Update on the IEA GHG Weyburn-Midale CO_2 Monitoring and Storage Project and PTRC's New Aquistore Project

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IEA GHG Weyburn – Midale
CO_2 Monitoring & Storage Project

IEA GHG
WEYBURN-MIDALE
CO_2 MONITORING
AND STORAGE PROJECT

"The Weyburn-Midale Project will provide policymakers, the energy industry and the general public with reliable information about industrial carbon sequestration and enhanced oil recovery."

- Samuel Bodman, Secretary of Energy, USA

Review: Weyburn-Midale CO_2 Storage Project

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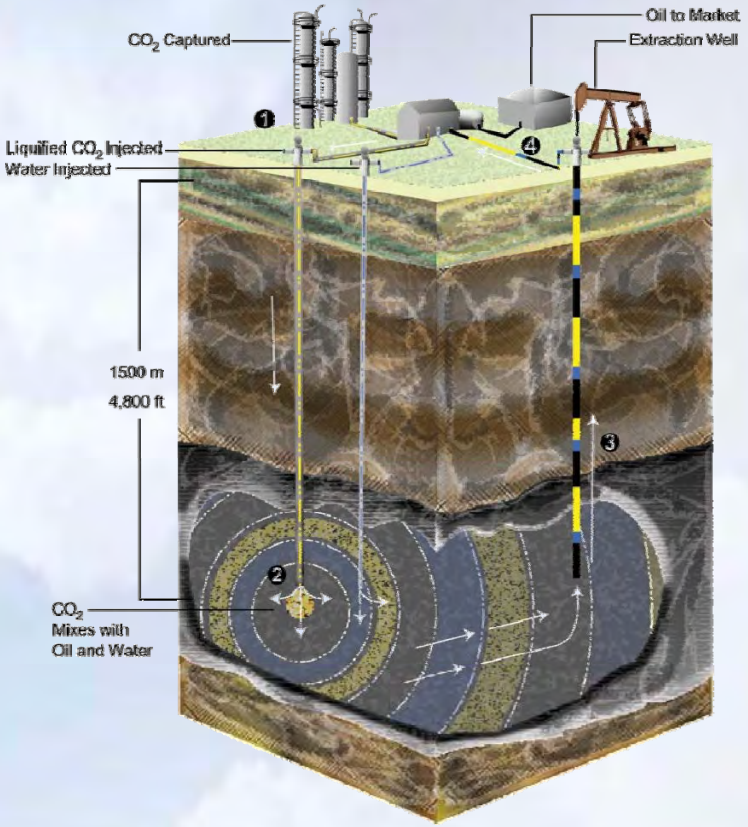
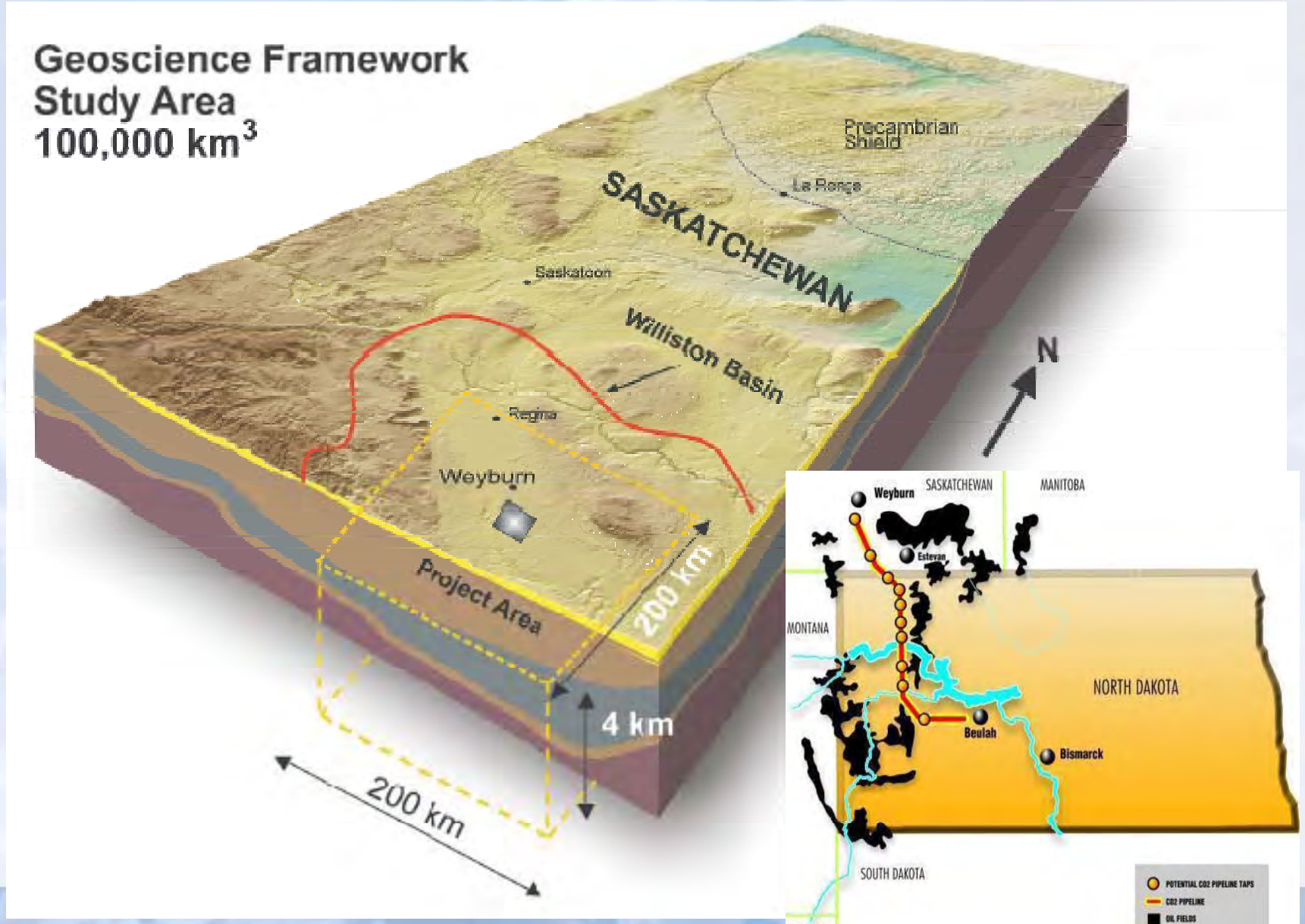
The world's largest full-scale, field study of CO_2 storage associated with commercial EOR operations

