TARGETED COMPUTED TOMOGRAPHY, PART I: PREDICTIVE ROCK MODELS WITHOUT SEGMENTATION

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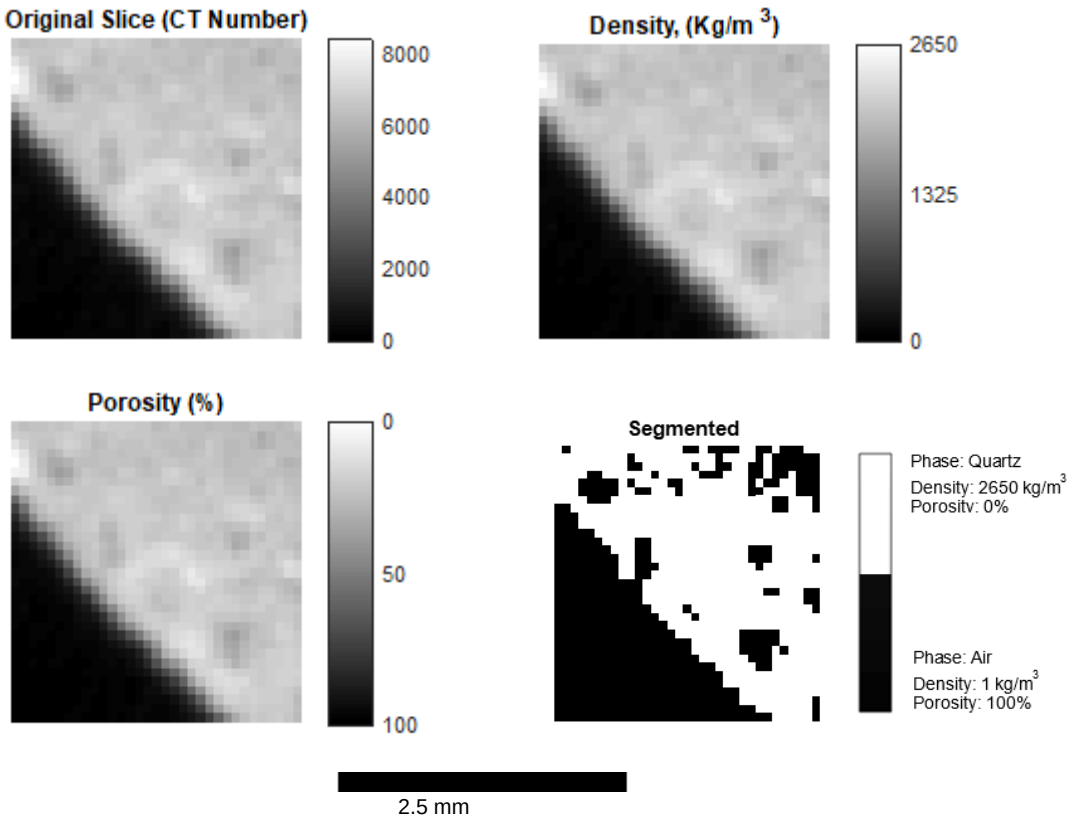
ABSTRACT

This is the first of three papers about a new digital rock physics (DRP) workflow to estimate petrophysical properties of rocks. This paper focuses on predictively estimating density and porosity of rocks, and we show its reliability with testing on four Berea Sandstone plugs. Measuring rock and elastic properties from physical samples is necessary in the geosciences in order to calibrate surveys and models that are obtained from geophysical surveys. Digital rock physics is one way to estimate properties from samples. Computed tomography (CT) scanning can be used to capture rock samples into 3D numerical models. Numerical simulations on such models are proxies for tests performed in the lab. In general, those working with digital rocks use a process called segmentation, where each voxel in a 3D model is assigned a property of a mineral phase or pore fluid. The density and porosity analysis are not predictive, as they are typically calibrated to lab tests. We propose a method that does not use segmentation, and instead preserves the scaling relationship between the voxel values that are originally recorded in units of CT attenuation. We name the method "targeted", or "segmentation-less". Targets, or phantoms, of known density were scanned alongside the rock and used as calibration points in a mathematical conversion curve between CT attenuation and density. A porosity model can be created as it is inversely related to density. Density is estimated within 2.5% of laboratory measurements, and porosity is estimated within 6%. This method allows rock properties to be estimated quickly and accurately, without invasive or cumbersome laboratory techniques. The second paper examines issues with quantitative CT scanning, including the effect of scan resolution on DRP. The third paper uses complex numerical modelling to estimates wave velocities and permeability for the same samples.



Slices from various steps in a targeted, and segmentation based DRP methodology.