Fluid behavior in fracture and its representative elementary volume using Lattice Boltzmann Method

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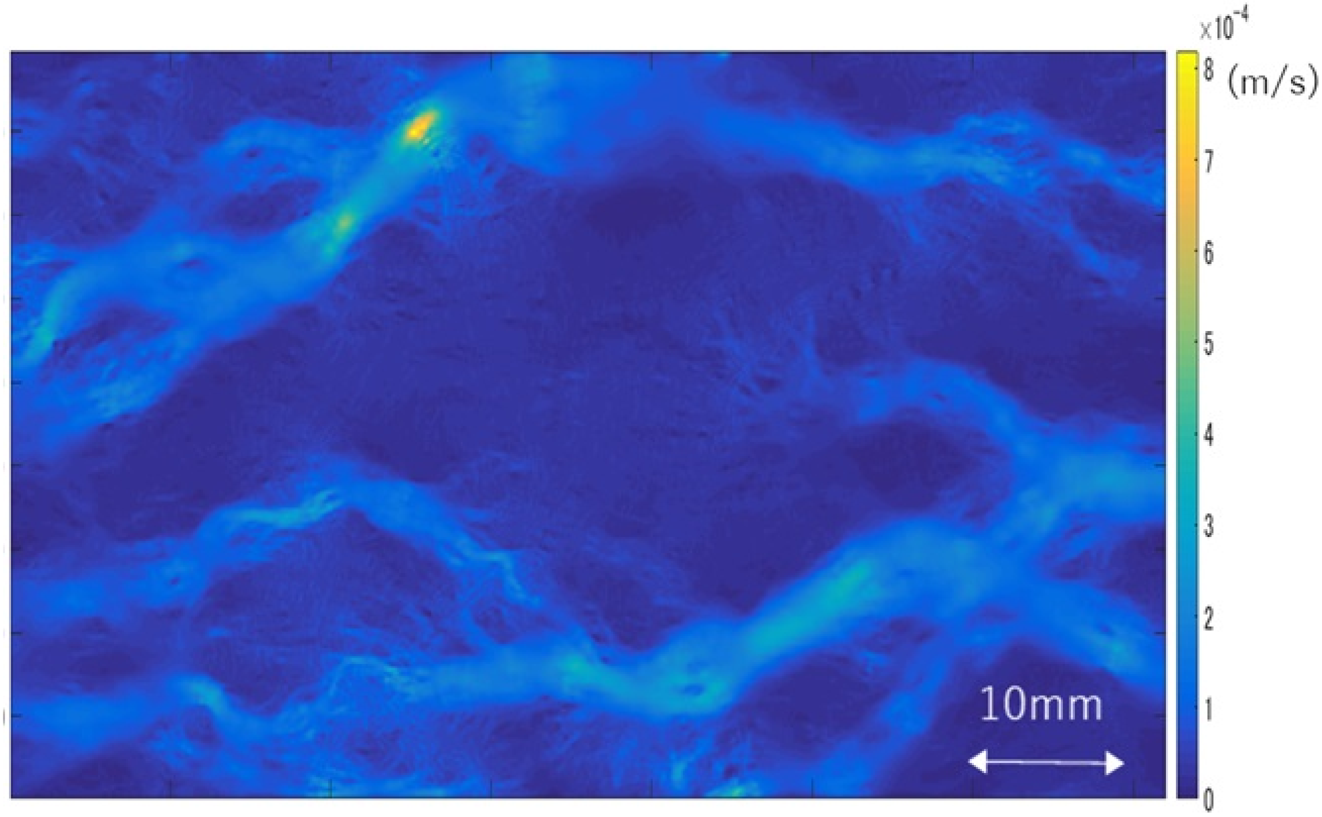
Characterization of fluid flow in the fault zone (e.g., fractures) is related to the fault activities, because pore pressure along fault zone was controlled by its hydraulic properties (e.g., permeability). The fluid behavior along the fault is further related to the fault healing process after the earthquake, and mineralization process. Permeability of fracture is usually measured by laboratory experiments, however few studies focused on calculating permeability by using flow simulation on digital fracture models. Here we use Lattice Boltzmann Method (LBM) to calculate the fluid velocity and permeability. Using LBM fluid flow simulation, we can easily change the reservoir parameters, such as temperature and aperture length of fracture. Here we use two natural fracture data: (1) sheared, and (2) non-sheared fracture models obtained by Ishibashi et al. (2014). After we digitalized these natural fractures, we numerically injected water into the two fracture models using LBM. To validate our simulation results, we compare the calculated permeability with the laboratory experiments. We then discussed the Representative Elementary Volume (REV) of the hydraulic properties of these fracture models. In this study, we extract several subdomains_ (i.e., small fracture models) from the whole model and estimate permeability of the subdomains. When the size of fracture model is smaller, the permeability estimated using LBM are scattered. However, the permeability is uniformly estimated when the model size is close to the whole model (0.1×0.15m). Therefore, the REV of the fracture model used in this study is ˜0.1m. Because the hydraulic properties of fracture models smaller than REV are largely influenced by local heterogeneity, it is important to calculate hydraulic property by considering REV of sample.

Keywords: fracture, permeability, Lattice Boltzmann Method, Representative Elementary Volume


×10⁻⁴
(m/s)
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