- $80 million project
- Currently in Final Phase, ending 2011
- 12 million tonnes of CO_2 injected to-date
  - 10 million Weyburn
  - 2 million Midale
- 40 million tonnes stored by 2035
- > 20,000 incremental bbl/day



Where is the CO_2 from? Where is it stored?



Courtesy © Geological Survey of Canada

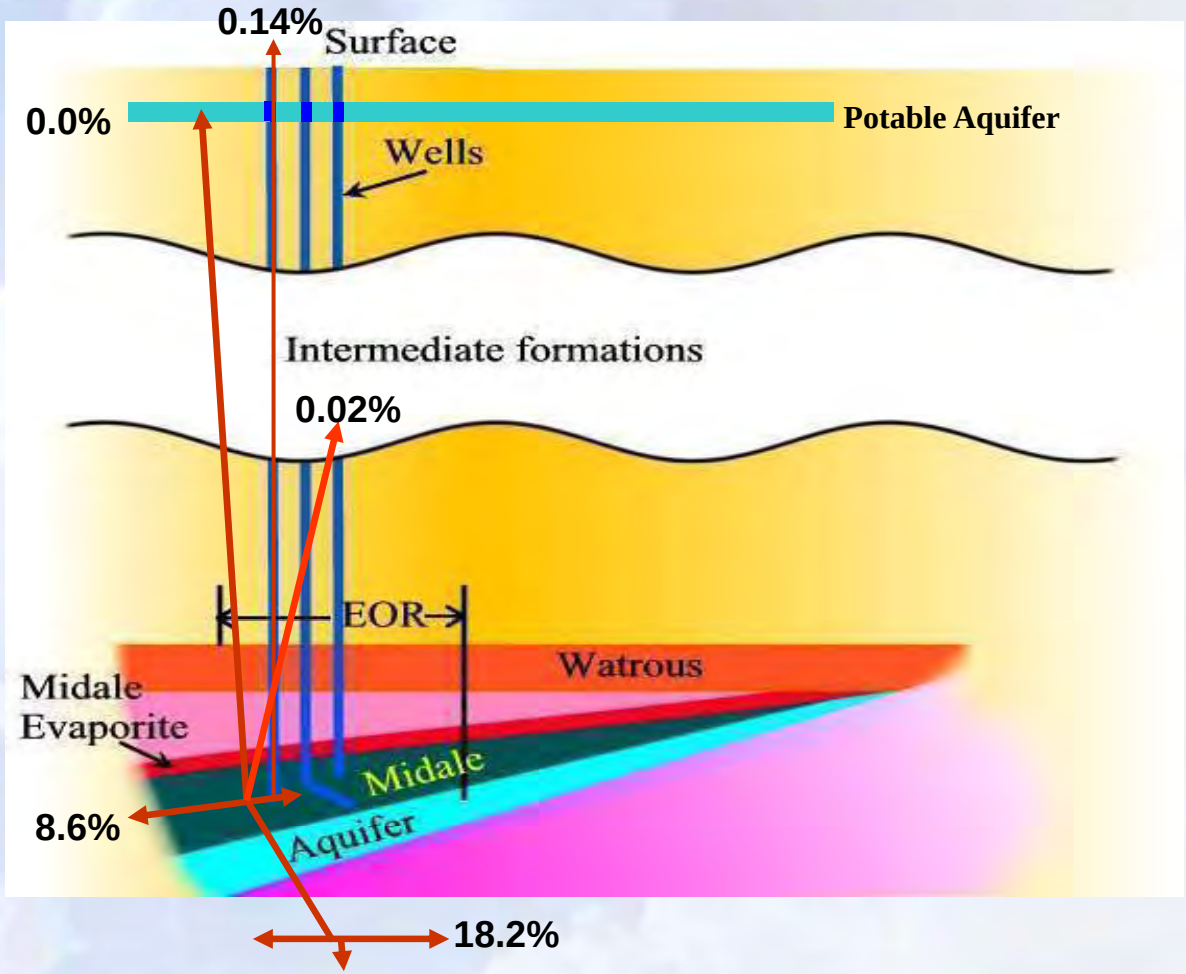
Phase One Results

Geological "container" at Weyburn is effective:

