

Simple Rock Characterization in PerGeos v1.7

Introduction

A key benefit to obtaining digital imagery data is the ability to use all parts of the imaged sample for characterization purposes—not just what you have time to explore manually. This is especially the case with large datasets that are created during acquisition of 2D mosaic images or Whole Core CT imagery. In these cases, a representative area or volume of material has been obtained. The next step will be to extract features, like porosity, for analysis.

But, what else can we do with this data? The answer is to use the textural/morphological characteristics of the sample to help auto-classify the sample into similar morphological groups. By definition, we are using the sample itself to assign a “type” so that interpretation can be made easier and sample properties, like its inherent heterogeneity can be objectively measured. Typing at a macro scale in the geosciences is generally referred to as Rock Typing. For typing workflows at smaller scales (that inform rock typing), and illustrated in this document, we prefer pore or (or other feature) typing as a descriptive term.

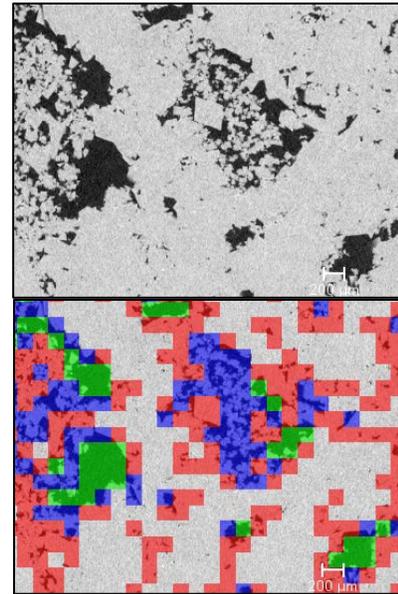


Figure 1. TOP: input grayscale data. BOTTOM: Processed and characterized label image overlaying input data. Color blocks represent different classes of features.

Regardless of the scale of an auto-typing algorithm to be applied, the results provide a robust characterization that is free of user bias and can be confidently applied on many samples. In this document we describe a couple examples on how you can use the powerful libraries in PerGeos to develop your own pore-scale typing routines in 2D or 3D.

Building the Workflow in PerGeos

The workflow below will illustrate how to build an autclassification routine within PerGeos using two different approaches:

1. Characterization by Mean Value
2. Characterization by Porosity

These examples obviously do not represent a complete list of approaches, but each illustrates the basic concepts that can be followed to build as complex or “zeroed-in” approach you would like to follow. As with all workflows developed in PerGeos, the workflows presented below can be easily automated and repeated—allowing your team to share approaches and protect internal knowledge due to personnel changes.

Fundamental Approach

The basic idea of the presented workflows is to split the input pixel/voxel-based data into multiple regions using the Arithmetic module in PerGeos; with each region created given an unique ID in an output labeled image file.

Given the general case of loading a data of size *SizeX*, *SizeY*, *SizeZ*, and a cubic block size of *blockSize*, the regions are computed using the formula:

$$(\text{floor}(i/\text{BlockSize})) +$$

$$\text{numBlocksX} * (\text{floor}(j/\text{BlockSize})) +$$

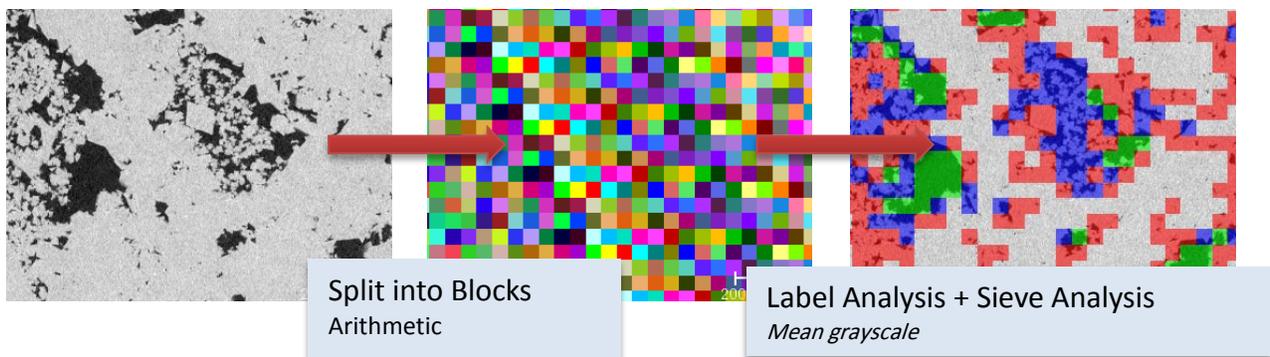
$$\text{numBlocksX} * \text{numBlocksY} * (\text{floor}(k/\text{BlockSize})) + 1$$

Where *i,j,k* represent indexes of the current voxel, *numBlocksX* is the number of blocks in the X axis, *numBlocksY* is the number of blocks in the Y axis and *floor(x)* will return *x* lower integer values. It should also be noted that *floor(i/BlockSize)* will give a unique ID to all voxels of the current block being considered during the computation process.

Case 1: using the Mean value

For each label, a Label analysis with the grayscale data as second input is computed, in order to compute the mean grayscale value of every block inspected (see diagram below).

