CATO-2 Deliverable WP3.03-D05

Agreement on representative sites

(1st Year Progress Report)

Prepared by: C.J. Spiers

Reviewed by: C.J.Peach

Approved by: J.Brouwer
(CATO-2 Director)

1 Executive Summary (restricted)

During Year 1 of CATO-2, the following reservoir-caprock systems were jointly agreed upon, by researchers and site-owners, as having the highest priority for studies of caprock and fault integrity, at least in Years 1 and 2 of the programme:

1. The Bunter sandstone plus overlying Solling & Röt claystone/marl caprocks (cf. P18);
2. The Rotliegend sandstone plus overlying Zechstein anhydrite caprock;
3. Carboniferous sandstones, shales and coals (cf. DSM Chemelot site).

For laboratory experiments under WP3.03 (and for WP3.02 and 3.04), samples have been obtained that are considered reasonably representative for all three of these choices. Bunter/Solling/Röt samples and statigraphic equivalents have been obtained from:

- TAQA P18/P15 and from the Q16 field;
- Field excursions by Utrecht University (UU) and TU Delft to Germany;
- The TU Delft sample collection/repository.

Pore fluid compositions relevant to the Bunter reservoirs at P18/15, Q16 and Q08 have been obtained from Wintershall. Rotliegend & Zechstein samples, and closely similar equivalents, are available from:

- The UU sample collection/repository (including Zechstein anhydrite cores provided by Shell);
- TU Delft sample collection/repository.

A sample inventory at TU Delft has provided Carboniferous coal, sandstones and shales of Westphalian origin that can be used to represent the Chemelot site if needed, though older material would be preferred.

Characterisation work on the various samples is reported in Deliverable WP3.03-D06. First results from experiments are reported in Deliverable WP3.03-D08 and WP3.02-D01.

Geomechanical modelling in WP3.03 has concentrated to date on generic reservoir-caprock systems (see Deliverable WP3.03-D02), in line with later application to the Bunter and Rotliegend reservoirs-caprock sequences chosen for obtaining samples for experiments.

Distribution List

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Document Change Record

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Version	Nr of pages	Short description of change	Pages

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2 Applicable/Reference documents and Abbreviations

2.1 Applicable Documents

(Applicable Documents, including their version, are documents that are the "legal" basis to the work performed)

	Title	Doc nr	Version date
AD-01	Beschikking (Subsidieverlening CATO-2 programma verplichtingnummer 1-6843	ET/ED/9078040	2009.07.09
AD-02	Consortium Agreement	CATO-2-CA	2009.09.07
AD-03	Program Plan	CATO2-WP0.A-D.03	2009.09.29

2.2 Reference Documents

(Reference Documents are referred to in the document)

	Title	Doc nr	Version/issue	Date

2.3 Abbreviations

(this refers to abbreviations used in this document)

3 General Text

3.1 Introduction

Gas reservoirs and aquifers are generally sealed by both caprocks and laterally bounding faults. Injection and storage of CO_2 will change the stress-strain field in such reservoir-seal systems. Under extreme circumstances, these changes may influence caprock and fault integrity.

WP 3.3 (Caprock and Fault Integrity) addresses the evolution of caprock and fault integrity during CO2 injection and storage via two, integrated lines of attack:

a) Experimental studies of the sealing capacity of caprocks and faults.
b) Numerical modelling of the geomechanical evolution of the reservoir-seal system.

In performing both the experimental and numerical studies, representative reservoir-seal systems and associated rock types have to be selected to form the focus of detailed generic and site-specific investigation. This is especially so for the experimental studies, where the long duration of experiments addressing slow fluid-rock interaction effects means that only a limited number of reservoir, caprock and fault rock types can be investigated. Note here that faults generally incorporate components of the reservoir and caprock materials that they transect.

This report documents the choices made in Year 1 of CATO-2 (WP 3.3) regarding reservoir-caprock systems that should receive priority for study, thereby forming the best basis for the WP3.03 programme and for the usefulness of WP3.3 data in other workpackages, notably WP 3.2 (Reservoir Behaviour) and WP 3.4 (Wellbore Integrity).

3.2 Selection process

The choice of which reservoir-caprock systems should be given priority for detailed study was conducted in the framework of SP3 meetings, WP3.3 meetings, and in joint meetings with WP3.2 and WP3.4 research partners. All site-owners were informed of the key meetings held and asked to participate and/or confirm the choices made. Additional meetings and discussions were held with Shell and TAQA, regarding their specific needs and research questions. The main meetings held are listed in Table 1.

The choices made were based on the following considerations:

1. What are the most representative reservoir-caprock systems amongst the potential gas reservoir and aquifer storage sites considered under CATO-2?