- Primary carbonate and secondary shale seals are highly competent
- Hydraulic separation between adjacent aquifers

Initial results indicate over 98% of the initial CO_2 in place will remain stored for hundreds years:

- Further work is required
- Develop risk management practices



Update: Final Phase (2005-2011) *Objectives*

Best Practices Manual

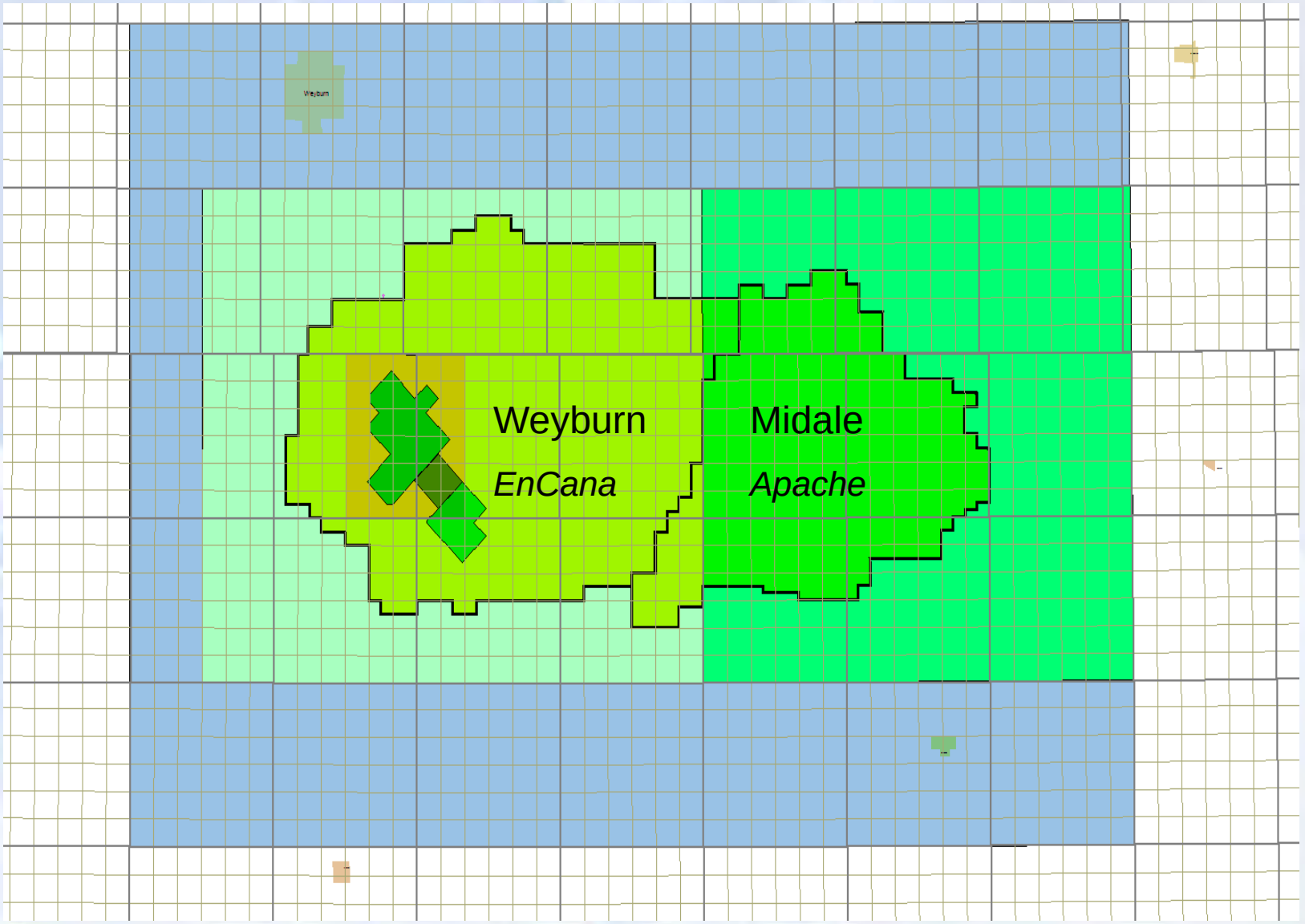
- Guide all aspects of future CO_2 EOR-Storage projects
- Ensure integration across Technical and Policy Research

Technical Components ⟷ **Policy Components**

- Site Characterization
- Monitoring and Verification
- Wellbore Integrity
- Performance Assessment