Then, a Sieve analysis is used to classify the blocks into multiple classes. The sieve analysis can be tailored to group by the user, or directed by auto-populating bin sizes. The result is a new label field image. The new output collects a number of materials that were defined by the sieve analysis and views their distribution in the image. These blocks can be used as a basis for further analysis of features that exist in each block.

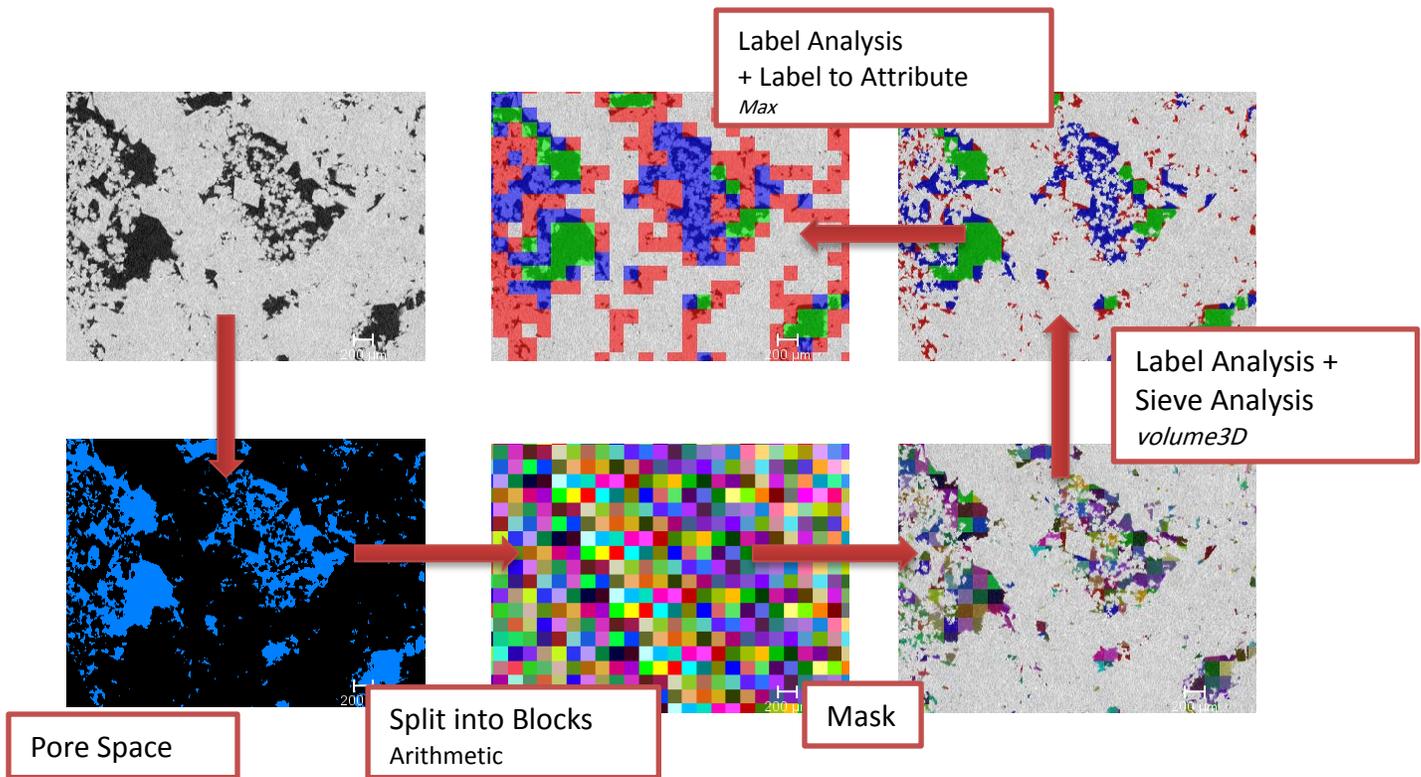


This simple approach tends to work quite well for a general characterization, however, it does not draw on morphological details directly. To do so requires some extra work, but can provide a more quantitative approach that can classify a sample based on geological or other process driven feature. We will next explore using porosity as a focus for classification.

Case 2: using the pore space

When using the pore space as the differentiator, the process is a little bit more complex. The label data is masked with the pore space, and the *Label analysis* computes the *Volume3D* of each label ID. Then, the *Sieve Analysis* classifies the labels into multiple classes.

As every class voxel is masked by the pore space, the next step consists of applying a new Label Analysis , computing the *Maximum* value of the label IDs in the different blocks. Then, *Label To Attribute* is used to associate this Maximum value to every block, in order to generate the final characterization label data.



Summary

The power of image analysis is exemplified in the above examples. Taking images and extracting accurate and uniquely powerful observations accessible only using software that can handle large images. Automating pore scale characterization, with classifications guided by experts, provides the perfect marriage between the characterization prowess of a person with the computation power and statistical robustness of a digital solution.

Above, we present two easy to replicate workflows. Far more complicated approaches are possible. We always welcome requests for demos or aid in developing custom solutions for our customers. The recipe files and example data can be found here:

Give PerGeos a try yourself or contact us for more information.