Understanding the Risks Associated with CO_2 Geological Storage: Weyburn CO_2 Monitoring Project

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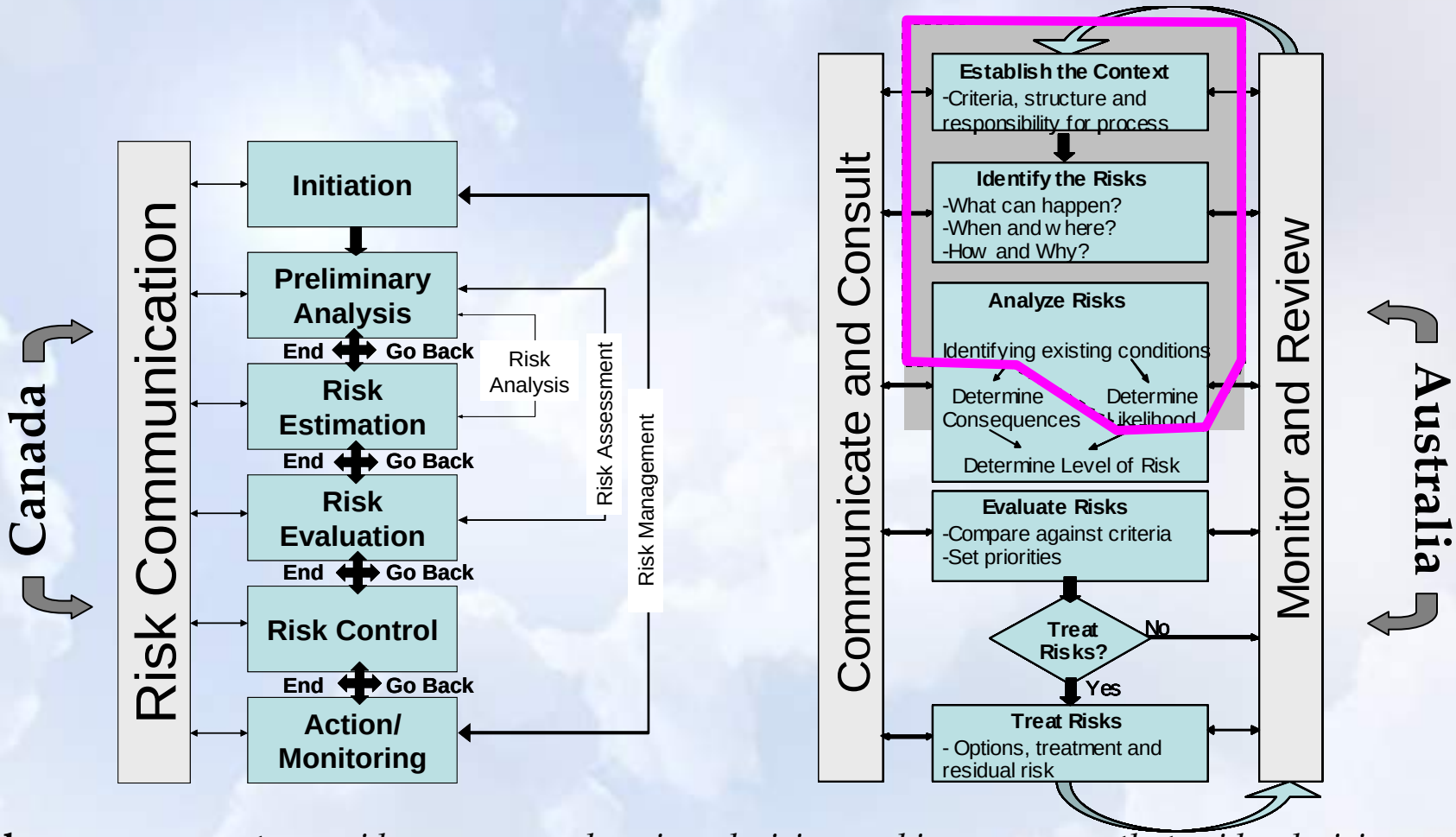
IEA GHG
WEYBURN-MIDALE
CO_2 MONITORING
AND STORAGE PROJECT

Risk Management Processes



Risk management *provides a comprehensive decision-making process that aids decision-makers in identifying, analyzing, evaluating and controlling all types of risks, including risks to health and safety. The objective of risk management is to ensure that significant risks are identified and that appropriate action is taken to minimize these risks*

Objectives of Phase 1 Risk Assessment Activities

- Apply risk assessment techniques to predict the long term fate of CO_2 within the storage system
  - Identify risks associated with geologic storage
  - Assess ability of oil reservoirs to securely store CO_2 (where CO_2 might escape from the reservoir)

These first two bullet points define a PERFORMANCE ASSESSMENT!

