CO₂ storage modelling and capacity estimates for the Trøndelag Platform - a basin modelling approach

Ane E. Lothe, Benjamin U. Emmel & Per Bergmo

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Contact: Centre Director Nils A. Rokke • +47 951 56 181 • Nils.A.Rokke@sintef.no
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Summary

CO₂ storage modelling and storage capacity estimates for the Trøndeslag Platform using SEMI software tool a tool readapted from exploration hydrocarbon migration modelling to reservoir modelling The SEMI software tool models migration, losses, leakage, spill and faults. It uses a ray-tracing technique to migrate CO₂ within a carrier below a sealing cap-rock.


Keywords
Modelling, storage capacity, SEMI, migration, losses, leakage, spill, faults

Authors
A. Lothe, Sintef, Norway, Ane.Lothe@sintef.no
Benjamin U. Emmel, SINTEF, Norway, BenjaminUdo.Emmel@sintef.no
Per Bergmo, SINTEF Petroleum Research, Norway, Per.Bergmo@sintef.no

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CO₂ storage modelling and capacity estimates for the Trøndelag Platform – a basin modelling approach

A. E. Lothe¹, B.U. Emmel.¹ & P. E. Bergmo ¹

¹ SINTEF Petroleum Research, P.O. Box 4763 Sluppen, NO-7465 Trondheim, Norway

There are several approaches to estimate possible storage capacities for aquifers and traps in sedimentary basins, ranging from static theoretical capacities estimates to more detailed methods involving dynamic modelling. Several techniques are available, from basin modelling approach – readapted from exploration hydrocarbon migration modelling to reservoir modelling – coming from oil and gas field production modelling. The SEMI software tool models migration, losses, leakage, spill and faults. It uses a ray-tracing technique to migrate CO₂ within a carrier below a sealing cap-rock [2]. This carrier unit may also act as a storage unit. The technique uses the dip of the carrier to determine pathway directions.

Figure 1 shows an example of capacity estimates using SEMI at the Trøndelag Platform area, offshore Mid-Norway. The modelling results suggest a total maximum trap-storage capacity of ca. 5.9 Gt for a non-fault scenario and significantly higher value of 21.4 Gt if sealing faults were taken into account (Figure 1). These estimates include also the eastern part of the Halten Terrace area. If we exclude the three largest traps, the storage capacity in the Trøndelag Platform will be in range of 4.9 Gt for non-fault scenario and 15.1 Gt with faults included.

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Figure 1 (Left map) Main structural elements offshore Mid-Norway, reworked from [2]. (Right map) CO₂ accumulations projected onto the top Garn Fm. depth map, SEMI modelling result.

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There are several approaches to estimate possible storage capacities for aquifers and traps in sedimentary basins, ranging from static theoretical capacity estimates to more detailed methods involving dynamic modelling. Several techniques are available, from basin modelling approach – readapted from exploration hydrocarbon migration modelling to reservoir modelling – coming from oil and gas field production modelling.

Method

The SEMI basin modelling software tool models migration, losses, leakage, spill and faults. It uses a ray-tracing technique to migrate CO₂ within a carrier below a sealing cap-rock [1,2]. This carrier unit may also act as a storage unit. The technique uses the dip of the carrier to determine pathway directions.

Study area – geological setting

During the last two decades the Halten Terrace area, offshore mid-Norway has become a rather mature exploration area for oil and gas (www.npd.no). In the shallower Trøndelag Platform area (< 2 km), no hydrocarbons are explored and CO₂ storage on industrial scale can be a possibility [4, 5, 6]. The platform has been a large stable area since the Jurassic and it is covered by relatively flat-lying and mostly parallel-bedded strata that dips gently north-westwards.

The cap rock

The overlying low-permeable elasic rocks have a reported thickness up to 1650 m, will most likely provide an effective seal. However, they are thinning towards east and intersecting with Quaternary sections close to the Norwegian coast.

The storage unit

The Middle Jurassic Garn Formation is considered as the best reservoir candidate for CO₂ storage. It is widely laterally deposited and with a sufficient thickness (see Figure). The Garn Formation consists of medium to coarse grained, moderately to well-sorted sandstones [8].

Results

The total trap-storage capacity was estimated assuming the parameters given in the Table. An infinite amount of CO₂ was injected into the carrier unit and migration loss was disabled. The modelling results suggest a total maximum trap-storage capacity of ca. 5.9 Gt for a non-fault scenario and 21.4 Gt if sealing faults were taken into account. These estimates include also the eastern part of the Halten Terrace area.

Conclusions

Basin modelling approach can be used for storage capacity estimates. This example demonstrates that taking the effect of sealing faults into account will have a large effect on the amount of storage capacities.

References

[4] Bøe et al. (2005): , CO₂STORE project, NGU report: