CLEAN

CO_2 LARGE-SCALE ENHANCED GAS RECOVERY in the ALTMARK NATURAL GAS FIELD

CO_2 leakage in shallow aquifers: Factors affecting the geometry and dimension of CO_2 phase bodies

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Motivation:

The European Framework demands monitoring of the environment, especially of potabel groundwater resources irrespective of the probability of a CO_2 leakage from a reservoir. The detection of a CO_2 legkage in shallow aquifers can be managed by detection of the CO_2 phase body or the dissolved CO_2 plume. The dimension of the plume depends directly on the structure of the phase body. The geometry and dimension of the phase body depends on aquifer geology (aquifertype and heterogeneities) and leakage rates.

The aim of this work is to evaluate processes and parameters which control CO_2 phase spreading to enhance the development of site specific monitoring concepts. For prediction of possible CO_2 phase body geometries we model some first multiphase flow scenarios to analyze the main factors for CO_2 phase distribution and to develop monitoring methodes, using the model TOUHGREACT/EOS2.

Results:

Schematic model:

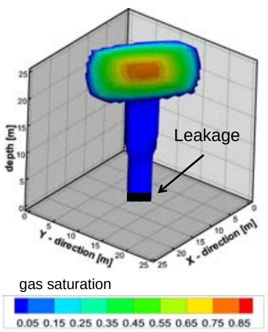

Fig. 1: gas saturation results from a 3D homogen schematic model.

Influence of Aquifer type:

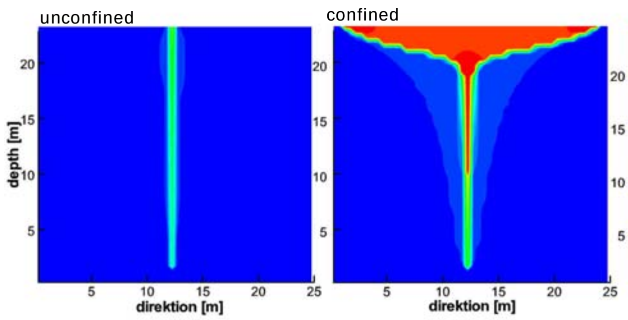

*Fig. 2: gas saturation in an unconfined(left) and confined (right) aquifer after one year. Leakage rate: 3.6*10^-1kg/d.*

Influence of heterogenity:

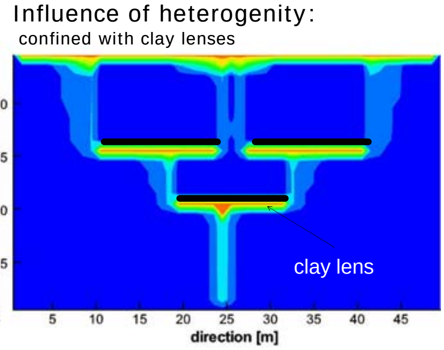

*Fig. 3: gas saturation of CO_2 in an aquifer with clay- lenses. After one year. Leakage rate: 3.6*10^-1kg/d.*

Influence of time and leakege rates :

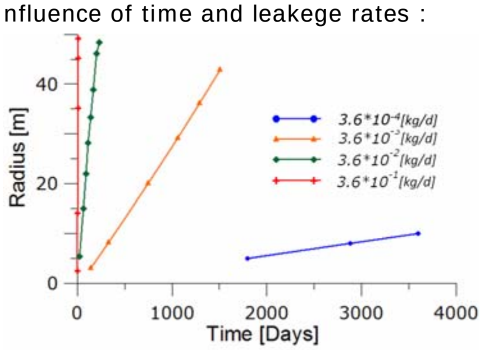

Fig. 3: Changing in phase body radius over time for different leakags rates in an confined aquifer. Legkage rates from a literature value range.

Conclusions:

- In unconfined aquifers the phase body remains small, because CO_2 degases from the aquifer.
- In confined aquifers CO_2 accumulates under the overlying layer causing a larger phase body.
- In heterogenieous aquifers with impermeable clay lenses, the CO_2 phase body can become clearly larger by spreading, as compared to heterogenieous aquifers.
- Heterogeneities, as found in natural systems, lead to enhanced phase spreading and enhanced CO_2 dissolution due to increase surface ot the CO_2 Phase.
- Leakage rates and leakage time depends the spreading of the accumulated gas pool.

=> Confined, heterogeneous aquifers and high leakage rates courses CO_2 gas spreading and lead to better delectability

=> Unconfined, homogeneous aquifers and small leakage rates result in only small CO2 affected areas, which increases the monitoring effort.

Outlock:

- More detailed investigation of the influence of leakage rates with longer simulation time and larger model set ups.
- Construction of realistic heterogeneous aquifer structures depending on geological environment for multiphase flow scenarios.
- Combination of physical and chemical processes in 3D scenarios, to develop and test monitoring strategies.

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GEOTECHNOLOGIEN

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