- Derive how much CO_2 is stored in the Weyburn reservoir as a function of time
- Explore consequences of any leakage
- Provide assessment results primarily in terms of flux of CO_2 from the geosphere as function of time

Risk Assessment Methodology

- FEPs (Features, Events and Processes)
- Systems Analysis
- Scenario Development
  - Base Scenario
  - Alternative Scenarios
- Deterministic Risk Assessment provides an estimate of risk associated with a specific set of parameter values
- Probabilistic Risk Assessment provides risk distribution attributed to the uncertainty in all parameter values.

Features, Events and Processes

Quintessa CO2 FEP Database - Microsoft Internet Explorer

Main Index
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Logout
(You are logged in as: P R Maul Change your password)

Database: Generic

◀ 20/202 ▶ Full list / External Factors / Climatic factors / Climate change, global

Suggest FEP improvement

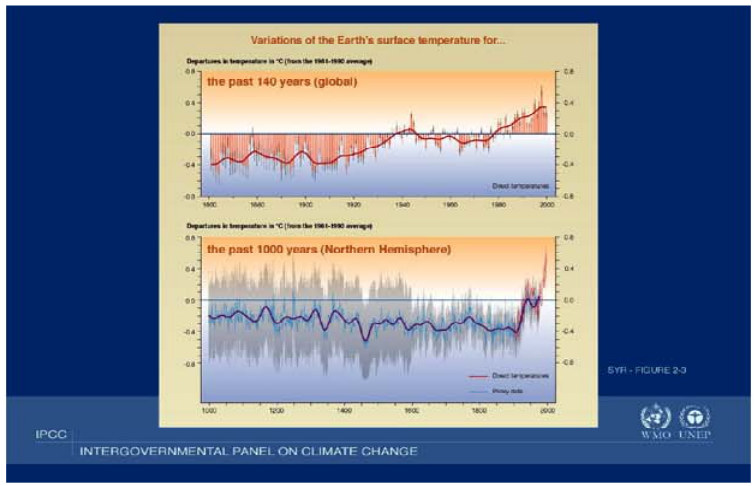
Name

1.2.1 Climate change, global

Description

The process of global climate change due to natural and/or anthropogenic causes. The last two million years of the Quaternary have been characterised by glacial/interglacial cycling. According to the Milankovitch Theory, the Quaternary glacial/interglacial cycles are caused by long-term changes in seasonal and latitudinal distribution of incoming solar radiation which are due to the periodic variations of the Earth's orbit about the Sun (Milankovitch cycles).

Evidence suggests that the Earth is presently in a period of global warming (see the figure below). The anthropogenic release of gases into the atmosphere may be increasing the rate of global warming by enhancing the natural 'greenhouse effect', a process by which longwave radiation emitted from the Earth is trapped in the atmosphere by 'greenhouse gases' such as CO2.



Original image: IPCC website

Relevance to performance and safety

Changes in the global climate are likely to impact the CO2 sequestration system in a number of ways. For example, through it's affect on sea levels and the local and regional climate.

References

1. Houghton J T, Ding Y, Griggs D J, Noguer M, van der Linden P J and Xiaosu D (Eds.). (2001). Climate Change 2001: The Scientific Basis. Cambridge University Press

Links

1. Intergovernmental Panel on Climate Change (IPCC)
2. The Hadley Centre
3. Graph of global temperature change, 1861-2000 and 1000-2000