- Regulatory Issues
- Public Communication and Outreach
- Fiscal Policy Issues

Weyburn & Midale Fields



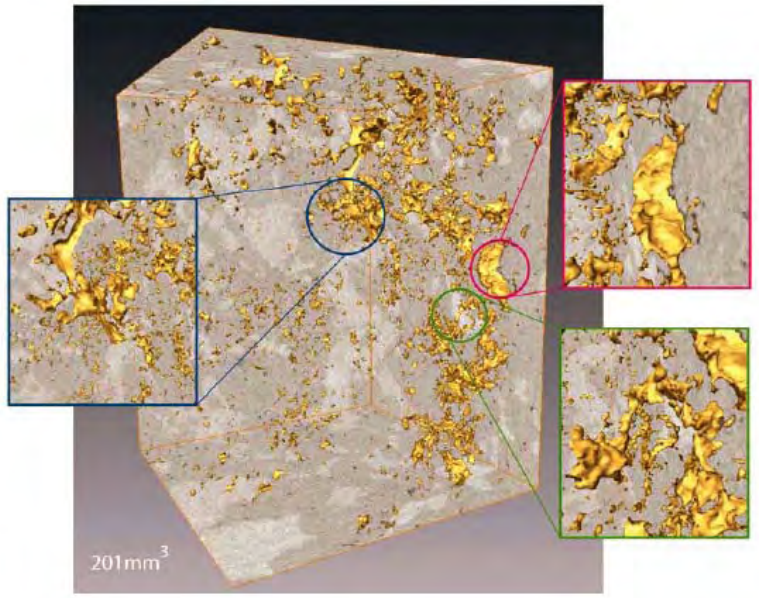
Review: Weyburn & Midale Statistics

	Weyburn (EnCana)	Midale (Apache)
Field Size	70 square miles	40 square miles
Original oil in place	1.4 billion barrels	515 million barrels
Oil recovery (pre-CO_2-EOR)	370 millions barrels	154 million barrels
Projected CO_2 IOR	155 million barrels	67 million barrels
Projected CO_2 stored	30+ million tonnes* (gross) 26+ million tonnes (net)	10+ million tonnes* (gross) 8.5+ million tonnes (net)

***equivalent to removing <u>more than 8 million cars</u> off the road for a year**

Final Phase Technical Program

- ***Currently about 33 tasks that have been reviewed and initiated under the four major Technical Themes***
  - **Geological Integrity**
  - **Wellbore Integrity**
  - **Monitoring**
    - **Geophysical**
    - **Geochemical**
  - **Risk Assessment**



Synchrotron analyses of pore spaces and mineralogy in Midale Vuggy

- ***As project progresses additional data requirements and tasks may be identified.***
- ***PRISM meeting in December***

