

**Venice Open Forum 2009**  
**Interactive panel discussions – future developments**



**3. Research**

*CO2GeoNet expert: Franz May*

*Panellists: Jeroen Schuppers (EC), Ludwig Stroink (Geotechnologien), Malcolm Wilson (Univ. of Regina), Robert Finley (Illinois State Geol Survey)*

see accompanying pdf file 'Research'

Franz May proposes two questions and his opinion to initiate discussions:

- Do we know enough to guarantee safe storage in populated areas? – YES, because ...
- Do we know enough to propose CCS as an emission reduction option ready for wide-spread large-scale implementation? NO, because ...

The panellists are then given the floor and invited to comment on what they feel are important developments in Research

R Finley

- USEPA has proposed regulations for class VI installations, which include CO2 storage. These included 50-year post injection monitoring of the plume and other constraints that are worrying in terms of deployment.
- Hydrological recharge and studies to ensure that the saltwater present in saline aquifers will not be pushed into neighbouring potable aquifers due to CO2 injection.
- Regulators also demand pressure monitoring. Need to monitor pressure, but also respect the balance of how many boreholes to drill – potential leakage pathways. How do we measure pressure on a basin scale?

J Schuppers

- Is storage safe? – this is difficult to say with certainty. Unfortunately, uncertainty is a reality.
- BUT – we know the situation reasonably well and know enough to start on identified selected sites.
- Concerning future research needs, storage is an essential factor, but it has been, and is still, too often overlooked.
- Saline aquifers offer greatest potential – need regional characterization studies. The highest risk is during the initial injection stage when pressure is at its highest. With time, the pressure drops, trapping takes place and the risk decreases. But this is an unknown process that needs qualifying along with the timeframe. Need guidelines and well integrity. Good monitoring programme – find a good balance.

A call is due for 2010 – open in the summer. Possible calls under discussion include:

- site characterization to support large-scale demos
- site abandonment
- sub-sea storage and the environment.

All three opportunities are relevant to CO2GeoNet

L Stroink

Comments on gaps, and future research needs.

- Need more reliable capacity estimations – do not yet know if the existing figures are reliable yet. Need an atlas of capacity – and for this we need capacity estimates.
- Smart monitoring techniques + successful demos
- Matching laboratory activities and results with field results
- Geochemical reactions between reservoir rocks and seals
- Impure CO2 streams
- Predictive modelling – essential to have a benchmark for coupled THMC simulators through testing and matching models
- Quantification of leakage scenarios.



### 3. Research

#### M Wilson

##### Future research considerations

- How to move to larger scales and saline aquifers (where we have less existing knowledge than depleted O&G fields). Important to use natural and technical analogue data. Need to populate models with new data
- A considerable amount of valuable data is sitting within industry – we need this for efficient storage
- Resolve differences between laboratory and fieldwork
- How can we migrate from EOR to storage?
- Physical modelling of faults and systems with population of simulation models
- Safety condition of aged steel-cement systems
- Life cycle assessments

#### Question Time

- Pressure is the key uncertainty limiting storage capacity in aquifers. The main difference between depleted O&G reservoirs and saline aquifers is that the latter are full of large amounts of water. Need to monitor effects on a regional scale, not only at the injection point. Suggests calling upon water experts. May be the best way to find out whether injection works in such contexts is to do it on a large scale.
- Based on water-supply systems experience, it is possible to measure and monitor pressure by installing captors above the cap rock (?). This can be and is being done by hydrogeologists using a technique developed in the 1960s. Combine hydrogeological mapping with reservoir engineering mapping. The main uncertainty in fluid migration is the heterogeneity of the subsurface and the prediction of the number of wells required for aquifer injection.
- Consider storage in basalt. Uncertainty due to poorly known reaction kinetics. Necessity for coupled THMC simulations. Stress effects on well infrastructure. Microseismicity as a monitoring tool
- Pressure issue and build up – complicated geology in the subsurface (connectivity, dome, faults, etc.). It is important to manage pressure response. Relieved that we are finally incorporating the hydrogeology.
- Need to include geomechanics in studies at a higher level and an earlier stage
- Understanding of coupled geochemical-mechanical effects on fault properties. Detection of faults
- Impurities in CO<sub>2</sub> stream – experiments are expensive. Lack of data, it's a matter of tackling the issue with time
- Coupling of geomechanics and geochemistry – study fault location and geometry with respect to the injection well because mineralogy and reactions are influenced
- Based on natural gas storage experience, pressure measurements should be safe due to solubility and mineral trapping
- Problem of transport for CO<sub>2</sub> impurities: if greater than 7-8%, then it will be impossible to compress into liquid phase. Need to purify the stream because transport leads to an increase in impurities.
- 200 km of pipeline in N Sea (Newcastle study?), shown that impurities increase compression costs because the critical point is moved. Agrees that transportation is the issue, not the impurities.
- Optimization of overburden monitoring in time and space