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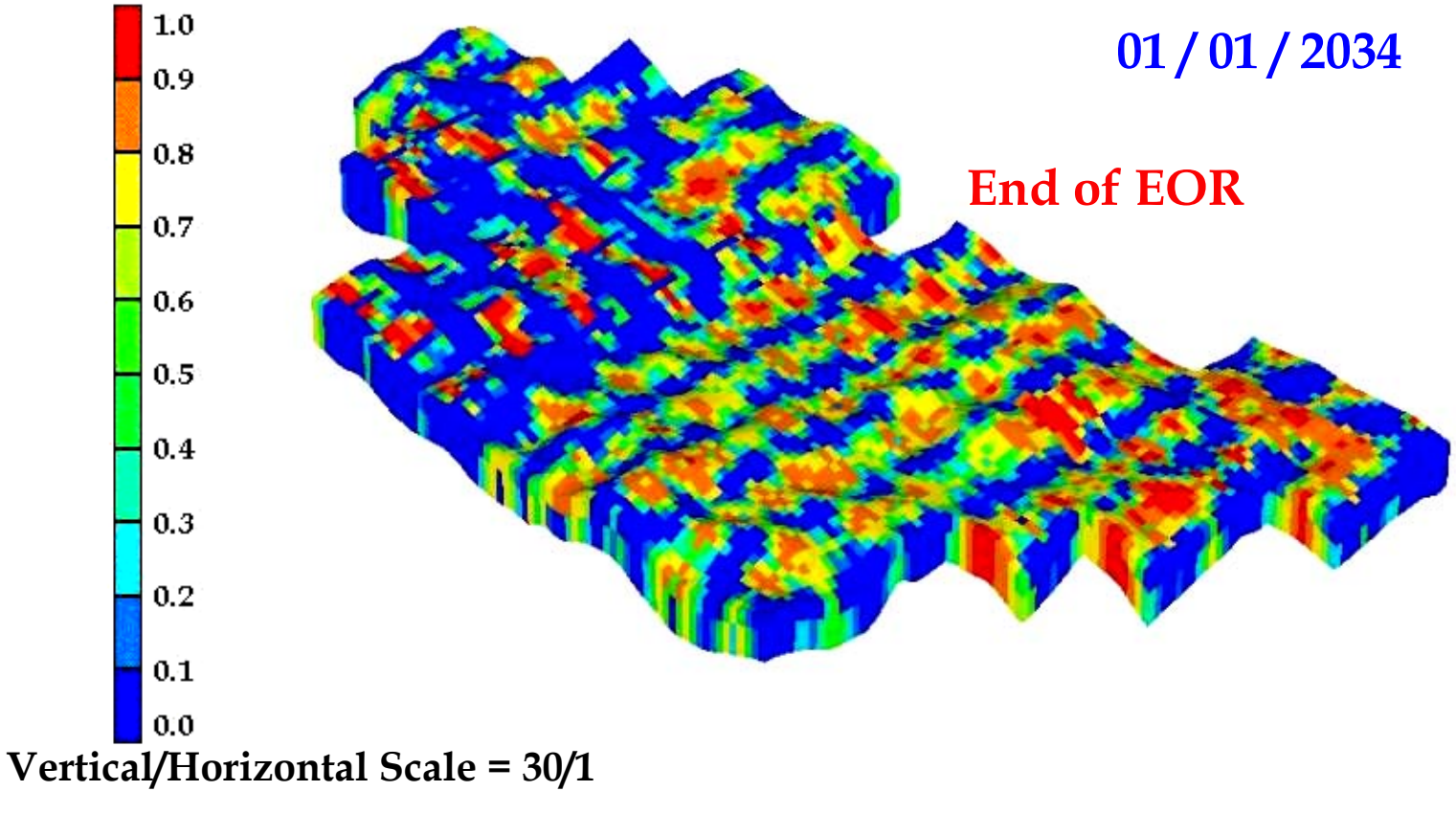
Alternative Scenarios

Engineering options for EOR
Reservoir operation options
Well abandonment options
Impact of salt dissolution