2. What are the generic and (site-)specific requirements of the site-owners?

3. What data are already available?

4. What geomechanical models are already available?

Date	Meeting	Main conclusion / remark
2009.08.13	SP-meeting with site-owner TAQA	Detailed workplans specifically for P18 within SP-3.
2009.09.21	SP meeting with site-owner TAQA	Detailed workplans specifically for P18 within SP-3. Main focus will initially be on WPs 3.1 to 3.4.
2009.10.09	CATO-2 kick-off meeting	WP3.3 plans for Yr 1 discussed and consolidated
2009.10.30	SP-meeting with site owners	Discussion on specific issues concerning the individual sites, including WP 3.3 issues such as sample availability and status of previous geomechanical models; Reservoir/caprock systems identified + Rotliegend/Zechstein and Bunter/Solling-Röt
2009.11.13	WP meeting	Technical kick-off WP3.3. Above reservoir/caprock systems agreed as representative for experiments and modelling
2009.11.20	SP-meeting with RWE	Clarification of needs RWE; reservoirs rather than Rotliegend aquifer in N-NL?
2009.12.08	WP-meeting	Joint technical meeting with WP3.2 + WP3.4; experimental methods discussed/exchanged, representative samples confirmed, modelling approach confirmed
2010.03.05	SP-meeting with TAQA	Plans made for reservoir/caprock sample selection for WP3.3 (Bunter/Solling-Röt) plus possible extension of geomechanical modelling to TAQA P18 in 2010.
2010.03.23	SP-meeting with DSM	Preliminary work plan and samples plan defined
2010.04.07	WP visit TNO	Visit to TNO core store to select Bunter/Solling/Röt for lab tests
2010.04.20	WP to NAM	Visit to NAM to select Solling/Röt caprock for lab tests
2010.05.06	WP-meeting	Status and planning meeting; site-owners invited. Confirmation of representative reservoirs-caprocks

Table 1. Main meetings featuring discussions regarding reservoir-caprock samples and systems that should receive priority for study. Visits to TNO and NAM to collect samples are also listed.

3.3 Chosen reservoir- caprock systems and samples

The following reservoir-caprock systems were jointly identified, by researchers and site-owners, as having the highest priority for studies of caprock and fault integrity, at least in Years 1-2:

4. The Bunter sandstone plus overlying Solling and Röt claystone/marl caprocks
5. The Rotliegend sandstone plus overlying Zechstein anhydrite caprock
6. Carboniferous sandstones, shales and coals

Choices (1) and (2) were based on the fact that many of the Dutch gas reservoirs (and some potential aquifers) are sited within the Bunter or Rotliegend sandstones and are sealed by the corresponding overlying caprocks, and by faults that cut these units and accordingly incorporate components of them, or of similar lithologies, in the resulting fault rocks. The primary caprocks

were identified from gas content log records and from discussions with the site-owners and with TNO. These choices are directly relevant to the following sites, amongst many others:

- Bunter/Solling/Röt:
  TAQA P18 & P15, Q08

- Rotliegend & Zechstein anhydrite:
  N. Netherlands s.l, GdF K12B

Choice (3) was based on the relevance to the DSM Chemelot site. The WP 3.03 team also identified the need to obtain samples of claystones that could serve as reference material for interlab comparison of work on clay-dominated caprocks. The Opalinus clay from the Mont Terri site has been proposed as a possibility here.

To date, samples have been obtained that are considered reasonably representative for all three of the above choices. Core material has been obtained from TNO and NAM, with the assistance of TAQA and Wintershall (see Table 1).

Bunter/Solling/Röt samples and statigraphic equivalents have been obtained from:
- TAQA P18/P15 and from the Q16 field
- Field excursions by UU and TU Delft to stratigraphic equivalents in the Eiffel and in E. Germany
- TU Delft sample collection/repository

Pore fluid compositions relevant to the Bunter reservoirs at P18/15, Q16 and Q08 have been obtained from Wintershall.

Rotliegend & Zechstein samples, and closely similar equivalents, are available from:
- UU sample collection/repository (including Zechstein anhydrite cores provided by Shell)
- TU Delft sample collection/repository.

Carboniferous samples:
A sample inventory at TU Delft has provided Carboniferous coal, sandstones and shales of Westphalian origin that can be used for the Chemelot site if needed, though material older than Westphalian is preferred.

Characterisation work on the petrological- and reservoir-seal system relevance of the various samples for the Netherlands sites identified in CATO-2 is reported in Deliverable WP3.03-D06. First experiments are reported in Deliverable WP3.03-D08 and WP3.02-D01.

Geomechanical modelling in WP3.3 has concentrated to date on generic reservoir-caprock systems (see Deliverable WP3.03-D02), in line with later application to the Bunter and Rotliegend reservoirs and overlying caprock sequences chosen for obtaining samples for experiments.