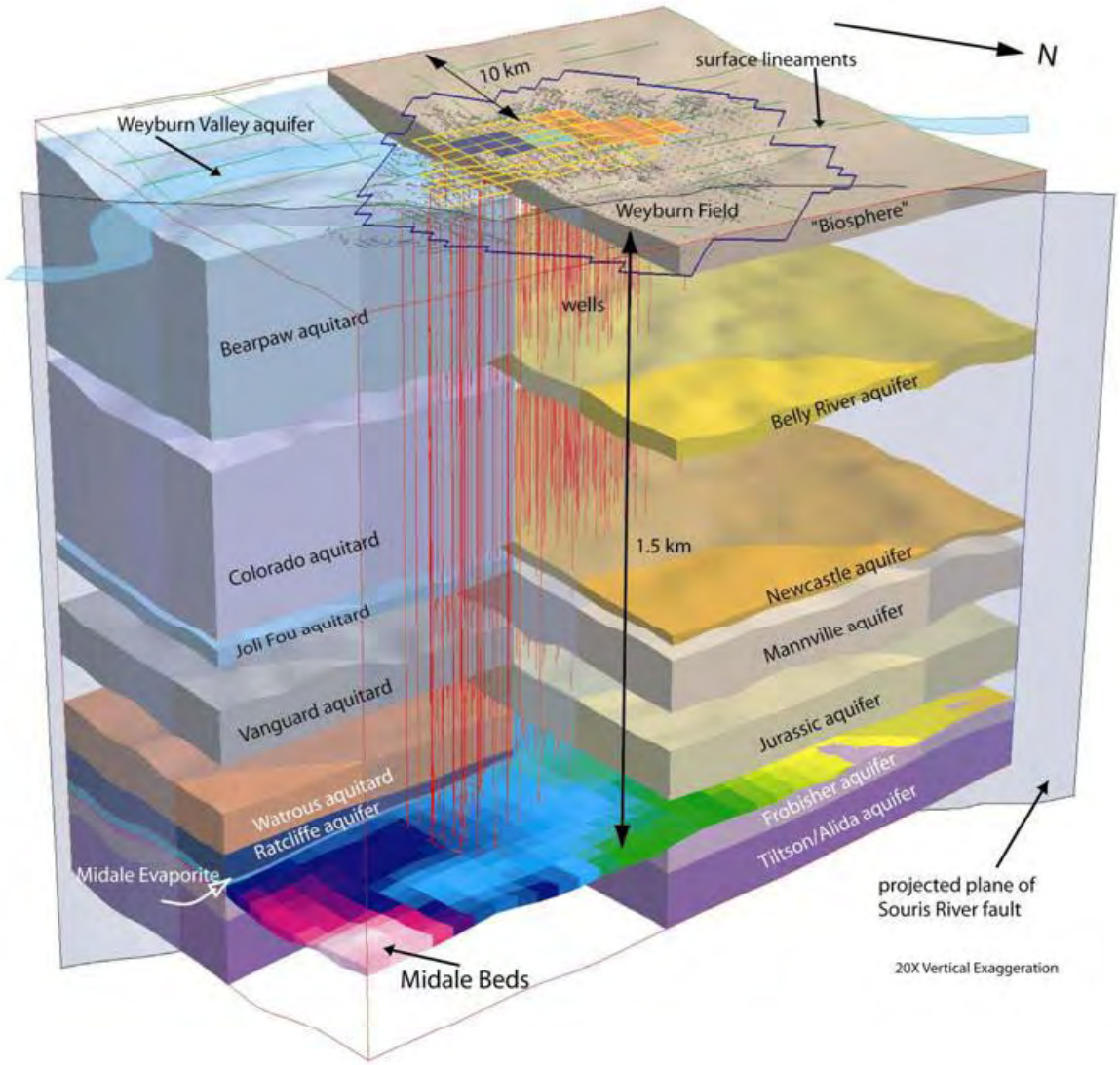
Geological Model

Geological architecture of system

Geocellular model

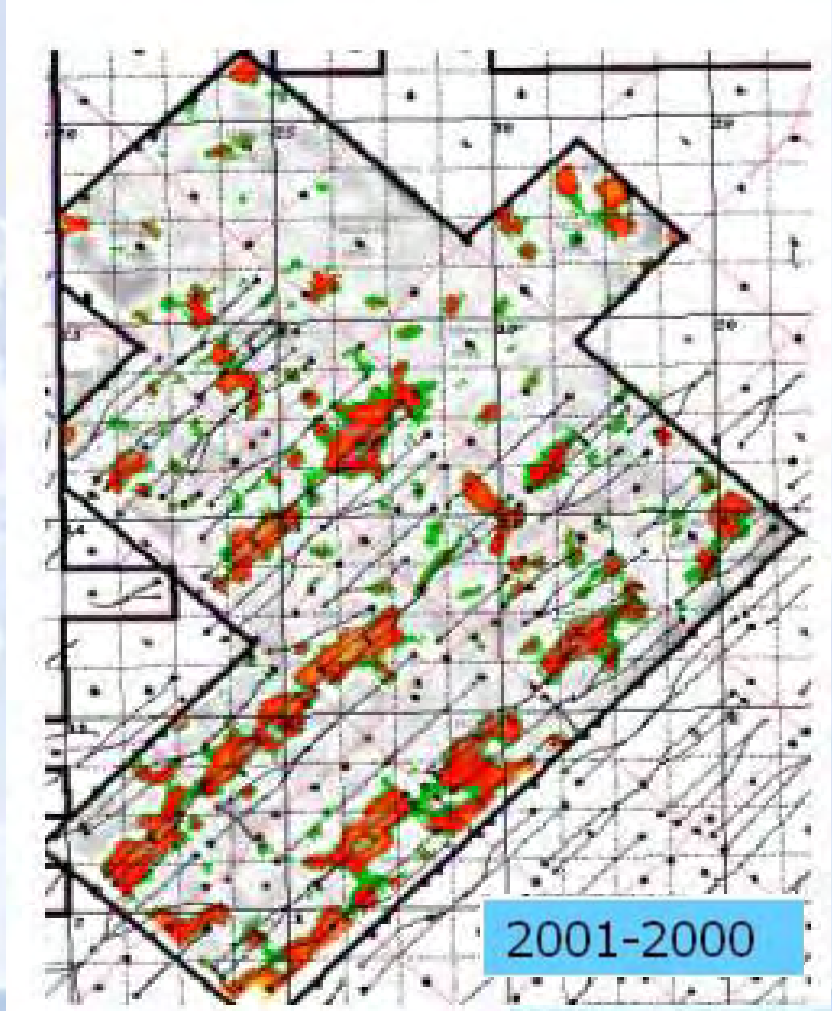
- lithology
- hydrogeological characteristics
- Faults
- Well bores