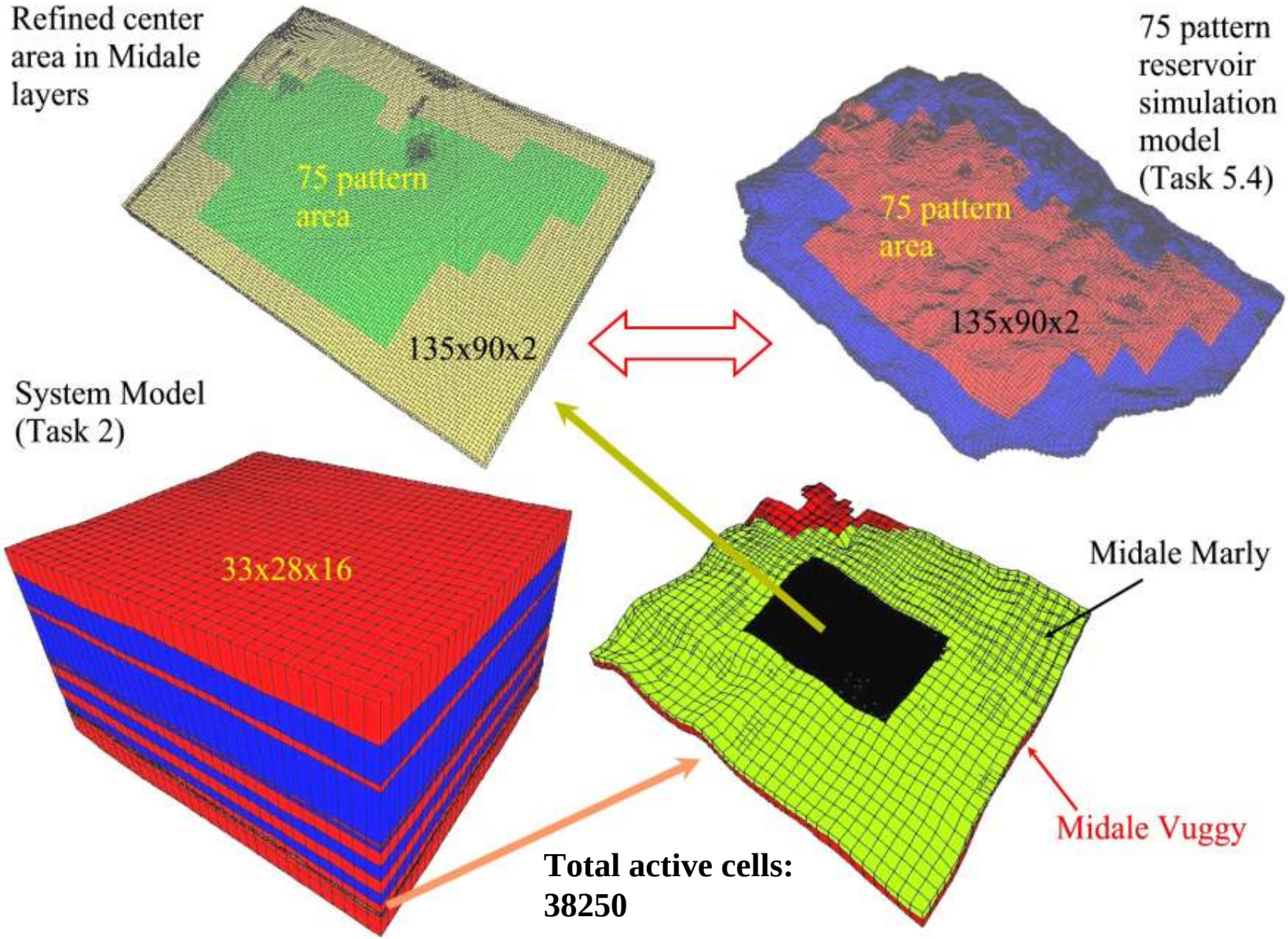
Fault activation/re-activation
Tectonic activity
Human intrusion

Alternative Scenario Name	Unique characteristics
Engineering options for EOR (a) Maximize CO_2 storage (b) Water flush at the end of EOR	Option (a) involves larger reservoir pressures; over-pressurisation and caprock fractures are possible problems. Option (b) would result in changes to CO_2 distributions in the reservoir and could also decrease CO_2 storage
Well abandonment options	Emphasis on improved long-term sealing capabilities
Salt dissolution of underlying formations	Dissolution and subsidence may lead to development of fractures
Leaking wells	Involves extreme failures only as the Base Scenario has 'normal' leakage
Fault movement or reactivation, including undetected faults	Could represent a new and fast CO_2 transport pathway; could affect several formations
Tectonic activity	Low probability but possible
Deliberate & accidental human intrusion (a) Destruction of surface casing (b) Resource extraction	Likely scenario involves intrusion into the reservoir in search for CO_2 or petroleum. Option (a) could affect the uppermost seal in one or more wells. Option (b) likely involves extraction of some shallower resource, but could lead to CO_2 blow-out from CO_2 trapped in formations above the reservoir

