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Flooding of North Sea chalk and greensand cores with specific brines

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Elasticity and Electrical Resistivity of Chalk and Greensand during Smart Water Flooding

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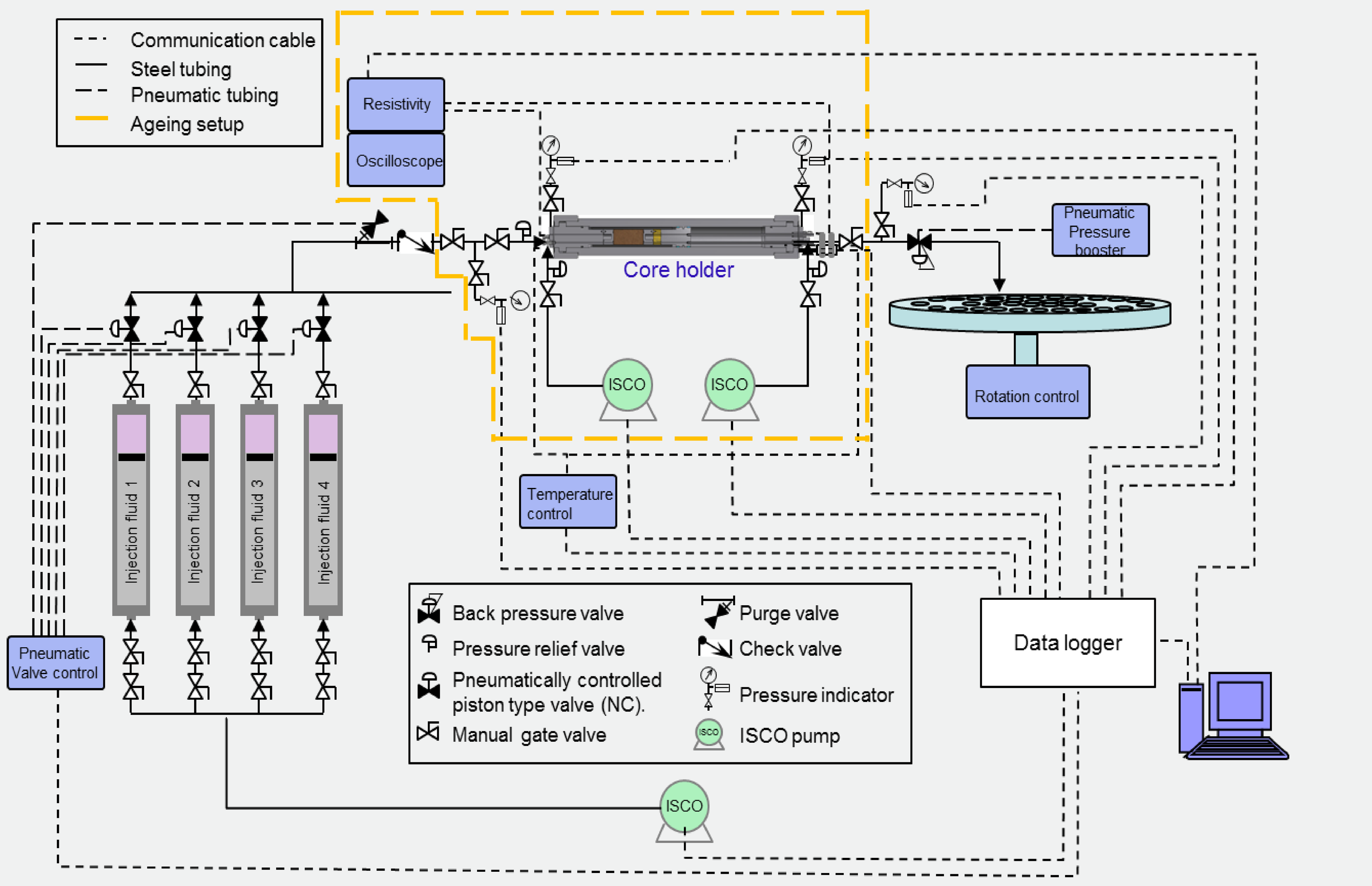
