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Visualization of solute transport and particle tracking in a three-dimensional porous medium, using optical index matching

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The experimental study of preferential flow paths in real soil porous systems usually requires elaborate and expensive techniques such as X-ray tomography or MRI. When one aims at studying a particular feature of transport in such systems, one can utilize a laboratory experiment in which the real porous medium is replaced by a model porous system; in this case, it is sometimes possible, even for a three-dimensional medium, to rely on optical visualization techniques. We present here an experimental setup addressing the visualization of solute transport and particle advection in a synthetic porous medium consisting of glass beads. At fluid preparation, we obtain optical index matching between the glass beads and the fluid by mixing two miscible fluids whose refraction indices are respectively smaller and larger than that of the beads. The right proportions for the two fluids are found when the transmission of a laser beam through a box containing a sample porous medium is observed to be maximal. The matched fluid allows monitoring of solute dispersion inside the porous medium. The influence of the index mismatch on the uncertainty of the measurements has been estimated using available theories[1]. Successful attempts at tracking colloidal particles advected inside the porous medium are presented. The simple tracking algorithm requires that particles not too close to each other be monitored at a large enough acquisition frequency.

[1] J. Crassous, *European Physical Journal E* (2007), **23**(2), 145-152.