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Cementation features in fractured chalk: A petrographic study based on optical microscopy, the Kraka Field (Danish North Sea)

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The Kraka Field in the southeastern part of the Danish Central Graben is an anticlinal structure induced through several phases of halokinesis spanning from the early Late Cretaceous to Paleocene. The Kraka reservoir consists of the Ekofisk Formation of Danian age, a naturally fractured and overpressured chalk interval, subdivided into the upper Danian Porous and the lower Danian Tight units. Average matrix permeability of pure chalk is 0.88mD and the fracture network is the main driving factor of fluid flow within the reservoir. The orientation, distribution, density and origin of faults and fractures were previously investigated using core, borehole imaging, and seismic data. However, petrographic studies on the type, distribution, and geometry of cements precipitating along fractures are still missing. Characterizing the cement optically will significantly strengthen the work with identifying phases of fracturing and cementation filling the fractures during burial, their relative timing, and impact on effective rock permeability.

The present study aims at characterizing the types and phases of cements that precipitates along fractures. Visual inspection of cores provides information on fracture geometries and changes in cement filling at a macro-scale. Seventeen thin-sections are studied petrographically using optical microscopy in order to identify cement phases. The fractures are locally folded and show signs of brittle deformation along the vertical axis. The occurrence of clay-rich laminae influence fracture propagation. In addition, fractures are categorized into two groups according to the types of cement observed. The first set of fractures shows an early, polyphase quartz cementation followed by a calcite cementation. The second set of fractures suggests two successive calcite cementation phases separated by a period during which fractures may have remained open.
Isotopic analyses of calcite cement precipitating along fractures and bulk rock adjacent to fault planes (wells A2, A3 and A-5P) are compared to the petrographic findings to identify the origin of the brines from which calcite cement precipitated and better constrain the relative timing between different cementation phases during burial of chalk in the Kraka reservoir.