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Grain boundary wetting in halite rocks

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Intercrystalline fluid distribution governs physical properties of fluid-bearing rocks: seismic velocity, electrical conductivity, rheological property, etc. Interfacial energies have been considered to principally control fluid distribution in rocks. Equilibrium fluid distribution can be characterized by dihedral angles. A number of studies have been done on dihedral angles in various materials to understand fluid distribution, especially the connectivity of fluid. The halite-water system is a simple solid-liquid system. Solid-liquid textures and physical properties have been studied to understand natural salt rocks and to use this system as a good analog for crustal and mantle rocks. The dihedral angle between NaCl and brine has been measured systematically at various pressure and temperature conditions [Holness and Lewiss, 1997]. The measured dihedral angle suggests that grain boundaries are brine-free. Observations contradictory to these dihedral angle studies, however, have been reported. Watanabe and Peach (2002) performed deformation experiments on wet halite rocks under non-dilatant conditions. Intercrystalline brine significantly weakens halite rocks by fluid-assisted grain boundary migration, strongly suggesting the existence of grain boundary brine. However, the nature of brain boundary brine has been poorly understood. In order to understand its nature, we have examined the resistivity change reported by Watanabe and Peach (2002) to infer the brine geometry. By employing a simple tube model, we have found that the resistivity change must be caused by deformation of thin fluid path with the initial aspect ratio less than 10^{-4}. Grain boundary brine exists even under the hydrostatic condition, and its thickness is less than 100 nm. Such a thin fluid film might have distinct properties from the bulk fluid and coexist with brine pores at corners and grain faces. Although the cause of grain boundary wetting is still poorly understood, similar wetting might occur in crustal and mantle materials to affect physical properties.