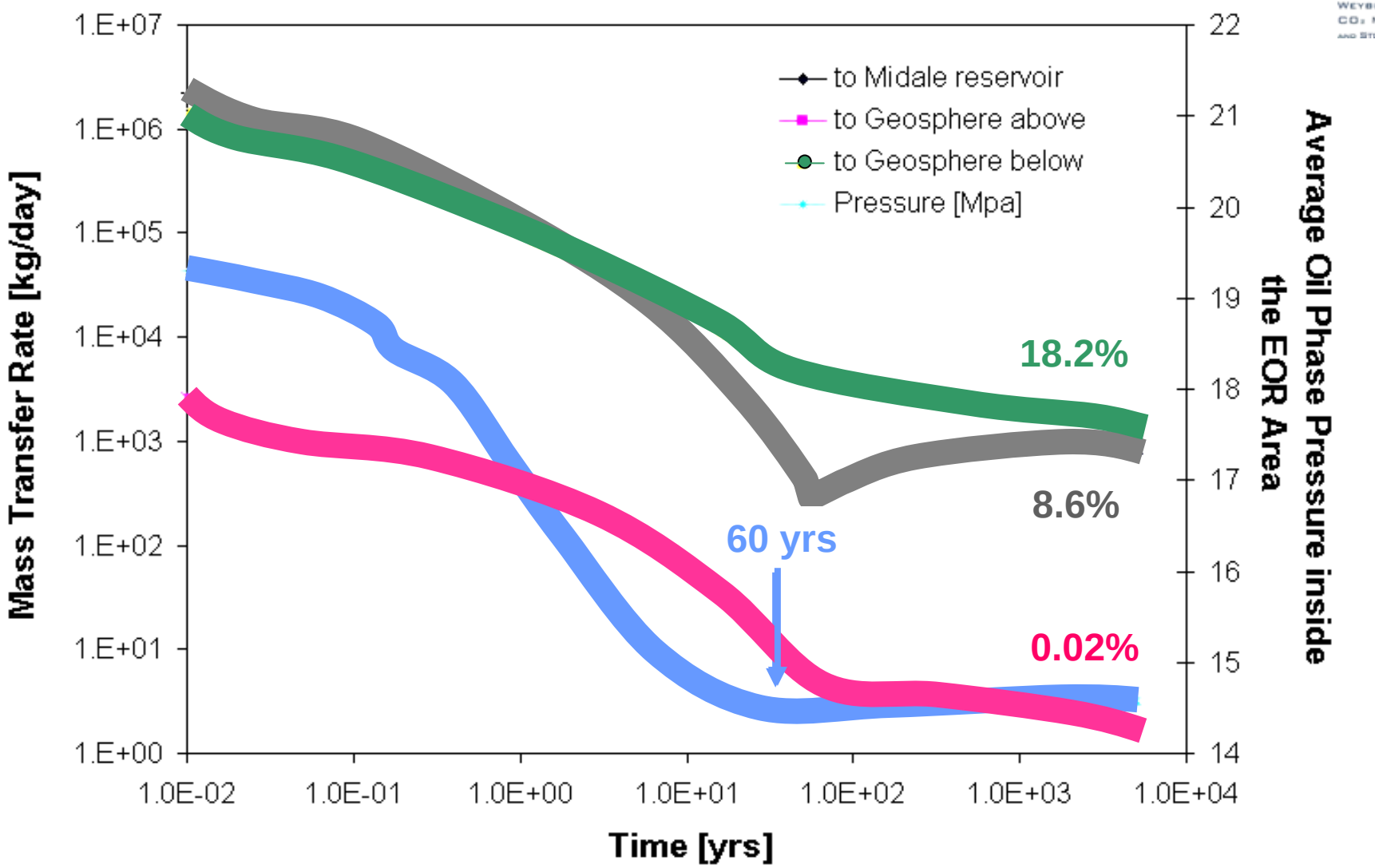
75-Pattern Simulation Model and Results



Geosphere Migration Model: Integration