# Interactive Panel Discussion

## Future Research Developments

## Panel

**Robert Finley**

Director, Energy and Earth Resources Center,  
Illinois State Geological Survey

**Jeroen Schuppers**

Research Programme Officer, European Commission,  
Research Directorate General

**Ludwig Stroink**

Head of GEOTECHNOLOGIEN Coordination Office, Germany

**Malcolm Wilson**

Director, Office of Energy and Environment,  
University of Regina, Canada

**Franz May**

Deputy Network Manager, CO<sub>2</sub>GeoNet



## Plume Development and Basin-Scale Interactions

What happens when multiple injection sites are developed in a single geologic basin?

- Regulators are asking not just where is the CO<sub>2</sub> but where is the pressure front from the plume?
- Can multiple plumes affect hydrologic recharge in a basin and/or create pressure gradients that will mobilize brine into surrounding formations?
- What techniques need to be used/developed to address these issues? Modelling? Observations?



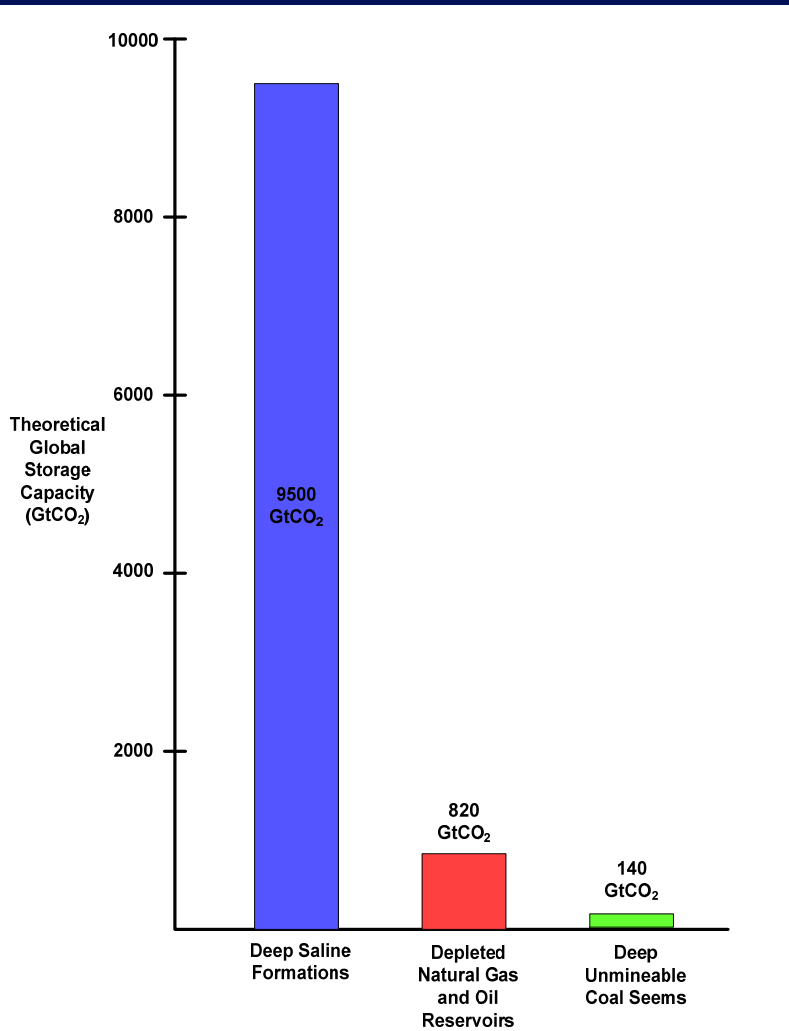


## Statement of J. Schuppers

### Research needs in geological storage

The key issue: storage site characterisation

- ✓ Focus on aquifers
- ✓ Best practice guidelines for site selection & operation



