Rock Porosity Analysis using High Resolution X-ray Tomography

Leo Gronsky[1], Dula Parkinson[2], Katya Bazilevskaya[3]

[1]San Francisco Unified School District [2]Lawrence Berkeley National Laboratory [3]Pennsylvania State University

Diabase (basalt) pores at varying thresholds

Abstract

Understanding rock porosity, the fraction of rock volume that is in pores, is a key to modeling weathering and flow of water, petroleum and CO2 through geologic structures. Weathering of rocks affects the CO2 cycle, nutrient cycle and soil formation. Rock porosity affects water flow rates and, in turn, affects weathering. Avizo software was used to explore, visualize and measure the reconstructed-solution x-ray micro-tomography data collected from scanned rocks. Many Avizo approaches were tried before arriving at an acceptable process to determine their porosity characteristics. Porosity dynamics are affected by weathering and lithification. At micron resolution, the image is cleaned up by Avizo and the picture emerges. This image, which shows the porosity of the rock, and the channels between the pores, may then be analyzed to reveal how easily CO2 will flow through it under pressure and thus the capacity for CO2 sequestration at that site.

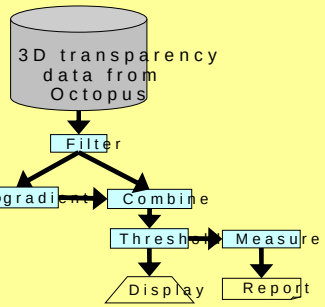
Introduction

To characterize soil weathering factors, the high-resolution x-ray micro-tomography used in Advanced Light Source (ALS) Beamline 8.3.2 is a nondestructive technique that characterizes interiors of solid objects and measures their three dimensional geometries. At the ALS electron bunches traveling at nearly the speed of light, when diverted by magnets, emit high intensity x-rays down beam lines to the experiment end stations. This high resolution x-ray micro-tomography is used for analyzing rock, bone, ceramic, metal and biological tissue. It differs from medical CAT-Scanning in its ability to resolve micron-sized details even in high density materials like rock.

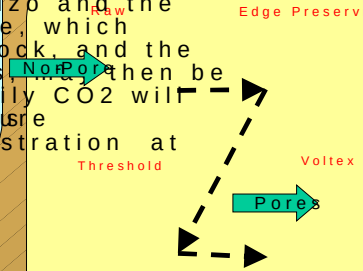
Methods

"Octopus software reconstructed a stacked object from projection images and produced a density map of the object. Avizo analyzed the reconstructed data from scanned rocks to characterize their pore characteristics. A combination of intensity and gradient values were combined to create a threshold in order to isolate pores. This analysis yielded pore pictures and quantitative summaries.

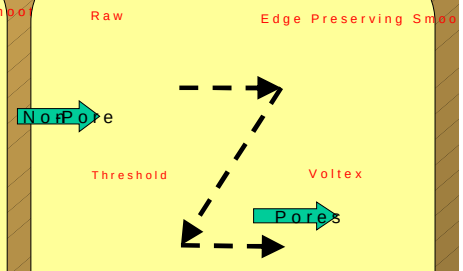
Avizo Process



Granite



Diabase



3D rotation to visualize structu

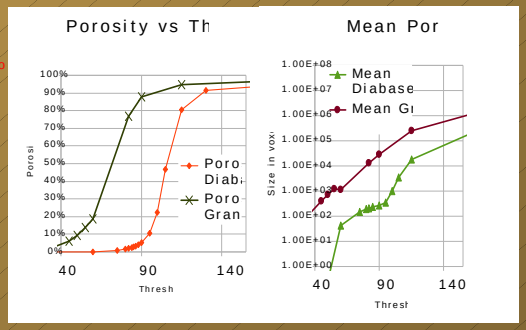
Results and Discussi

"Using only Avizo, calculated po were strongly influenced by subj judgments of pore boundaries. I images above, the 8th image app capture valid pores.

"Watershed segmentation was us pointing the way toward use of t gradient as a segmentation varia

"Accurate Avizo porosity estimat calibration against other technic pressurized-flow through reactor vesse against reference samples.

"Higher thresholds increase mea size and lead to mergers of iden



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