CO_2 Migration within System Model



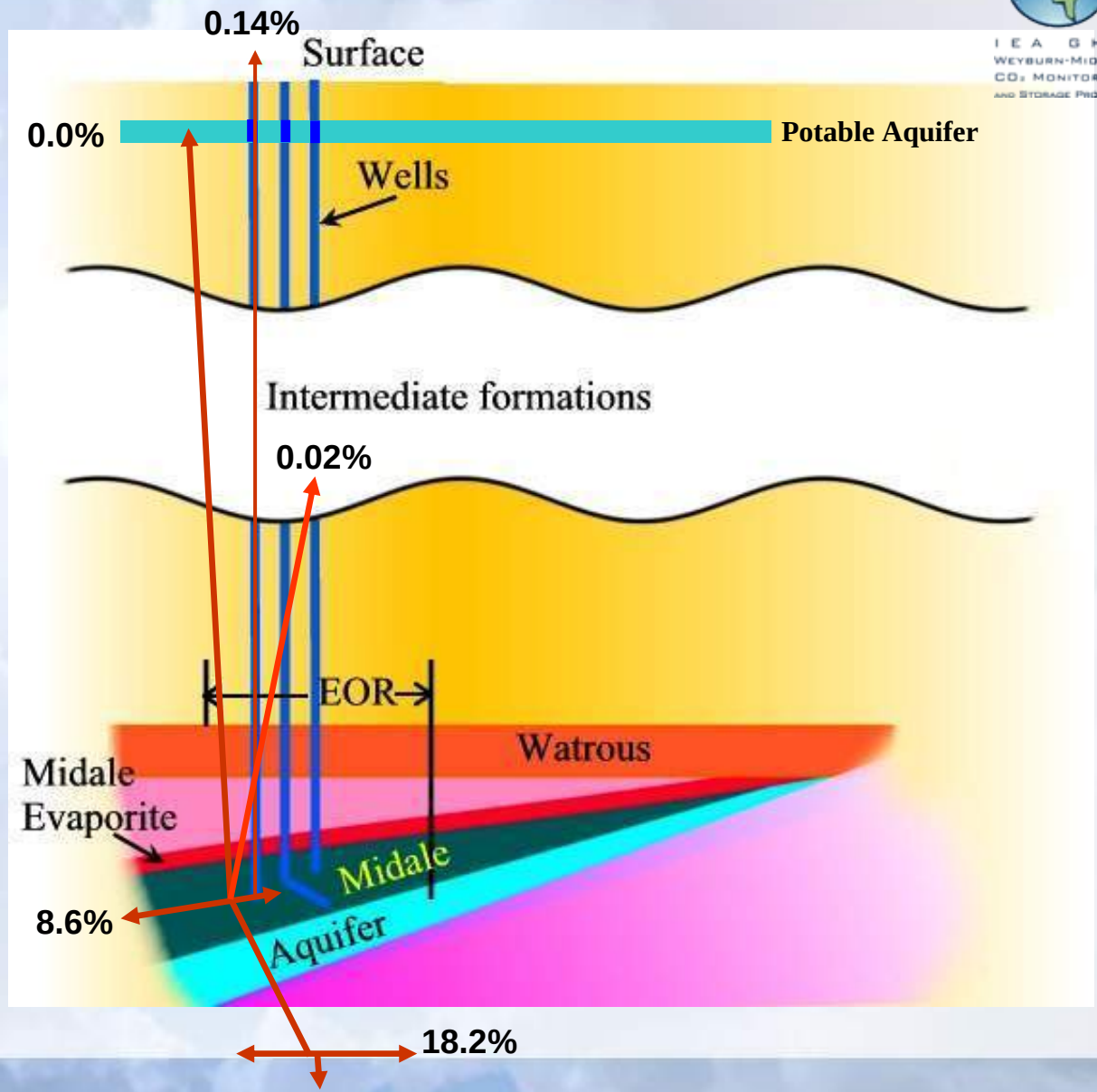
Summary of Phase 1 Results

Geological "container" at Weyburn is effective:

