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A study on wetting behaviour of NaCl brine in halite rocks using electrical impedance measurements

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Impedance measurements were conducted in order to clarify the wetting behaviour of water in halite rocks. We covered a range of temperatures (75-175ºC) and pressures (30-90 MPa), where the boundary between wetting and non-wetting of brine is suggested from studies of the dihedral angle (e.g., Lewiss and Holness, 1996). The conductivity normalized by the fluid conductivity shows a big change at around 150ºC, suggesting a big change in the fluid connectivity. This is in broad agreement with the wetting / non-wetting boundary suggested by previous works. However, from conductivity values, brine still looks to form a connected network at lower temperatures. The fluid connectivity must be maintained through very thin elements that microstructural study could not resolved.

The wetting behavior of fluid in crystalline rocks controls transport properties like permeability through the fluid connectivity. The temperature and/or pressure dependence of wetting behaviour is important for understanding fluid transport processes in the Earth's interior. Studies of wetting behavior have been mainly based on microstructural analyses of quenched materials. Although the structure of fluid phase is mostly preserved, the fine structure is likely to be modified rapidly. Quenched textures might provide us misleading information. Moreover, it is difficult to characterize dynamic aspects of wetting behaviour. We employed impedance measurement as an in-situ observation method.

Impedance measurements were conducted on a wet halite sample (10.5 mm diameter and 16 mm long) by an impedance analyzer (Solartron 1260) with a dielectric interface (Solartron 1296), which enables us to measure the impedance up to 10^14 ohm. The impedance was measured at frequencies from 0.01 Hz to 1 MHz. We covered a range of temperatures (75-175 C) and pressures (30-90 MPa), where the boundary between wetting and non-wetting of brine is suggested from studies of the dihedral angle (e.g., Lewiss and Holness, 1996). One P-T condition was held until the measured impedance became fairly stabilized, and then changed to a different P-T condition.

The conductivity normalized by the fluid conductivity shows a big change at around 150 C, suggesting a big change in the fluid connectivity. This is in broad agreement with the wetting / non-wetting boundary suggested by previous works. However, from conductivity values, brine still looks to form a connected network at lower temperatures. The fluid connectivity must be maintained by very thin elements that microstructural study could not resolved. We also observed interesting settling behaviour of the impedance, which may reflect dynamic aspects of redistribution of fluid.