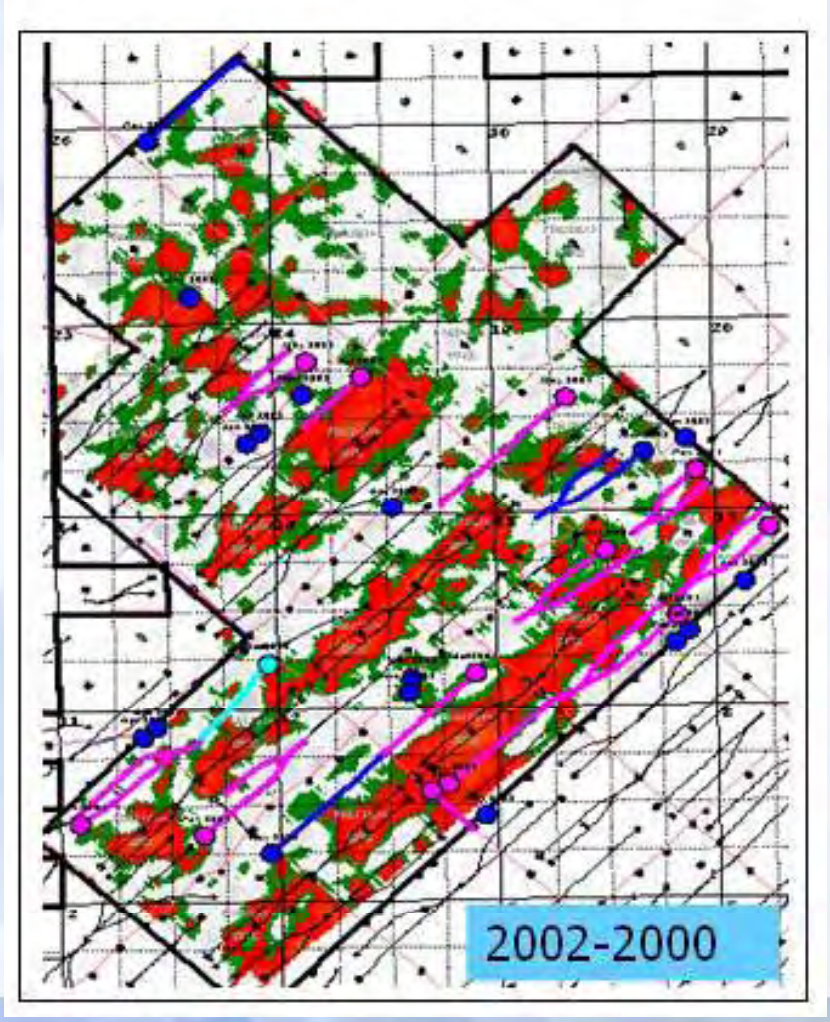
Can be tailored for different RA methods and scenario analyses



Tracking CO_2 Movement: Seismic Surveys (Baseline to 2002)- Phase 1

Monitoring continued in Phase 2





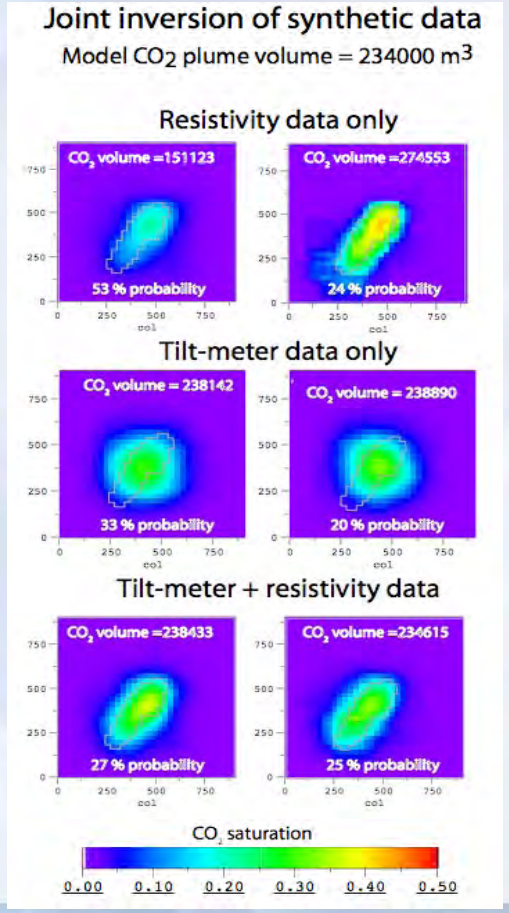
EnCana Corporation; Geological Survey of Canada

Theme 3: Storage Monitoring Methods

Forward Tuned Stochastic Modeling

- Improved Site Characterization and Storage Prediction through Stochastic Inversion of Time-Lapse Geophysical and Geochemical Data.

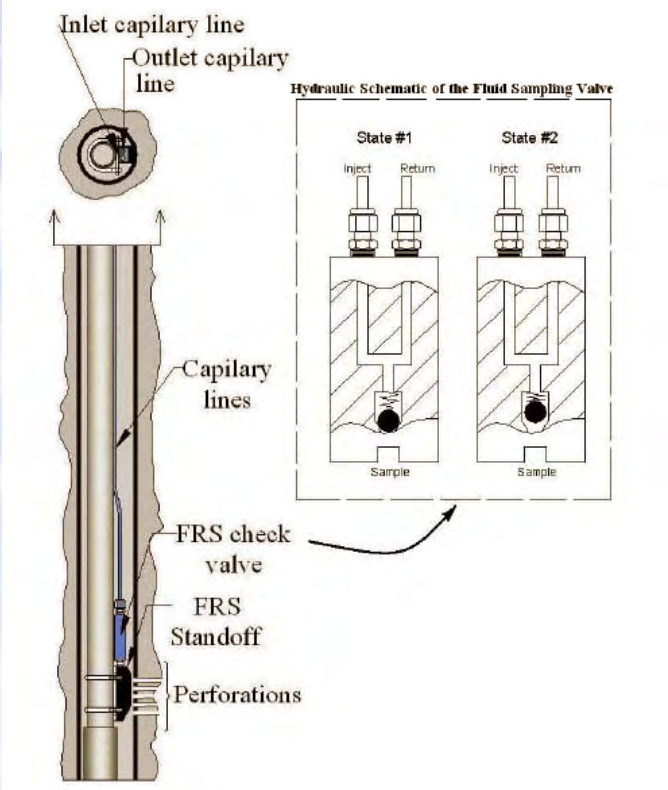
- Develop and Demonstrate a new stochastic modeling technique that will improve site characterization and dependant predictions of CO_2 storage performance at Weyburn
- Utilizes 4D seismic reflection and fluid chemistry data collected during Phase I and the Final Phase.
- This work represents a truly novel and broadly integrative research, which is widely applicable.



