

Morphological and textural analysis of geomaterials by using advanced X-ray microtomography techniques

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Imaging techniques play an important role in several research fields of the geosciences. As an example, the well known optical and scanning electron microscopy techniques are widely adopted tools for the investigation of the texture of rock samples. X-ray based techniques are also of particular interest and X-ray microradiography has proved to be useful for the monitoring of the heavy-metal accumulation in vegetal tissues and for the analysis of soils.

In recent years great interest has been posed on X-ray computed microtomography (μ -CT) techniques, based on both conventional and synchrotron radiation sources. These techniques produce three-dimensional (3D) images of the internal structure of objects with a spatial resolution at the micro- and submicro- scale. In fact, investigations performed directly in the 3D domain overcome the limitations of stereological methods usually applied to microscopy-based analyses. Moreover, μ -CT techniques enable to get 3D images of the internal core of a sample in a non-destructive way, more suitable for further analyses and for precious samples (fossils, archeological finds, etc.). An intriguing challenge lies on the extraction of quantitative measures and indices directly from these kinds of images. Porosity and specific surface area as well as anisotropy, connectivity and tortuosity are interesting descriptors of a 3D model. However, accurate image processing and analysis methods for an effective assessment of these parameters are still an open issue in several applications. To this purpose, the *Pore3D* software library has been developed by the SYRMEP research group of the Elettra Synchrotron Light Laboratory in Trieste. Although any kind of 2D image and 3D dataset is a valid input, *Pore3D* has been mainly conceived for the handling of X-ray μ -CT images. In fact, the particular case of high-resolution μ -CT images requires *ad hoc* software tools able to manage large 3D dataset in an easy way. Several commercial software and public available libraries as well as research codes have been developed in recent years for 2D and 3D image analysis. Within this framework the *Pore3D* project merges many of the features implemented in existing software tools, customizing in some cases their characteristics or adding new tools, on the basis of the specific know-how acquired inside the SYRMEP collaboration. Moreover, a custom-developed software assures a complete control of the algorithm implementation and permits different strategies of analysis as a function of the specific scientific application.

In this seminar several applications of X-ray μ -CT methodologies for the extraction of quantitative information from μ -CT images of geomaterials will be presented. In particular, results obtained from the characterization of texture and 3D shape orientation distribution of crystals and vesicles in volcanic products and applications to cement-based materials will be illustrated.