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New insights into fracture characterization of chalk

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Knowledge of natural fracture systems is inherently crucial, as an increased number of Danish sites are considered for CO2 storage. Natural fractures control fluid flow in tight chalk reservoirs, and can determine the reservoir potential for CO2 storage. The fractures also serve as enhancers in current energy production from the North Sea.

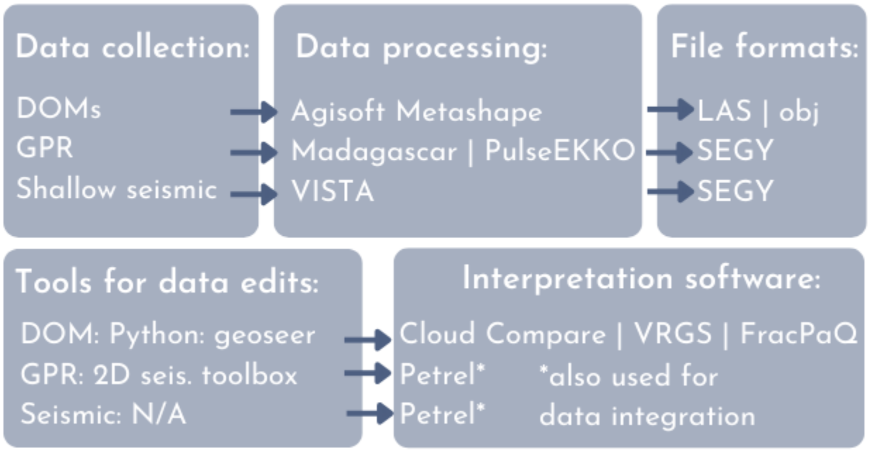

Figure 1 Workflow for combining the DOMs and the shallow geophysical data collected at Rørdal between 2016 and 2019

A three-dimensional dataset, surveyed in the Maastrichtian chalk of the Rørdal quarry – an active cement production site located in Aalborg, enables structural analysis of chalk at a scale significantly below the resolution of conventional (offshore) seismic. Imagery for five digital outcrop models (DOMs) were collected at different time steps during the excavation of the quarry. Fault structures and bedding features were mapped in the five DOMs (one point cloud and four meshes) and combined with interpretations from shallow seismic and ground penetrating radar (gpr). This allows us to assess the true orientation of the structures, as well as their along-strike variability. In the Rørdal quarry, the main observed structures were two steeply dipping NE-SW oriented normal faults, and gently-dipping E-W oriented folds. The structures are slightly oblique and may therefore have formed at different times. Both normal fault systems are segmented on the scale of a few hundred meters, where individual strands may die out along-strike, and displacement be taken up on new strands which are slightly offset.

In addition to the three-dimensional data, a unique dataset consisting of 26 100 digital fractures ranging from cm- to m scale within an area of approximately 1000 x 200m in the point cloud DOM. This extensive dataset offers two key strengths to alleviate typical uncertainties in outcrop studies: 1. the dataset is large and 2. it is taken from an area of near-continuous exposure, providing a population of observations that we believe to be both statistically significant and representative of natural variability in the system. This fracture dataset provides a realistic foundation for fluid flow simulations in chalk and provides calibration and validation possibilities for discrete fracture network modelling.