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Technical University of Denmark

The effect of kaolinite on the permeability of the Gassum sandstone

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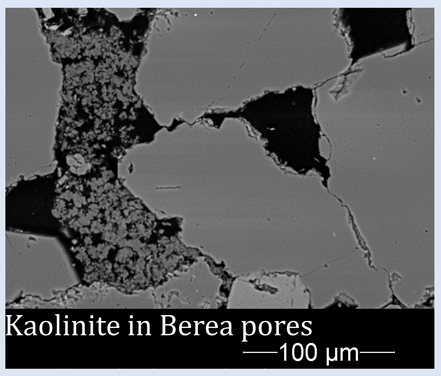
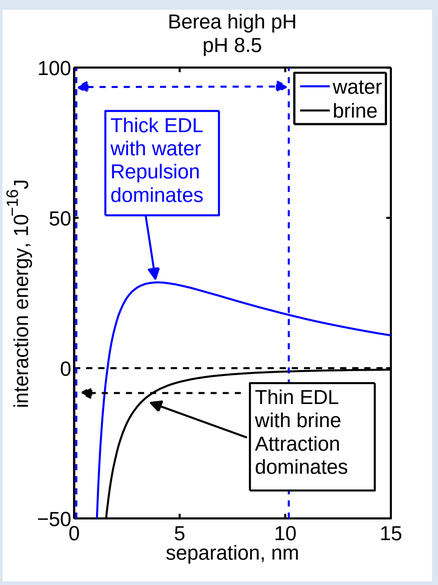
Previous studies on Berea Sandstone

Naturally high pH



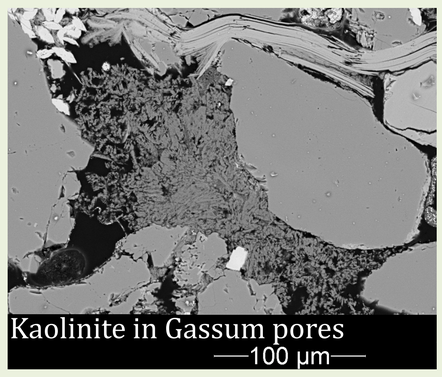
- A sharp permeability reduction was observed when flow rate was increased or salinity was reduced in the Berea sandstone [1,2,3].
- This is attributed to kaolinite mobilisation and pore plugging [1,2,3].

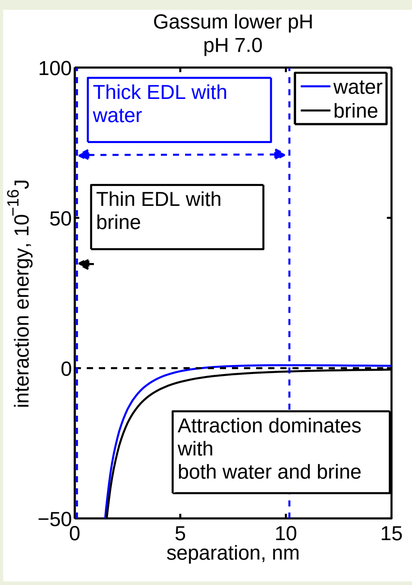


Current study on Danish Gassum Formation

Naturally lower pH

- We find no sharp permeability reduction when flow rate is increased or salinity is reduced in the Danish Upper Triassic-Lower Jurassic Gassum Formation sandstone.
- This suggests no kaolinite mobilisation.





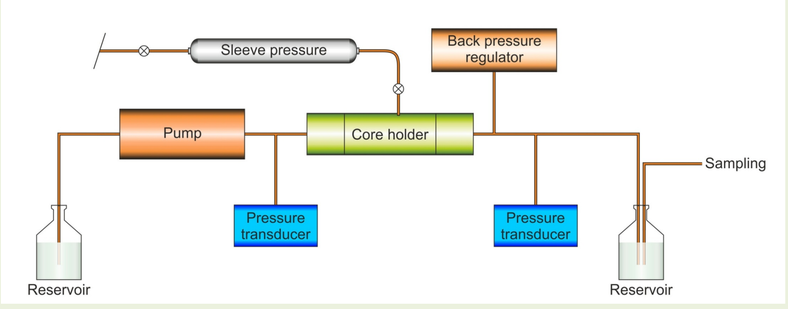
Effect of pH and brine on kaolinite mobilisation

Kaolinite and quartz have a more negative surface charge at a high pH [4, 5].

