1.723 – Computational Methods for Flow in Porous Media

Homework #1

Due on February 12, 2015

Problem 1 (4 points) The files `berea_xsection_top.dat` and `berea_xsection_bot.dat` (available for download at the class website as a zip file) each contain a matrix of 400×400 pixels, representing cross sections from a micro-CT image of a sample of Berea sandstone (a value of 0 means void, a value of 1 means solid rock).

1. Plot the two cross sections of the micro-CT image using MATLAB.
2. From the cross sections, estimate the porosity of the rock.
3. For each cross section, plot (together, on the same graph) the average porosity as a function of window size, each time starting at the center of the image.
4. From your previous answer, estimate the length scale (in pixel units) of the representative elementary volume.

Problem 2 (2 points) A porous medium has a permeability of 1 darcy.

1. What is the mediums permeability in cm^2?
2. What is the hydraulic conductivity of this medium for water (kinematic viscosity ν_w=0.013 cm^2/s) and for a viscous oil (ν_o=1.8 cm^2/s)?

Problem 3 (4 points) At the course website you will find a document with the experimental data collected by Darcy (`darcydata_partial.xls`). Use linear regression to obtain estimates of the permeabilities of the sand in all series of experiments. Give the value of the hydraulic conductivity K (in cm/s and m/day) and the associated permeability k (in md) for each experiment. Comment on the results.

Hint: The regression of Q vs. Δh should have a zero intercept.