熱クラックが含水岩石の弾性波速度と電気伝導度に与える影響

Impact of thermal cracks on elastic wave velocity and electrical conductivity in a brine-saturated granitic rock

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Cracks have strong influence on elastic wave velocity and electrical conductivity in fluid-bearing rocks. As the pressure is increased, cracks are closed to reduce their influence. Some parts of a crack, however, can remain open to affect physical properties under high pressure. Does the increase in the number of crack lead to the increase in the quantity of pores that can remain open under high pressure? In order to answer this question, we have conducted simultaneous measurements of elastic wave velocity and electrical conductivity on brine-saturated thermally-cracked granitic rocks.

A fine grained (500-1500 μm) granite (Oshima, Ehime Pref., Japan) was used as a rock sample and made into the cylindrical shape (D=26 mm, L=30 mm). Some cylindrical samples were heated up to 650 ℃ and quenched to create thermal cracks. Heating to 650 ℃ reduced compressional wave velocity by at most ~70 %. Samples were filled with 0.1M KCl aqueous solution and loaded in a pressure vessel to measure ultrasonic velocity (f=2 MHz) and electrical conductivity. The electrical conductivity of the pore-fluid is high enough (~1 S/m) to suppress the contribution of surface conduction. The pore-fluid was electrically insulated from the metal work by using plastic devices. The confining 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.

At the atmospheric pressure, the heated sample showed remarkably lower velocities and higher conductivity than the unheated sample. The compressional and shear wave velocities in the heated sample were lower than those in the unheated sample by 19% and 40%, respectively. The electrical conductivity in the heated sample was one order of magnitude higher than that in the unheated sample. As the confining pressure was increased, velocity increased and conductivity decreased both in heated and unheated samples. Large velocity increase was observed in the unheated sample at pressure lower than 50 MPa. These changes must be caused by the closure of cracks under pressures. The velocity difference between heated and unheated sample was greatly reduced with the confining pressure at the confining pressure of 150 MPa. On the other hand, the conductivity in the heated sample was still higher than that in the unheated sample by more than one order of magnitude. This suggests that the heat treatment increases the amount of pores which can maintain open at high pressure.

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