Source: The Global Energy Technology Strategy Program: Carbon Dioxide Capture and Geological Storage: A Core Element of a Global Technology Strategy to Address Climate Change, 2006

## Research needs in geological storage

### The key issue: storage site characterisation

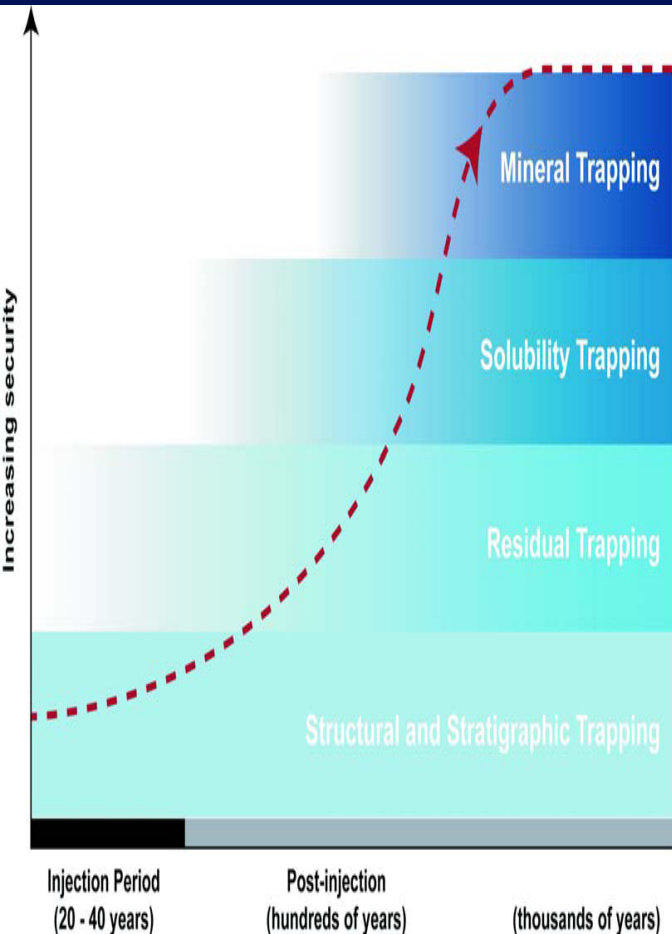
- ✓ Focus on aquifers
- ✓ Best practice guidelines for site selection & operation
- ✓ Timeframes and pathways of CO<sub>2</sub> migration
- ✓ Chemical interaction of CO<sub>2</sub> with formation

### Site abandonment

- ✓ Best practice guidelines; well-integrity

### Monitoring

- ✓ Low-flux seepage of CO<sub>2</sub> (incl. offshore)
- ✓ What should be the detection limit?
- ✓ Understanding induced seismicity



Do we know enough to guarantee safe demo projects in populated areas?

### Statement of F. May

Yes, because ...

- build upon a wide range of geotechnical experience
- full choice of best suited sites is still available
- support by research consortia providing extensive site characterization, safety assessment and monitoring programmes
- CCS directive prescribing many safety precautions
- natural CO<sub>2</sub> leakage is common but rarely a safety issue



# Future R&D Needs

Do we know enough to propose CCS as an emission reduction option ready for wide-spread large-scale implementation?

## Statement of F. May

No, because ...

- uncertain storage capacity due to aquifer storage interference
- no storage quality classification and requirements  
(acceptable leakage rates)
- uncertain prediction of regional fluid migration  
(up-scaling, fault properties)
- geomechanical effects of large storage volumes  
(fault reactivation, overburden deformation)

