CO_2 Capture Project

An Industrial Perspective on the Use of Models for Geological Sequestration of CO_2

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www.co2captureproject.org

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Models are used throughout all aspects of oil & gas industry operations

- Exploration
- Appraisal
- Production
- Facilities design
- Safety and environmental assessments

Many of the issues that face geological sequestration are the same or similar to issues facing the oil & gas industry

- Reservoir characterization
- Geomechanics
- Geochemistry
- Fluid flow

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A large number of modeling studies have already been done that have helped identify the issues and some of the solutions surrounding geological sequestration of CO_2.

The oil & gas industry funds many of these geological sequestration R&D programs, for example the CO_2 Capture Project.

The oil & gas industry has not endorsed specific standards for models or simulations as they relate to geological sequestration.

The CO_2 Capture Project Storage, Monitoring & Verification program demonstrates how modeling can fit into a geological sequestration program that is funded by the oil & gas industry.

This presentation is given from the perspective of the CO_2 Capture Project (CCP) Storage, Monitoring & Verification team and does not necessarily reflect the views of CCP member companies.

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CO_2 Capture Project (CCP)

An industry consortium with the goal of developing new technologies to

- Reduce the cost of capturing CO_2 from combustion sources
- Safely store captured CO_2 underground
- Reduce the impact of continued fossil energy use while cleaner energy sources are being developed

CCP Phase 1 ran from 2001 – 2004

CCP Phase 2 started in 2005 and will run through 2008

The Storage, Monitoring & Verification (SMV) program is one of 5 major activity areas that comprise the CCP2 work program.

SMV	Capture
Economics	Policies & Incentives
Communications	

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CCP1 – SMV Program (2001 – 2004)

The CCP1 – SMV program was comprised of more than 30 projects distributed over four technical themes

- ***Integrity*** of geological and engineered systems
- ***Optimization*** of processes and economic assets
- ***Monitoring*** for performance and leakage
- ***Risk assessment***

The CCP1 – SMV program defined

- Ground-breaking site assessment protocols
- Ways to optimize storage
- Cost-effective monitoring technologies
- A pioneering risk-based site assessment methodology

Instrumental in achieving some of these results were CCP1 funded modeling studies

- Reservoir
- Geochemical
- Geomechanical
- Leakage/seepage

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CCP2 – SMV Program (2005 – 2008)

Builds on the work of CCP1

Seeks to address critical topics where the need for further work was identified in the monitoring, verification, and risk assessment of CO_2 storage projects

- Ready potentially cost effective technologies for deployment
- Systematize site assessment and protocols
- Address emerging issues in CO_2 storage

Is comprised of a slate of projects designed to

- Develop key operational and monitoring strategies specific to coal beds
- Address CO_2 containment issues for wells and reservoir seals
- Develop a simplified tool for lifecycle monitoring and decommissioning schemes

Capitalizes on modeling studies to achieve program goals

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CCP2 – SMV Projects – Well Integrity

Objective is to initiate an integrated CO_2 wellbore integrity field study that will

- Address well survivability
- Identify potential solutions
- Make recommendations on well designs and materials of construction likely to survive CO_2 exposure
- Develop new approaches for remediation and intervention

The project addresses CO_2 containment for wells since this has become the premier containment issue in geological storage of CO_2

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CCP2 – SMV Projects – Well Integrity - Major Tasks

- Select field and well based on production history, records and operational status
- Characterize the well using logging tools
- Sample well fluids and rock
- Analyze fluids and solids to determine the extent of reactions and their impact on permeability and mechanical integrity
- Construct a 3D model of the well with subsequent history match
- Forward simulate fate of the well under a range of CO_2 exposure scenarios

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CCP2 – SMV Projects – Certification Framework

Objective is to provide a simplified tool for assessing the risk of leakage from a CO_2 storage project and for identifying the impacts of any leakage.

The project addresses certification, monitoring and decommissioning of CO_2 storage projects

- At present, site selection criteria, reservoir simulation approaches, and risk assessment methodologies are fragmented and vary in complexity
- The "Certification Framework" is a streamlined, life-cycle approach to project certification (pre-operation, operation, and decommissioning) aimed at meeting regulatory expectations

Project tasks involve a variety of models

Reservoir	Aquifer
Hydrogeologic	Geochemical
Geomechanical	Leakage
Flux	

Lawrence Berkeley/UT at Austin

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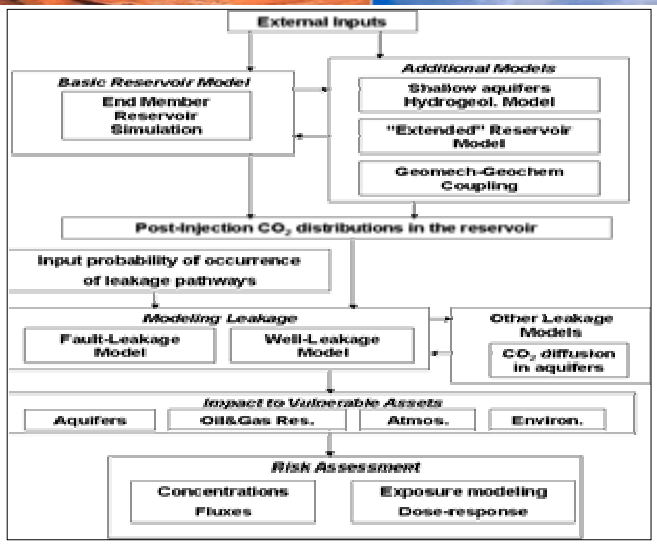
Certification Framework: Working Scheme



