Elastic wave velocities and electrical conductivity in a brine-saturated granitic rock with single fracture

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Geophysical mapping of fluids is critical for understanding crustal processes. Interpretation of seismic velocity and electrical resistivity structures requires a thorough understanding of the pore structure that governs physical properties under high pressures. Watanabe et al. (2019) showed that wide aperture parts in cracks remain open to govern physical properties under high pressure. In the crust, there should be cracks with various sizes: from grain boundary to large faults. In order to understand the role of a fracture as a conduction path under high pressure, we have made measurements of elastic wave velocities and electrical conductivity in a brine-saturated granitic rock with single fracture. A cylindrical rock sample (D=26 mm, L=30 mm) with single fractures was cored from a block (20 cm x 20 cm x 20 cm) of Aji granite from Kagawa Prefecture, which was artificially fractured. The fracture goes through the sample from top to bottom. The sample was 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. Compressional and shear wave velocities were measured in the direction subperpendicular to the fracture, while electrical conductivity in the axial direction.

A preliminary experiment was conducted up to 40 MPa. Compressional and shear wave velocities increase with increasing confining pressure. At 40 MPa, the compressional wave velocity was almost the same as that in intact Aji granite samples, while the shear wave velocity was significantly lower than that in intact samples. The electrical conductivity at the atmospheric pressure was around one order of magnitude higher than that in intact samples. It greatly decreased from 0.1 MPa to 5 MPa, then showed a gradual decrease to 40 MPa. The conductivity at 40 MPa is also around one order of magnitude higher than that in intact samples. The average aperture of fracture at 40 MPa is estimated to be 2 micro meters. However, the fracture should be segmented under high pressure. X-ray CT observation will be conducted to understand the pore structure under high pressure.

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