The surface charge is shielded by ions that form an electrical double layer (EDL). The EDL is thin with brine when the ion concentration is high.

The net interaction energy is the sum of EDL repulsion and van der Waals attraction according to DLVO theory [6,7,8].

Experiments on Gassum Formation



Experimental Procedure

- Samples were tested first with formation brine, subsequently with water.
- The interstitial flow velocity was increased and subsequently reduced.
- Viscosity, density, pH, and electrical conductivity of effluent were measured.
- Permeability was calculated according to Darcy's law.

Results and Discussion

Permeability in the Gassum samples is higher with brine than distilled water.

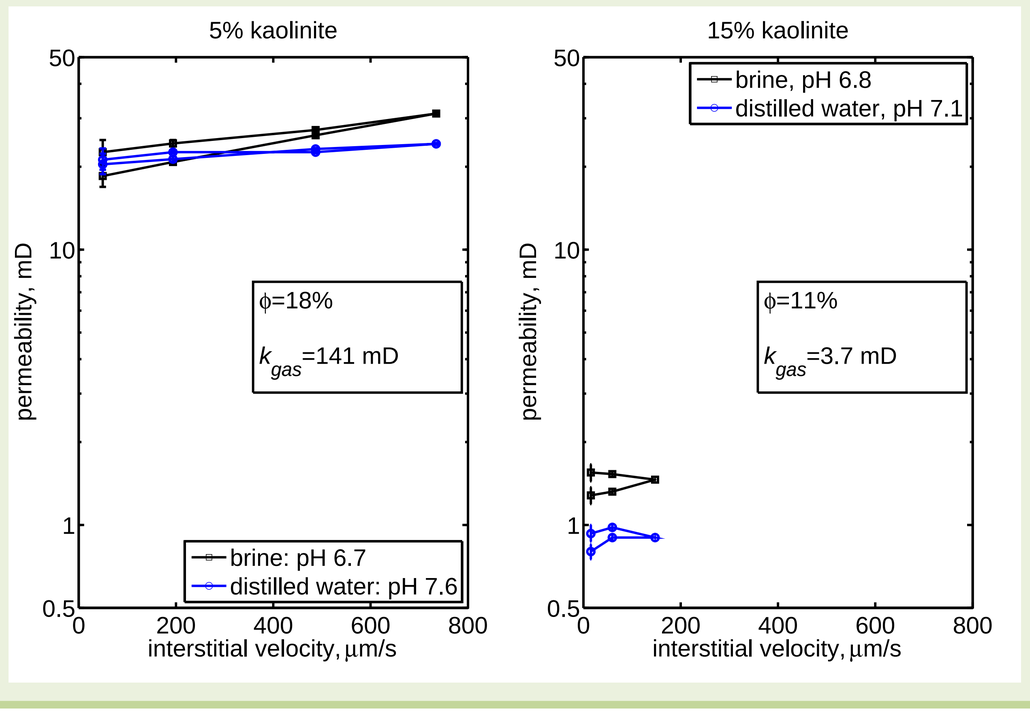
The difference is greater in samples with more kaolinite.

However, the difference is less than that reported for Berea sandstone.