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CCP2 – SMV Projects – Operability of ECBM

Objective is to

- Better understand CO_2 and methane leakage from coal deposits during and after CO_2 injection
- Identify optimal operational parameters
  - Production rates
  - CO_2 injection rates
- Identify preferred geologic settings
  - Depth of target coal
  - Type of overburden

The project addresses operational issues related to sequestration in coal beds

- Coal bed methane recovery might be enhanced by CO_2 via desorption of methane and adsorption of CO_2.
- However, coal's low permeability and reactivity introduce injectivity and conformance complications.

Sproule Associates

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CCP2 – SMV Projects – Operability of ECBM – Major Tasks

Construct a basic simulation model using geological and engineering data from the Blue Creek field in Alabama

Conduct basic simulations to identify key model inputs

Develop refined geologic models including characterization of roof rock and overlying strata

Run long term simulations modeling different injection/production strategies

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CCP2 – SMV Projects – Novel Geophysical Monitoring of ECBM Performance and Leakage

Objective is to evaluate non-seismic (gravity and electromagnetic) geophysical methods as lower cost alternatives to seismic methods for monitoring CO_2 injection into coal beds

- Spatial resolution of the methods will be compared
- CO_2 levels predicted from data inversion for the three methods will be compared

The project addresses developing monitoring strategies specific to coal beds

- Lower cost monitoring tools may be particularly important for lower margin operations such as CO_2 ECBM
- An analysis of the cost of gravity and electromagnetic surveys needed for monitoring showed them to be ten times less expensive than conventional 3D seismic surveys
- These costs are often cited as "trivial" when expressed in $/tonne avoided. However, these costs aren't trivial to planners as most of the costs are pre- and early-operational

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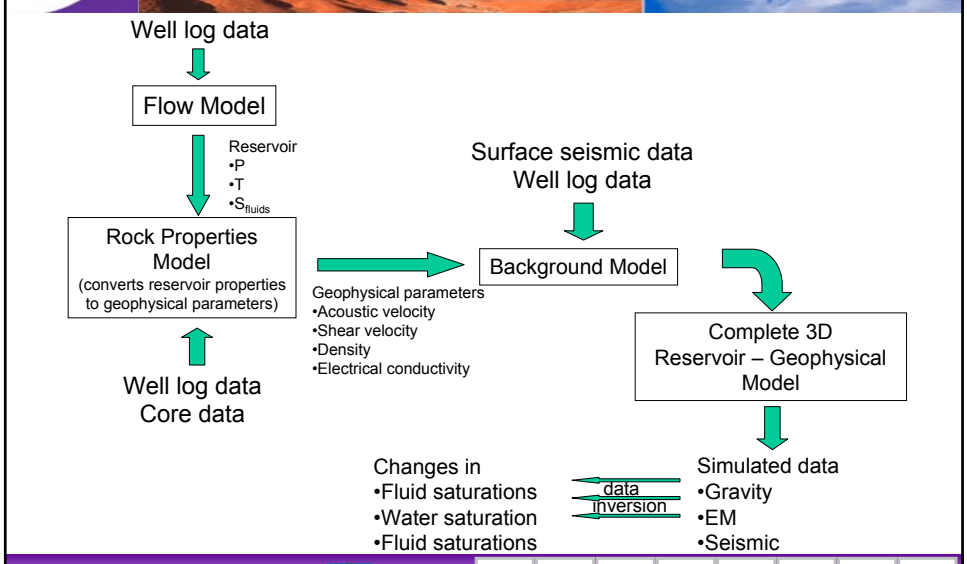

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CCP2 – SMV Projects – Coupled Geochemical – Geomechanical Simulation

Objective is to determine the extent to which permeability enhancements resulting from geomechanical effects due to CO_2 injection will be offset by geochemical reactions between CO_2 and formation minerals

The project addresses CO_2 containment issues resulting from pressure increases accompanying injection of CO_2 into a reservoir. These pressure increases can fracture reservoir rock or breach cap rocks.

The approach is to develop coupled geochemical and geomechanical modeling capabilities.

U of Bergen

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Conclusions

The CCP recognizes that modeling can be a powerful tool for the development of geological sequestration of CO_2

Important steps in the further development of these tools for application to geological sequestration of CO_2 will be the

- Integration of models with different capabilities
- Development of models that are both easy to understand and apply

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