objects module on the ooliths labels generated in step 10, to label individual ooliths separately.
12- overlay the slice generated in step 11 onto the filtered slice 841 generated in step 6 to arrive at the final visualization presented.