Additional Projects

Three large Field-Based Demonstration Tasks

1. **Monitoring / Observation well** **1.8M**
2. **Well Integrity Field Testing Program** **1.3M**
3. **Permanent Seismic Sparse Array** **1.5M**



Smart Well Technology

- Drill dedicated well
- Geophones
- Pressure sensors
- Temperature sensors
- Fluid Recovery System
- Downhole pH measurement

Final Phase: Partners to Date

Industry Sponsors

- Apache
- EnCana
- Chevron
- OMV Austria
- Saudi Aramco
- SaskPower
- Schlumberger
- Shell
- DGC
- Nexen

$40 Million

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Government Sponsors

- Natural Resources Canada
- United States Dept. of Energy-National Energy Technology Lab
- IEA GHG R&D Programme
- Saskatchewan Ministry of Energy and Resources
- Alberta Energy Research Institute
- RITE (Research Institute of Innovative Technology for the Earth – Japan)

Research Organizations

- Alberta Research Council (ARC)
- Canadian Light Source – Synchrotron
- ECOMatters (ECOM)
- Geological Survey of Canada (GSC)
- Permedia Group
- Saskatchewan Research Council (SRC)
- Canada Capital Energy Corp.

- T.L. Watson & Associates
- University of Regina (U of R)
- University of Sask. (U of S)
- University of Alberta (U of A)
- University of Calgary (U of C)
- URS Canada Inc.
- Saskatchewan Geological Survey

- Fugro Seismic Imaging
- Lawrence Livermore National Laboratories
- Bluewave Resources

- University of Bristol UK
- IEA GHG R&D Programme

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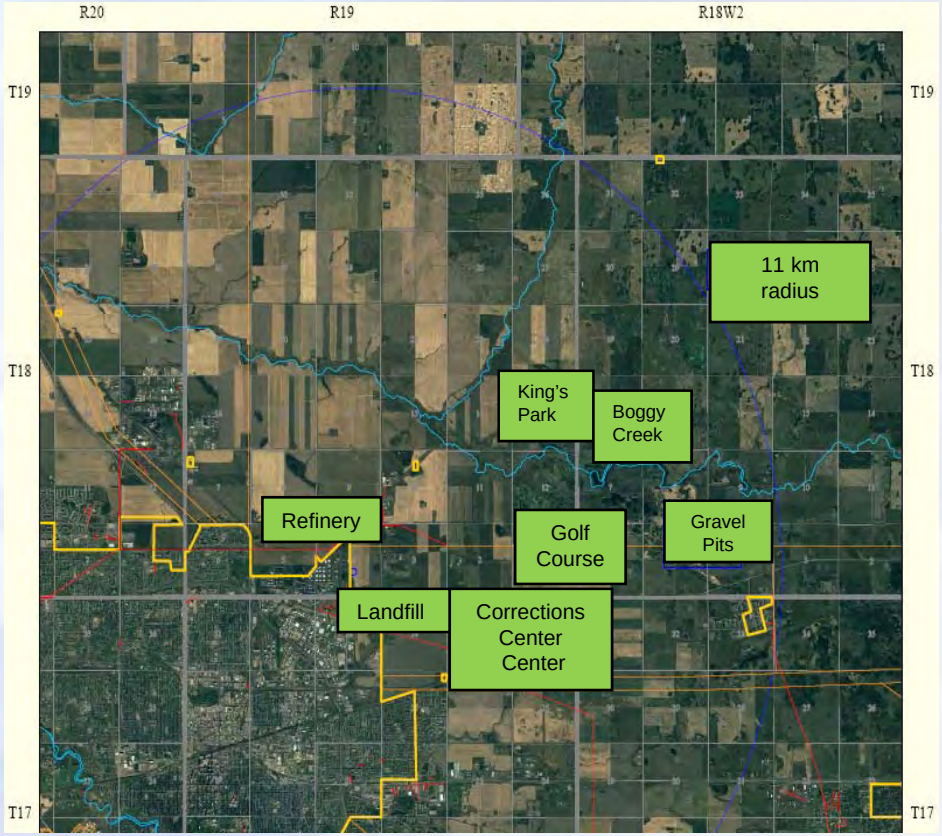
Deep Saline Aquifer Project

