Geophysical Research Abstracts
Vol. 20, EGU2018-4142, 2018
EGU General Assembly 2018

Experiments of preferential flow in 3D Self-Affine Fractures combined with Lattice Boltzmann Simulations

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Single phase flow through fractures can be encountered in different areas, such as enhanced oil and gas recovery and water resources exploitation. Laboratory experiments and simulations have been conducted to investigate single water phase flow through self-affine rough fractures. An agreement between the experimental data and the numerical simulation results was achieved. The fractal dimension is positively correlated to fracture surface roughness and the fracture inclination represents the gravity force acting on the water flow. The influences of fracture inclinations, fractal dimensions, and mismatch wavelengths were studied and analyzed, with an emphasis on flow paths through a self-affine rough fracture. Different values of fractal dimensions, fracture inclinations, and mismatch wavelengths result in small changes of flow rates from five sections of discharging surface. However, the section of discharging surface with the largest flow rate remains constant. In addition, it is found that the gravity force can affect flow paths. Combined with the experimental data, the simulation results are used to explain the preferential flow paths through fracture rough surfaces from a new perspective. The results may enhance our understanding of fluid flow through fractures and provide a solid background for further research in the areas of energy exploration and production.