Simultaneous measurements of elastic wave velocity and electrical conductivity in fluid-bearing granitic rocks under confining pressures

*Yohei Kaiwa[2], Aya Konno[2], Erina Deai[2], Kyara Teranishi[2], Tohru Watanabe[1]

1. Graduadate School of Science and Engineering, University of Toyama, 2. Department of Earth Sciences, University of Toyama

Geophysical mapping of fluids is critical for understanding crustal processes. Seismic velocity and electrical resistivity structures have been revealed to study the fluid distribution. However, the fluid distribution has been still poorly constrained. Observed velocity and resistivity should be combined to make a quantitative inference on fluid distribution. The combined interpretation requires a thorough understanding of velocity and resistivity in fluid-saturated rocks. We have studied elastic wave velocities and electrical conductivity in brine-saturated granitic rocks under confining pressures.
Aji granite (Aji, Kagawa Pref., Japan) and Oshima granite (Oshima, Ehime Pref., Japan) were selected as rock samples for textural uniformity. Cylindrical samples (D=26 mm, L=30 mm) were evacuated and filled with 0.1 M KCl aqueous solution. Velocity and electrical conductivity were simultaneously measured by using a 200 MPa hydrostatic pressure vessel. The pore-fluid was electrically insulated from the metal work by using teflon devices. The confining pressure was progressively increased up to 150 MPa, while the pore-fluid pressure was kept at 0.1 MPa. It took 3 days or longer for the electrical conductivity to become stationary after increasing the confining pressure.
Velocity and conductivity showed reproducibly contrasting changes with increasing confining pressure. Elastic wave velocities increased by less than 10% as the confining pressure increased from 0.1 MPa to 50 MPa, while electrical conductivity decreased by an order of magnitude. The changes must be caused by the closure of cracks under pressure. The large change at low pressures shows that there lots of cracks with small aspect ratios ($<10^{-3}$). Both velocity and conductivity showed no remarkable changes at higher pressures. The large conductivity change at low pressures must be related to the percolation of cracks.

Keywords: seismic velocity, electrical conductivity, fluid

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