Leakage and pressure evolution in large scale CO_2-storage scenarios

- an experimental and numerical simulation approach -

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1. Introduction

One of the main issues of CO_2 storage projects in geological formations is to make sure that CO_2 is safely contained below the surface, i.e., it is kept within a reservoir by different trapping mechanisms[1]. However, if CCS is to become industrial standard large amounts of CO_2 have to be injected on a basin scale forcing changes in the regional pressure regime due to the quasi incompressibility of the formation water. This may lead to brine migration far beyond the local storage area where it may affect upper groundwater reservoirs **(figure 1)**. On the other hand, overpressure may lead to fracturing of the sealing layers or the reactivation of faults causing migration pathways and consequently leakage of CO_2 into upper strata. In this context, we would like to **study the pressure evolution on a basin scale** and **run possible CO_2 leaking scenarios** to investigate the impact of leakage and pressure evolution in multilayered systems. As an example we will refer to the **Northern German Basin**.

2. Numerical simulation

- Pressure evolution and possible leakage on a basin scale multilayered system
- Example: Northern German Basin

Software:
- PetroMod *(IES Schlumberger)*
- ECLIPSE *(Schlumberger)*

Data base:
- Geotectonic Atlas (2001)[2]
- Fachinformation Geophysic[5]

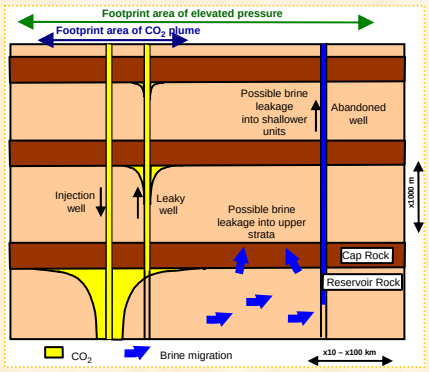

Figure 1: Relationships between injected CO_2, pressure evolution and leakage in a multilayer system. The pressure resulting from CO_2 injection influences the whole setting and may lead to brine migration or support possible CO_2 and/or brine leakage. The question of how much leakage may reach the surface is governed by many parameters like the number of layers, permeability of the formations, wells and/or faults and the pressure evolution (modified after [3, 4])

3. Experiments

- Leakage rates through different materials
- CO_2 leakage in multilayered system
- Amount of CO_2 escaping the reservoir under varying conditions

Equipment:
- HP/HT – Lab (Ocean Lab, Jacobs University, Bremen)
- HP/HT – Lab (Technical University, Hamburg-Harburg)

4. Work flow

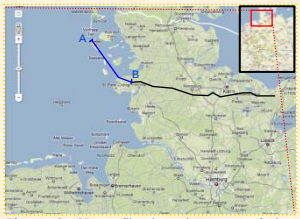

Figure 2: 2D profile through a part of the Northern German Basin with location of figure 4.

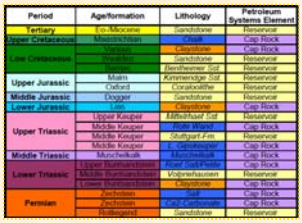

Figure 3: Stratigraphy of the Northern German Basin. A major target for CO_2 storage is the Volpriehausen-Fm., Lower Triassic.

Numerical simulation

PetroMod *(IES Schlumberger)*

- CO_2 kinetics
- Reference scenario for calibration
- 2D/3D model of Northern German Basin (fig. 2 & 4)
- P-evolution large CO_2 Injection (basinwide) Target-fm: Volpriehausen (fig. 4)
- Location of HP-areas
- Study of leakage into Upper strata (fig. 3)

ECLIPSE *(Schlumberger)*

- Parameter sensitivity study on leakage (fig.1)
- Reference scenario for calibration
- Modeling of the Experiments (fig. 5)

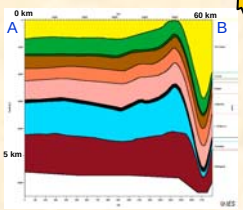

Figure 4: 2D model profile result through part of the Northern German Basin. The black horizon indicates a source rock for CO_2. (see fig. 2 for location)

Experiments

Jacobs University *(Bremen)*

- Assemblage and tests (fig. 5)
- Base experiments on different materials
- Evaluation of results

Technical University *(Hamburg – Harburg)*

- Reservoir conditions (<100 °C; <300 bar)
- Large-scale experiment (max.: 140 cm x 32 cm)

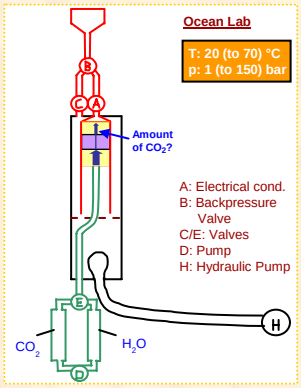

Figure 5: Extended setup of the laboratory equipment of the Ocean Lab (Jacobs University, Bremen).

5. Outlook:

- Setup of a kinetic model in PetroMod, suitable to generate a desired amount of CO_2
- Subsurface data acquisition
- First test runs on current experimental setup
- First results of the overall study are expected in the course of 2010

References:

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[4] Class et al. (2009): A benchmark study on problems related to CO_2 storage. *Computational Science.*

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[6] RWEDea (2009) CCS-Planung: Kriterien fuer einen CO_2-Speicher im noerdlichen Schleswig-Holstein (*http://www.nordfriesland.de/media/custom/45_6597_1.PDF)*

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