Elastic wave velocity and electrical conductivity in brine-saturated rocks and microstructure of pores

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Geophysical mapping of fluids is critical for understanding crustal processes. Seismic velocity and electrical resistivity structures have been studied to reveal 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 made measurements of elastic wave velocities and electrical conductivity in brine-saturated rocks under confining pressures, and examined pore structures with SEM.

Measurements and microstructural observations were made on granites (Aji, Kagawa Pref., Ohshima, Ehime Pref.), granodiorite (Enzan, Yamanashi, Pref.) and tonalite (Kadohara, Fukui Pref.). Cylindrical rock samples (D=26 mm, L=30 mm) were filled with 0.1 M KCl aqueous solution, and velocity and conductivity were simultaneously measured by using a 200 MPa hydrostatic pressure vessel. The pore-fluid was electrically insulated from the metal work by using plastic devices. The confining pressure was incrementaly 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.

Rock samples showed moderate increase in velocity and large decrease in conductivity under confining pressures. Electrical conductivity steeply decreased at low pressures (<20 MPa) and then showed gradual decreases. Grain boundary cracks are pervasive in rock samples. The increase in velocity and decrease in conductivity at low pressures must be caused by the closure of grain boundary cracks with small aspect ratios ($<10^{-3}$). SEM images show that the aperture of a grain boundary crack varies along its width. Large aperture parts can be open even under high pressures to be conduction paths. The difference in conductivity at high pressures must reflect the difference in the amount of large aperture parts.

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