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LBM numerical investigation of flow through fractured porous media

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Nowadays the Lattice Boltzmann Method (LBM), thanks to its mesoscale approach, is a powerful tool when dealing with upscaling problems in Fluid Dynamics. In this study a numerical investigation on the flow through fractured porous media has been performed, based on a three dimensional LBM model developed at the Engineering Department of the Roma Tre University. Two different kinds of porous matrices, consisting of deterministic and random arrays of spheres, have been considered. The formers have been arranged both as a primitive and body centred cubic system. The latters are characterized both by monodisperse and by polydisperse diameters. In order to calculate the permeability of every considered porous medium, the Darcy's experiment has been simulated. Then a channel has been considered in every porous matrix, giving raise to different fractured porous media. The Darcy's experiment has been repeated with the fractured porous media and the LBM has been used as a numerical lab to verify the ranges of validity of upscaled models based on the analytical solution of flow in equivalent porous media. It has been found that numerical and analytical results are in good agreement when a fractured deterministic porous medium is considered. In this case the order of magnitude of the relative error, defined as the absolute value of the percentage difference between the numerical and analytical velocity on the axis of the channel, is equal to few percents. Moreover, the error decreases with the permeability: the greater the permeability, the smaller the error. LBM numerical results obtained considering random fractured porous media are characterised by a relative error larger than that corresponding to numerical results obtained considering deterministic fractured porous media, being equal permeability and hydrodynamic conditions. Future work is addressed to the understanding of how the parameters characterizing the random fractured porous media affect the results obtained by applying the LBM model and the difference with the reference results.