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

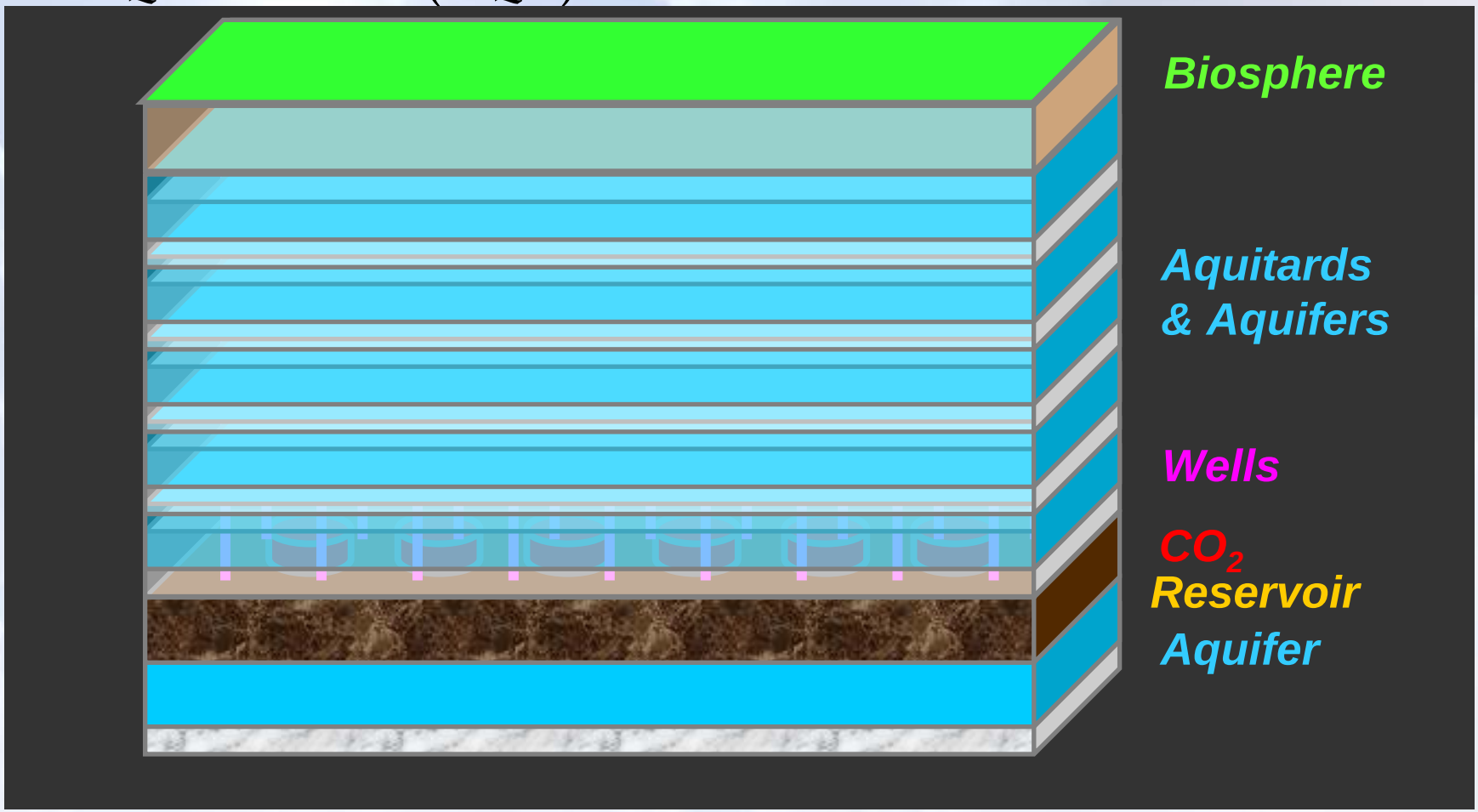
Migration of CO_2 outside the EOR area at 5000 years post-injection:

