Percolation of open grain boundaries and electrical conductivity in fluid-bearing rocks

*Tohru Watanabe[1], miho makimura[1], Yohei Kaiwa[1]

1. Gradudate School of Science and Engineering, University of Toyama

Numerical experiments were conducted on the percolation of open grain boundaries to study the percolation threshold and evolution of connectivity. Open grain boundaries are a major component of pores in crustal materials. Electrical conductivity and permeability are highly sensitive to the connectivity of open brain boundaries. The length and size of the largest cluster was surveyed in a 3D array of cubic grains for various fractions of open grain boundary. For sufficiently large size of array, the percolation threshold was found to be 0.20. If more than 20% of grain boundaries are open, an interconnected network of open grain boundaries is formed. If the aggregate is saturated with brine, the electrical conduction can occur through open grain boundaries. The connectivity of open grain boundaries steeply increases to 1.0 around the threshold. The electrical conductivity is also expected to increase steeply. The crack density parameter for the percolation threshold is estimated to be 0.1. The large change in electrical conductivity for a small change in crack density parameter is thus expected around crack density parameter of 0.1. Simultaneous measurements on elastic wave velocity and electrical conductivity in a brine saturated granitic rock (Watanabe and Higuchi, 2015) showed a steep change in electrical conductivity around the crack density parameter of 0.1. XCT images show that open grain boundaries are the dominant pores in the sample. The steep change in conductivity must thus be related to the percolation of open grain boundaries.

Keywords: percolation, grain boundary, electrical conductivity

