A fast Laplace solver approach to pore scale permeability

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ABSTRACT: We introduce a fast method to derive the permeability of porous media at the pore scale using an approximation based on the Hagen-Poiseuille equation to calculate permeability to fluid flow with a Laplace solver. The method targets the calculation of permeability from phase segmented tomographic images directly at the voxel scale and consists of calculating the Euclidean distance map of the fluid phase to assign local conductivities. It lends itself naturally to the treatment of multi-scale problems. We compare solutions derived with the Laplace solver with analytical solutions for simple structures with good agreement. Furthermore, we consider more complex structures including a set of reservoir rocks and benchmark rocks including Fontainebleau sandstone. Experimental measurements and lattice Boltzmann calculations are in good to excellent agreement with solutions derived by the proposed method over a wide range of porosities. The solver is significantly more stable than the lattice Boltzmann approach, uses less memory, and is significantly faster.