- 26.8% (7 million tonnes) moves outside the EOR area but remains within region

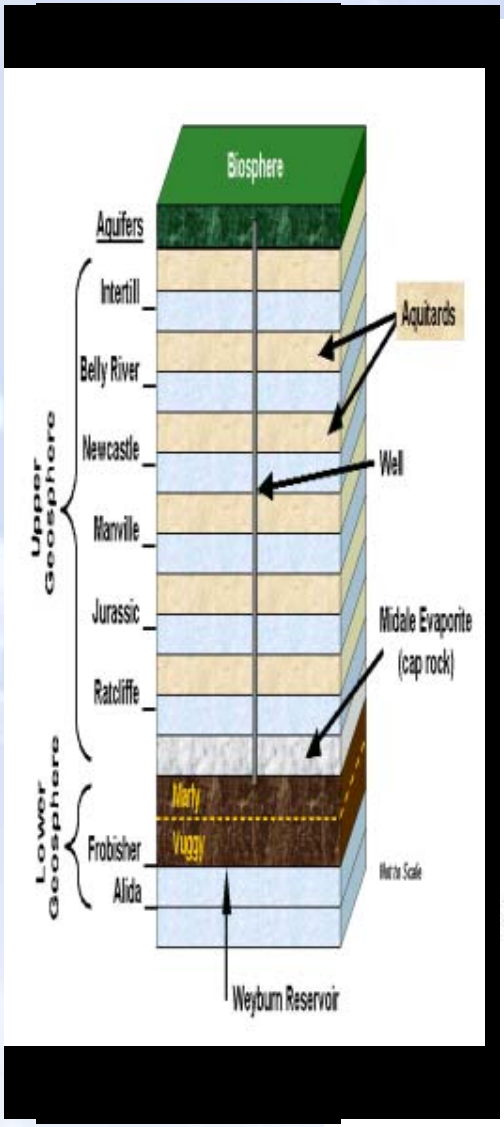


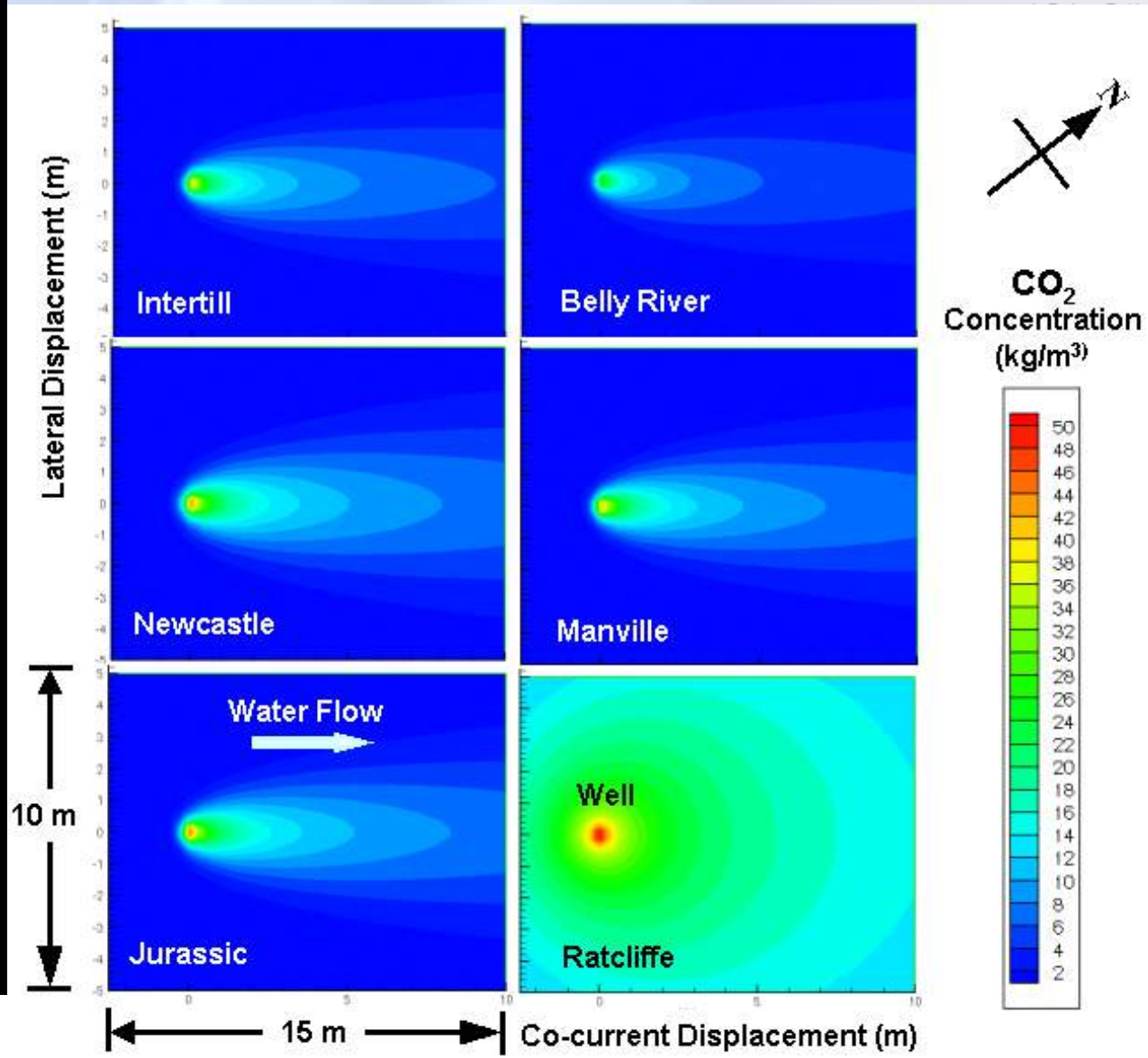
Probabilistic Approach

- A generalized performance assessment model, CQUESTRA-I (CQ-I)



PRA Demonstration Case Study





Final Phase Risk Assessment Activities

- Conduct peer review evaluation of the Base and Alternate Scenarios
- Update and refine the geosphere model
- Conduct a semi-quantitative risk assessment for Weyburn and Midale Project
- Use Experts and Stakeholders to provide opinions on likelihood and consequences of various impacts due to leakage at Weyburn
- Conduct a full-field Risk Assessment at Weyburn and Midale

*"All I'm saying is **NOW** is the time to develop the technology to deflect an asteroid"*