

The Basal Cambrian Sandstone in the Subsurface of Alberta: Quest Carbon Capture and Storage Injection Target

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Abstract

Quest is an integrated Carbon Capture and Storage Project, located northeast of Edmonton Alberta, committed to capturing up to 1.2 million tonnes per year of CO₂ from the Scotford Upgrader and injecting it for permanent storage in the Basal Cambrian Sandstone saline aquifer.

A detailed sedimentological analysis of the Basal Sandstone was necessary in order to incorporate all levels of heterogeneities in the reservoir model to determine the uncertainty ranges around injectivity and capacity. The Gog Group in the Rocky Mountains was used as an outcrop analog and proved to be of paramount importance in the understanding of the geometries and internal discontinuities within this type of sandstone bodies.

The Basal Sandstone is a lateral continuous unit widely developed in the subsurface of the foothills and plains as far north as about 54° N latitude in Alberta and Saskatchewan, and extends into south-western Manitoba, lying unconformably on crystalline Precambrian rocks of the Canadian Shield. The Basal Sandstone records a major transgression characterized by siliciclastic sedimentation within a large embayment in the cratonic interior, called The Lloydminster Embayment in the area of study.

Three cores were described and analysed in detailed: (1) Radway 100-08-19-059-20 W4M00; (2) Redwater 100-03-04-057-20 W4M00; and (3) Redwater 102-11-32-55-21 W4M00. In the studied interval of the Basal Sandstone (BCS) and the lowermost Earlie Formation (LMS), sixteen lithofacies were grouped into five lithofacies associations. The Lloydminster Embayment can be described as a large open bay in the cratonic interior, fringed to the west by a carbonate platform. Five main environments are recognized: (1) Fluvio-influenced tide-dominated bay margin; (2) Tide-dominated bay margin; (3) Proximal bay, (4) Distal bay and (5) Offshore. The fluvio-influenced tide-dominated bay margin and tide-dominated bay margin environments are characterized by the presence of channels, subtidal sand-bar complexes and interdune areas. The proximal bay environment is also characterised by the presence dune deposits, however these are arranged vertically with a progradational stacking pattern similar to the sand-sheets in the Gog Group. The distal bay and offshore environment are both characterized by thinly interbedded sandstone and mudstone with the later one being more intensively bioturbated.

The transgressive nature of the Basal Cambrian Sandstone and the lowermost Earlie Formation is evident from its overall retrogradational stacking pattern within an embayment. The described interval is included within a transgressive system tract, in which three genetically related intervals are separated by two flooding surfaces (FS), and capped by a maximum flooding surface (MFS).

The lateral continuity of this Cambrian sandstone and the excellent reservoir properties supports its use as a viable storage site with sufficient injectivity and capacity to meet the annual injection targets for up to 25 years of injection starting in 2015.