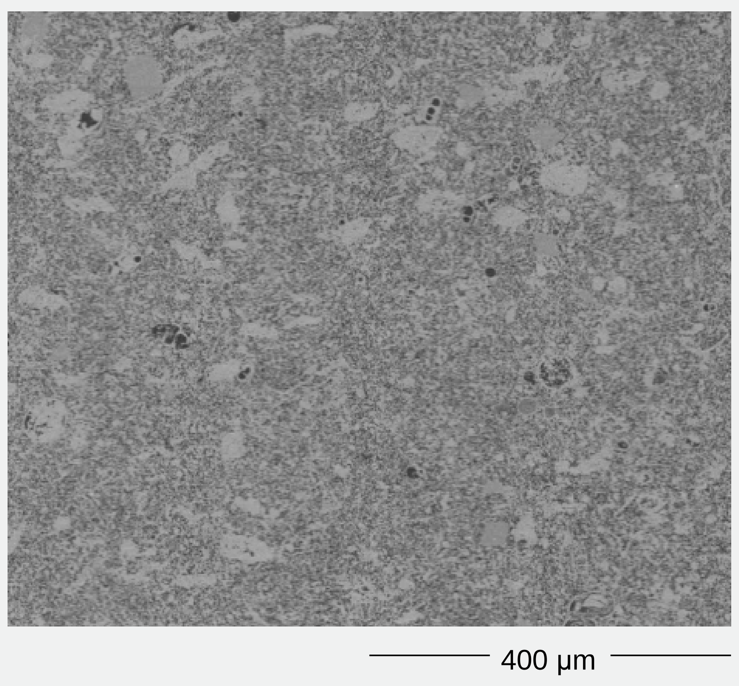
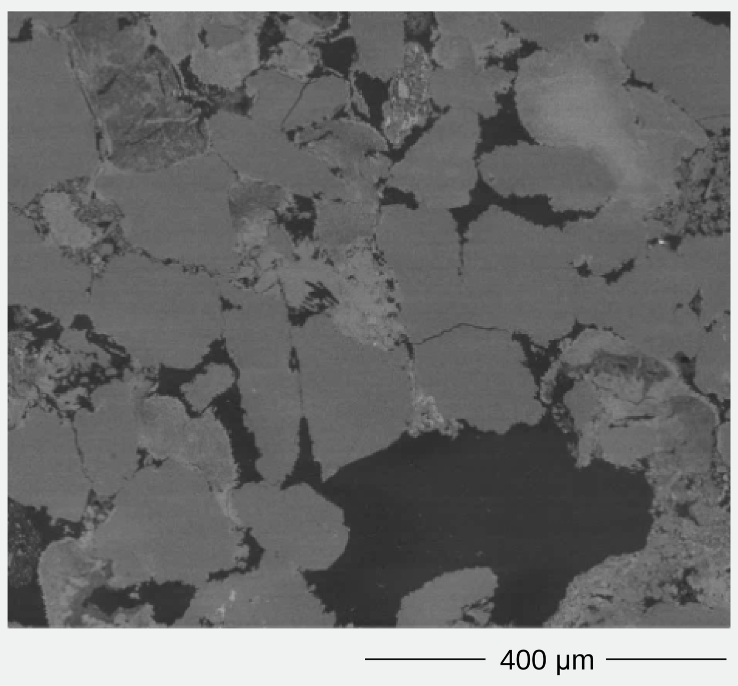
We investigate the physical processes on a pore scale that are responsible for changes in petrophysical and mechanical properties of four oil-bearing chalk and four oil-bearing greensand samples caused by flooding with brines containing varying amounts of dissolved NaCl, Na_2SO_4, $MgCl_2$ and $MgSO_4$.

