Cement placement in damaged shale rocks: effects of shale properties

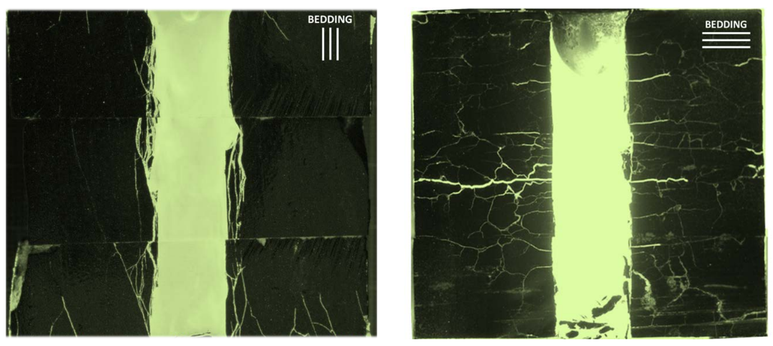
Malin Torsæter, Nils Opedal and Jelena Todorovic

SINTEF Industry, Dpt. Petroleum

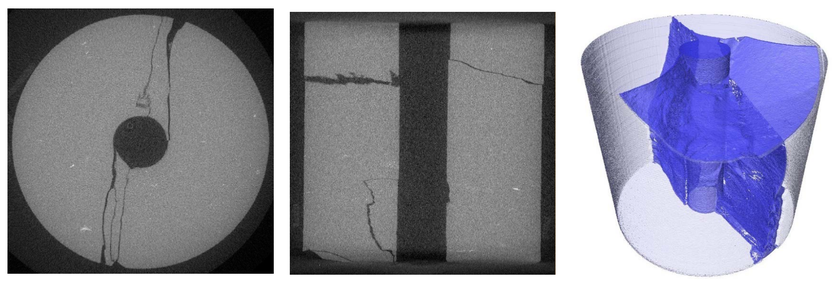
Background

Previous studies have shown that wellbore damage can vary in geometry and dimensions. Parameters such as shale type, bedding orientation, the drilling procedure and application of stress where shown to have an influence.

The main overall motivation for this project is to study whether drilling-induced damage at the near-well shale interface can produce significant leak paths, and if so, whether cement can penetrate and seal those leak paths.



***Torsæter et al. 2014**, Shale smearing at the borehole wall during drilling. **ARMA paper 14-7401**.*

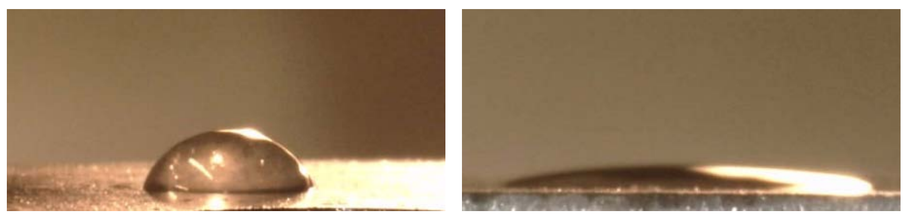


Opedal et al 2018**, CT scans of shale samples. (Left) Vertical cross section before cementing. (Middle) Vertical cross section before cementing. (Right) 3D visualization of the borehole and fractures. **IJGGC 2017 2422 (in press).

Objective

The objective of this work is to focus on the shale properties and more specifically how the wettability of the shale wall interface can have an influence on the bonding of cement.

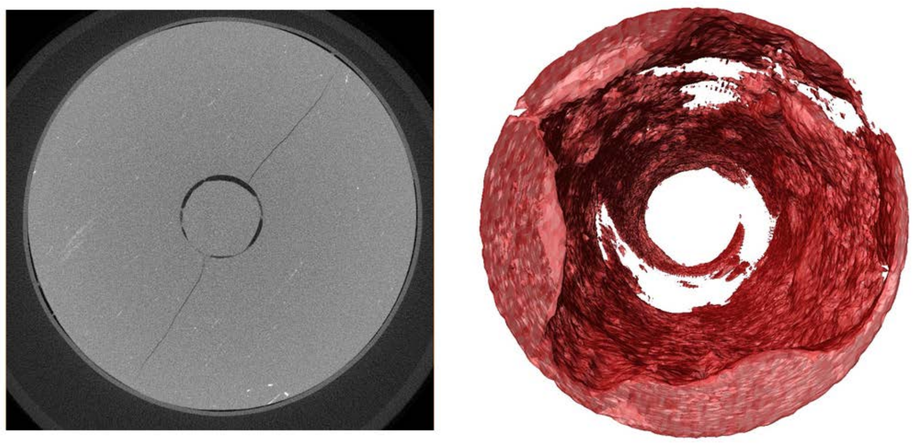
- *How will cement bond to different shale rocks with varying degree of oil/water wet surface?*



Photographs of shale rocks with varying wettability (Left) Water droplet on oil wet surface of shale type A. (Right) Oil droplet on water wet surface of shale type B.

Cementing oil wet shale surface

- Difficult to obtain sufficient bonding of cement to shale surface
- Film of oil along surface hinders cement-rock contact



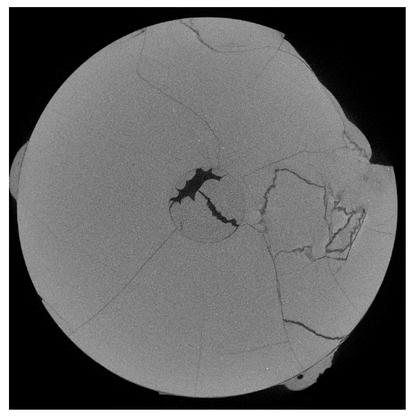
*Shale type B with **oil wet rock interface** (Left) CT cross section of a cemented smooth borehole. Cement was not observed in the cracks. (Right) 3D reconstruction of the void space at the interface between the cement and shale wall.*

Method

- Stage 1: subject hollow shale rocks to in-situ stress conditions to create wellbore damage.
- Stage 2: Circulate water or mineral oil through borehole to achieve oil- or water-wet surface.
- Stage 3: place cement in borehole using piston cylinder.
- Stage 4: scan cemented sample using X-ray CT
- Stage 5: segment and visualize non-cemented volume from CT data using AVIZO software

Cementing water wet shale surface

- Proper bonding of cement at water wet shale surface.
- Difficult to maintain bulk cement properties due to shale instability



*Example of cemented shale type A with **water wet rock interface** showing poor cement plug*

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