Swelling of clays/shales to ensure underground storage

CO_2 Seal Integrity

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Due to their low permeability, shales trap hydrocarbons in the subsurface. They are expected to fulfil the same role when utilizing depleted reservoirs to store CO_2 underground. However, any pathway to surface must be sealed to control CO_2 leakage. The CO_2 Seal Integrity project investigates mechanisms to promote expansion of shales and seal the interface between the formation and casing (Figure 1A) or across the well after milling of the casing (Figure 1B). Restoration of the natural sealing formation could create a barrier that is chemically more stable (upon exposure to CO_2), and has a lower permeability than cement. Using the shale as a barrier could also be less time consuming and cheaper than standard operations, especially when annular cement has to be repaired through perf-and-wash and cement squeeze jobs.

Samples from the Danish North Sea corresponding to the potential location of plugs are reconstituted to their in situ conditions (density, stress, pore-water chemistry) in large scale setups. Thereafter, a series of specimens are taken and exposed to fluids used in drilling operations (Oil based mud, water based mud). Finally, they undergo different treatments aimed at inducing swelling. Throughout the process deformation is measured at a macroscopic scale. Furthermore, microscopic characterization is performed by means of low-field 1-H nuclear magnetic resonance and X-Rays diffraction analysis. The aim is to evaluate different sealing strategies and compare their efficiency in terms of performance and feasibility.

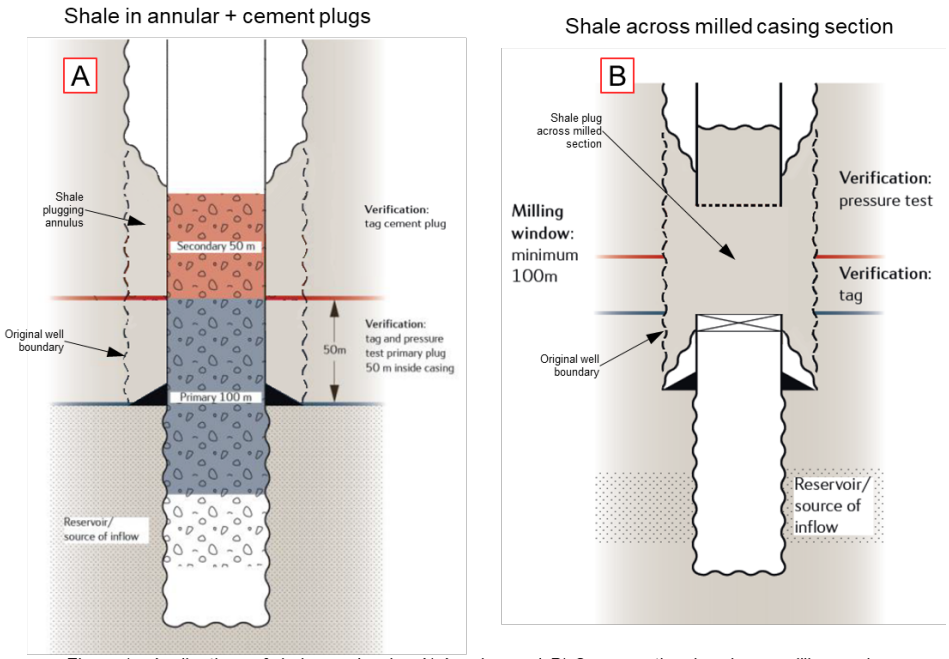

Figure 1 – Applications of shale as a barrier: A) Annular seal. B) Cross sectional seal upon milling casing. Adapted from *Revision 4 of NORSOK D-010 Well integrity in drilling and well operations*