Permeability prediction of porous media with the finite difference Stokes solver LaMEM

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The flow of fluids through porous media such as groundwater flow or magma migration is one of the most important processes in geological sciences. The property controlling the efficiency of the flow is the permeability of the rock, thus an accurate determination and prediction of its value is of crucial importance. For this reason, permeability of rocks has been measured across different scales. As laboratory measurements exhibit a range of limitations, the numerical prediction of permeability at conditions where laboratory experiments struggle has become an important method to complement laboratory approaches. At high resolutions, this prediction becomes computationally very expensive, which makes it crucial to develop methods that maximize accuracy. In this work we introduce the open-source finite difference solver LaMEM that can be used to numerically predict the permeability of porous media under laminar conditions. We employ a stencil rescaling method to increase accuracy due to a better description of the solid-fluid interface, thus reducing the computational cost. To validate the method, we perform a series of tests employing both analytical solutions for simplified geometries as well as results from other numerical approaches for more complicated geometries. Furthermore we compare our numerical results to laboratory measurements on glass bead samples with porosities ranging from 20% to 2.5%, showing good agreement.

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