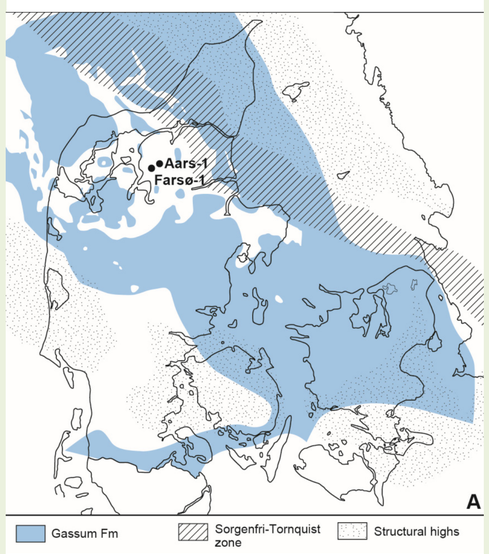
If fluid in the EDL is immobilised this reduces effective porosity.

Increasing flow rate increases permeability in some Gassum samples, although no kaolinite is observed in the effluent.

Possibly hydrodynamic forces displace kaolinite from flow paths.



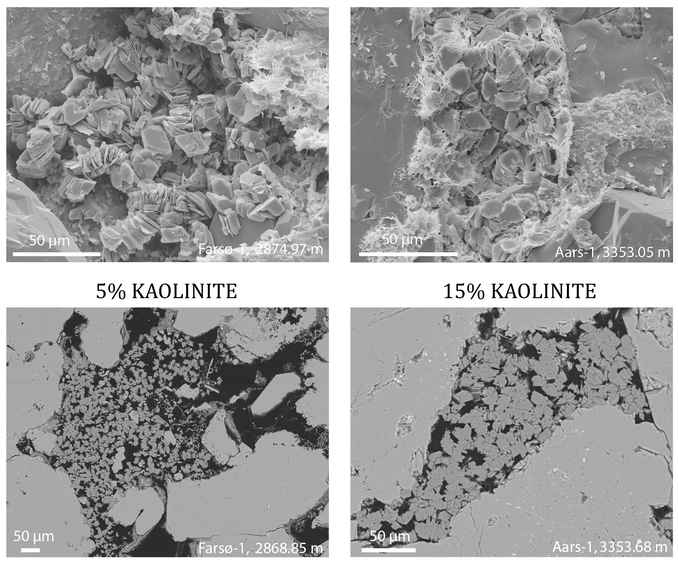
Gassum Formation in Denmark



References

[1] Khilar, K.C. and Fogler, H.S., The Existence of a Critical Salt Concentration for Particle Release, Journal of Colloid and Interface Science, 101, 214-224 (1984).
[2] Kia, E.F., Fogler, H.S. and Reed, M.G., Effect of Salt Composition on Clay Release in Berea Sandstones, SPE Production Engineering, 2, 277-283 (1987).
[3] Schembre, J.M. and Kovscek, A.R., Mechanism of Formation Damage at Elevated Temperature, Journal of Energy Resources Technology 127, (3), 171-180 (2005).
[4] Huertas, F.J., Chou, L. and Wollast, R., Mechanism of Kaolinite Dissolution at Room Temperature and Pressure: Part 1. Surface Speciation, Geochimica et Cosmochimica Acta, 62, (3), 417-431 (1998).
[5] House, W.A. and Orr, D.R., Investigation of the pH-Dependence of the Kinetics of Quartz Dissolution at 25 Degrees C, Journal of the Chemical Society-Faraday Transactions, 88, 233-241 (1992).
[6] Derjaguin, B.V. and Landau, L.D., Theory of the stability of strongly charged lyophobic sols and the adhesion of strongly charged particles in solutions of electrolytes, Acta Physicochimica URSS, 14, 633-662 (1941)
[7] Derjaguin, B.V. and Landau, L.D., Theory of the stability of strongly charged lyophobic sols and of the adhesion of strongly charged particles in solutions of electrolytes, Progress in Surface Science 43(1-4), 30-59 (1993)
[8] Verwey E.J.W, Overbeek, J.T.G.: Theory of the stability of lyophobic colloids. Elsevier (1948)

Gassum Formation



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