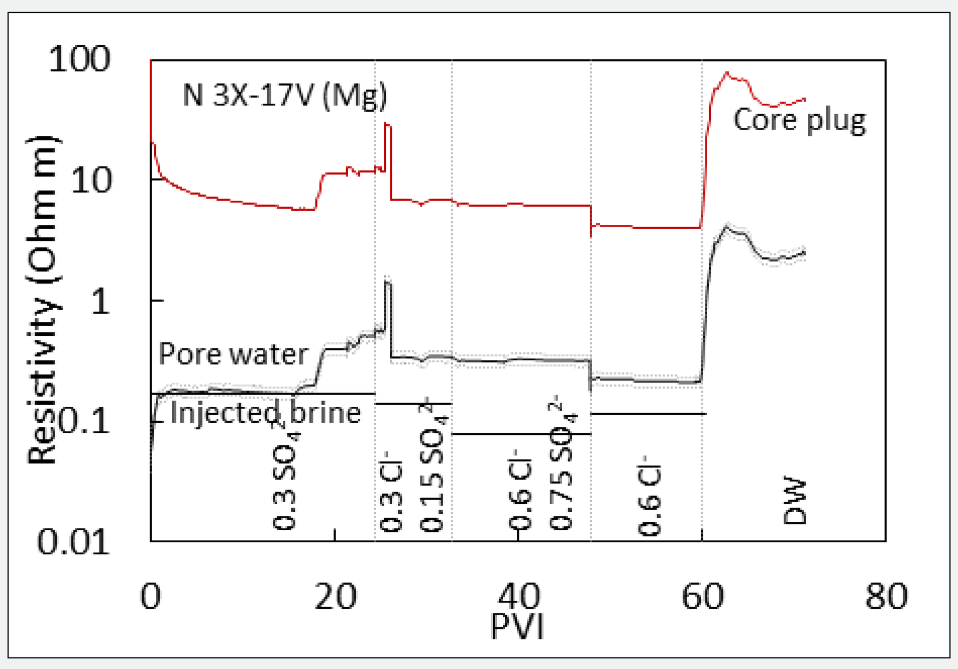


All samples were aged and flooded at 60°C. Ultrasonic velocities and DC electrical resistivity were used for monitoring.



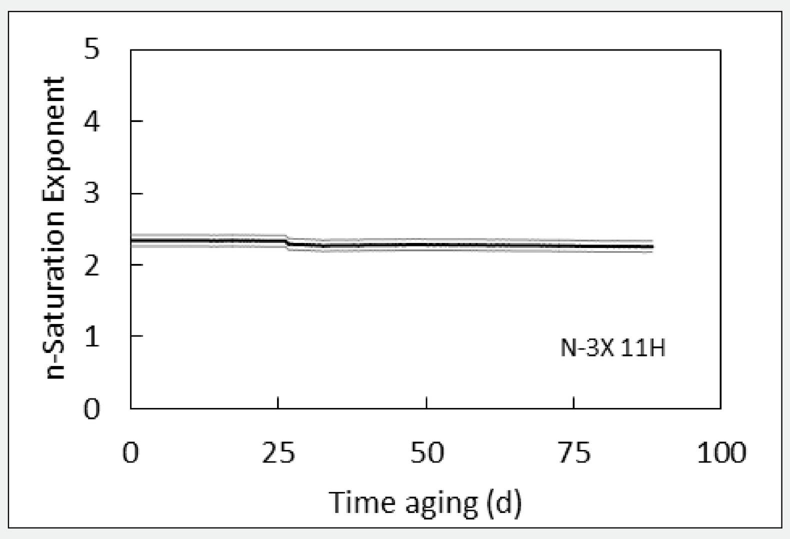


All samples are from the Danish North Sea.
Chalk samples are from the Upper Cretaceous of the Gorm field.
The greensand samples are from the Paleocene Solsort field.

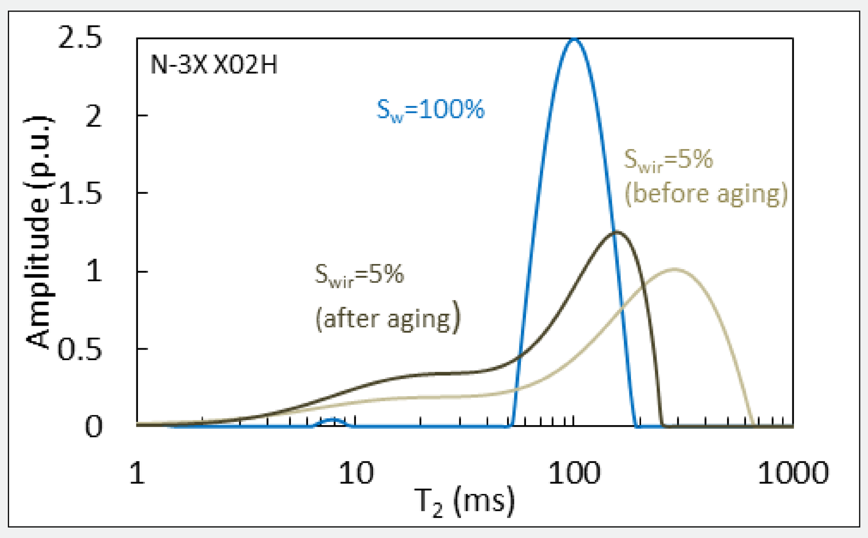


The electrical resistivity data during flooding revealed that the formation brine is not fully replaced by the injected water in both chalk and greensand.

