The change in electrical conductivity associated with the change in the water saturation degree of rocks

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Electrical properties of rocks are known to depend on degrees of water saturation, distribution of pore water, frequency, pore size and pore structures. Electrical conduction in rocks is considered to be composed of conductions in bulk pore water and mineral surfaces. At low frequency, conduction is dominated by ion transport in the pore water. At high frequency, besides ion transport, mineral/water interface contributes to conduction. When sandstones are saturated with water, border frequency depends on dominant pore-throat size (Scott & Barker, 2003).
In this study, we measured changes in electrical conductivity during drying for three Berea sandstones saturated with water (porosity: 25.4, 20.3 and 15.5%; permeability: 170, 230, 5 mD; hereafter described as Berea A, Berea B and Berea C, respectively) for frequencies from 0.1 Hz to 1 MHz. The measured pore size distributions by mercury intrusion porosimetry (MIP) showed that predominant pore diameters were about 40, 20 and 5 μm for Berea A, B and C.
As drying proceeds, pore water is lost first from larger pores followed by that from smaller pores (Nishiyama et al., 2012). Therefore, distribution of pore water at a certain degree of water saturation can be determined quantitatively from the pore size distribution. Relationships between the distribution of pore water and electrical conductivity for sandstones will be then discussed at low and high frequencies.

Keywords: water saturation, electrical conductivity, pore size distribution, sandstone