AQUISTORE Project

- *5 year, $100 million project, July 2008 to July 2013.*
- *500 tonnes/day of CO_2 captured from Consumers' Co-operative Refineries Limited.*
- *Transported by pipeline from upgrader to injection site.*
- *CO_2 injected into a suitable deep saline aquifer.*
- *Comprehensive Measurement, Monitoring and Verification Program.*



AQUISTORE: Work Plan

Task 1 Site Selection

Task 2 Geological and Hydrogeological Detailed Site Characterization

Task 3 Seismic Monitoring and Site Characterization

Task 4 Groundwater Sampling and Analysis

Task 5 Fluid Sampling and Analysis

Task 6 Aquifer Mineralogy

Task 7 Monitoring Wells

Task 8 Reactive Transport Numerical Simulations

Task 9 Risk Assessment and Risk Management Framework

Task 10 Commercialization/ Economic Analysis

Project Partners

Aquistore is a joint collaborative research project between governments and industry.

- **100 million dollar project**
- SDTC (5 million in funding announced, July 2008)
- ecoETI (application submitted)
- Saskatchewan Ministry of Environment (5 million in funding, November 2008)
- SaskEnergy (MOU)
- Canadian Co-op Refinery Limited (MOU)
- Schlumberger (MOU)
- Enbridge (MOU)
- Additional sponsors being sought

AQUISTORE

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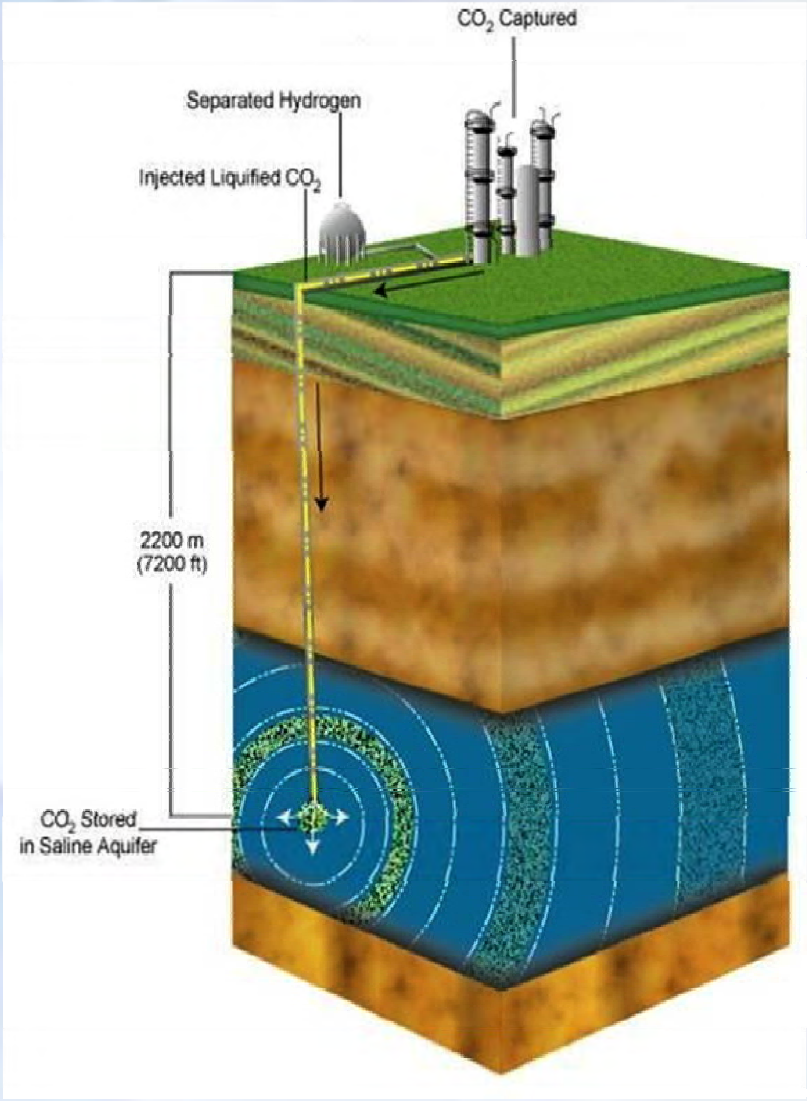
Objectives

- Demonstrate CO_2 deep saline aquifer storage is a safe, workable solution for emissions reductions.

- Develop a transportable, integrated suite of technologies for carbon storage in a saline aquifer.

- Establish an environment for creating:
  - linkages between financial institutions developing domestic trading schemes;
  - regulators designing an appropriate regulatory environment
  - Industrial commercialization, and
  - public acceptance



AQUISTORE: Conclusions

Leading Canadian project in terms of:

- Large CO_2 point source confirmed
- Experienced and integrated research team engaged
- Comprehensive, single phase work program defined
- Experienced pipeline, compression and well operators
- Feasibility evaluation complete
- Seed funding approved

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Thank You

AQUISTORE

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Enhanced Oil Recovery Projects

IEA GHG Weyburn-Midale CO_2 Monitoring and Storage Project

JIVE

JOINT IMPLEMENTATION VAPOUR EXTRACTION

SOLVE

Oil Sands Solvent Co-Injection Project