Most chalk samples remain water wet

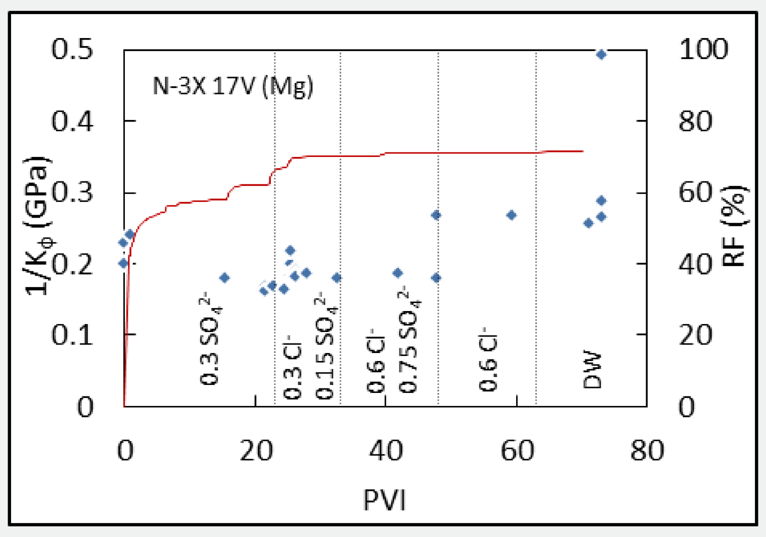


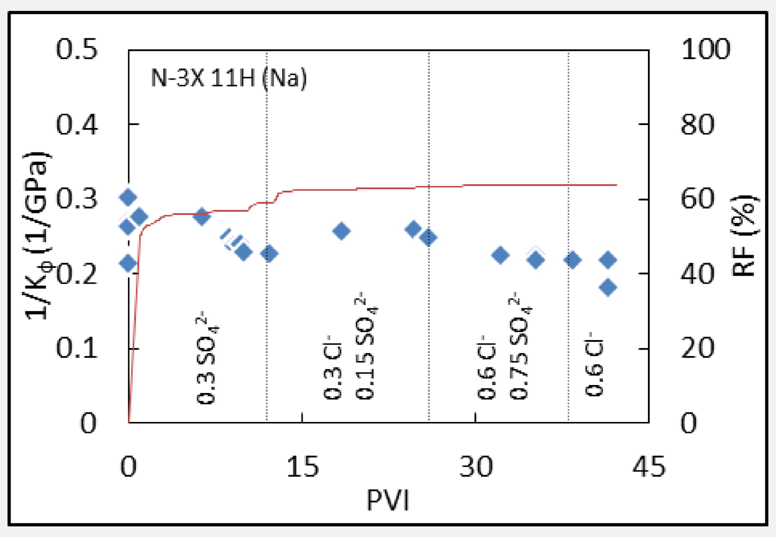
This chalk sample ages to more oil wet



Chalk: Wettability effects?

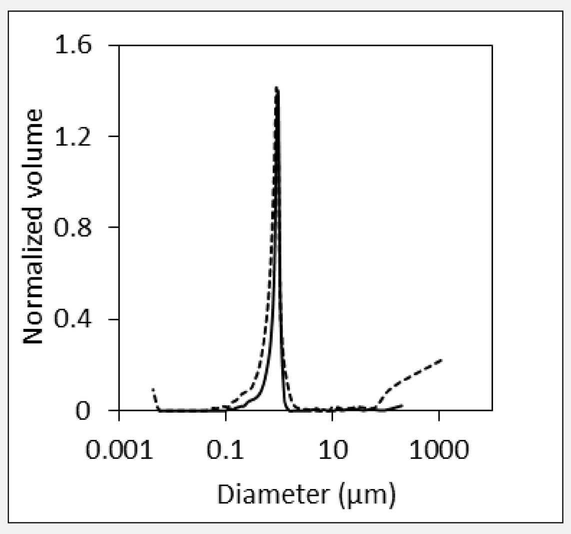
Electrical resistivity data and NMR indicate that chalk is water wet upon saturation to S_{wir}, but that aging in some cases lead to a wettability change to less water wet conditions (this can be a consequence of the evaporation method used for saturation). Upon flooding all samples regained their water wetness.





Chalk: Pore compressibility increase?

Changes in the elasticity of chalk during flooding illustrate the water softening effect of magnesium bearing brines as compared to the sodium bearing brines.



Chalk: Fines Formation?

Fines formation caused by chemical precipitation during flooding of chalk might be inferred from increase in specific surface and a shift to lower average throat diameter by MICP.

What about the Greensand? -nothing happened:

Electrical resistivity and NMR data indicate that **greensand remained mixed wet** during aging and flooding.
Stiffness of greensand was not affected by the smart water flooding as determined from the elastic wave measurements.
No indication of fines formation was observed for greensand.

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