Geophysical Research Abstracts
Vol. 12, EGU2010-2898, 2010
EGU General Assembly 2010


# The Pore3D library package for the textural analysis of X-ray computed microtomographic images of rocks

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Many research fields in Geosciences require the knowledge of the three-dimensional (3D) texture of rocks. X-ray computed microtomography (μCT) supplies an effective method to directly acquire 3D information.
Transmission X-ray μCT is a non-destructive technique based on the mapping of the linear attenuation coefficient of X-rays crossing the investigated sample. The 3D distribution of constituents and the contrast based on the different absorption properties of the components can be enhanced by phase-contrast imaging.
On an X-ray tomographic dataset, if spatial resolution at the micron scale and proper software are available, a complete textural and morphological quantitative analysis can be carried out and a number of parameters can be extracted, including geometry and organization of discrete rock components (such as crystals, vesicles, fractures, alteration-compositional zones).
In the case of volcanic rocks, μCT can be used to image and quantify the textural and morphological characteristics of the rock constituents, such as vesicles (gas bubbles in solidified, erupted products), crystals and glass fibers. For pyroclastic rocks, investigated parameters to characterize the vesicle portion are the size distribution, geometry and orientation of the pores, the pore-throat size and organization, the pore-surface roughness and the topology of the overall pore and pore-throat network.
In this work we present several procedures able to extract quantitative information from [U+F06D]CT images of volcanic rocks. The imaging experiments have been carried out at the Elettra Synchrotron Light Laboratory in Trieste (Italy) using both the synchrotron radiation at the SYRMEP beamline and a custom-developed μCT system, named TOMOLAB, equipped with a microfocus X-ray tube and based on a cone-beam geometry.
The reconstructed 3D images (or volumes) have been elaborated with a software library, named Pore3D, custom-developed by the SYRMEP group at Elettra. The Pore3D software library allows a quantitative description of the morphology and topology of the sample components and it operates directly in the 3D domain, without inferring about the 3D behavior from stacked 2D information. The library has been elaborated to merge together in a common environment some of the features already available in previous research and commercial software, customizing in some cases their applications, adding new tools for the artifact reduction in the tomographic images and enhancing state-of-the-art methods for the quantitative analysis, as based on the specific know-how acquired by the SYRMEP group.
The microtomographic experiments on selected pumices and scoriae have given us the opportunity to reconstruct and study the 3D internal structure of very different samples, originated at volcanoes with unique eruptive behavior and hazard potential. In particular, the analysis of vesicle size, shape, distribution, orientation and degree of interconnectivity, quantifies aspects that are directly related to the magma nature and dynamics. In fact, magma near the Earth's surface exists as a multiphase system, including gas bubbles and solid crystals in a liquid medium. The rheology of the magma and the processes that govern the transition between effusive and explosive eruptions can be fully understood if the gas permeability and flow through the bubble networks are quantified. As pyroclasts are natural records of the magma state, in terms of texture and composition, during the last phases of the conduit ascent, the textural 3D information can be coupled to physical, rheological and chemical properties of the parent magma.