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Quantitative monitoring of moisture content changes using micro-CT imaging technique

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X-ray computer assisted micro tomography (micro-CT) is becoming a widely available and flexible tool to perform three-dimensional imaging of rock and soil samples. Major advantages of these technique are (i) is a non-invasive method, thus leaving the specimens undisturbed during the scanning process, and (ii) can monitor changes occurring to all the phases composing the medium, and not to the aqueous phase only, as for NMR techniques. Given its strengths, the micro-CT method as been adopted in the last years to investigate a large set of rock and soil samples properties, including pore-space topology, single and multi-phase flow, mechanical deformation. When applied to monitor the temporal evolution of the sample properties, micro-CT suffers from an important draw-back. To make a quantitative comparison of images scanned at different times, the sample needs to be kept in place within the x-ray cell during the experiments. Consequently, extremely sophisticate, expensive, and often cumbersome experimental set-ups need to be constructed, that can be coupled with the micro-CT measurement system. In this work, we developed a semi-automated procedure capable of overlap two and three dimensional images of a specimen, thus allowing decoupling the experimental and imaging systems; the approach is based on the direct shift of sinogram raw data. The method is tailored to quantitatively monitor drainage and imbibition processes on a core-size sample. We measured the soil retention curve on a remoulded sample of Grugliasco sand, quaternary sediment of the Po river plain (near Turin, Italy); experimental measurements were conducted using a tempe cell laboratory equipment. At the end of each de-saturation step, a defined volume of the mea-

surement cell was scanned with a micro-CT facility (Universal HD-100 CT system, www.universal-systems.com), and images at selected locations were overlapped using the semi-automated procedure developed. Resulting images show that the overlapping method we propose provides a good precision, given that acquisition parameters are accurately known. Quantitative measurements of the volumetric water content were performed on the acquired images, showing good comparison with the water saturation values independently measured.