IEA Weyburn CO_2 Monitoring Project

The IEA Weyburn CO_2 Monitoring and Storage Project:

Geological and Hydrogeological Characterization and Input to Long-Term Assessment of the Fate of CO_2

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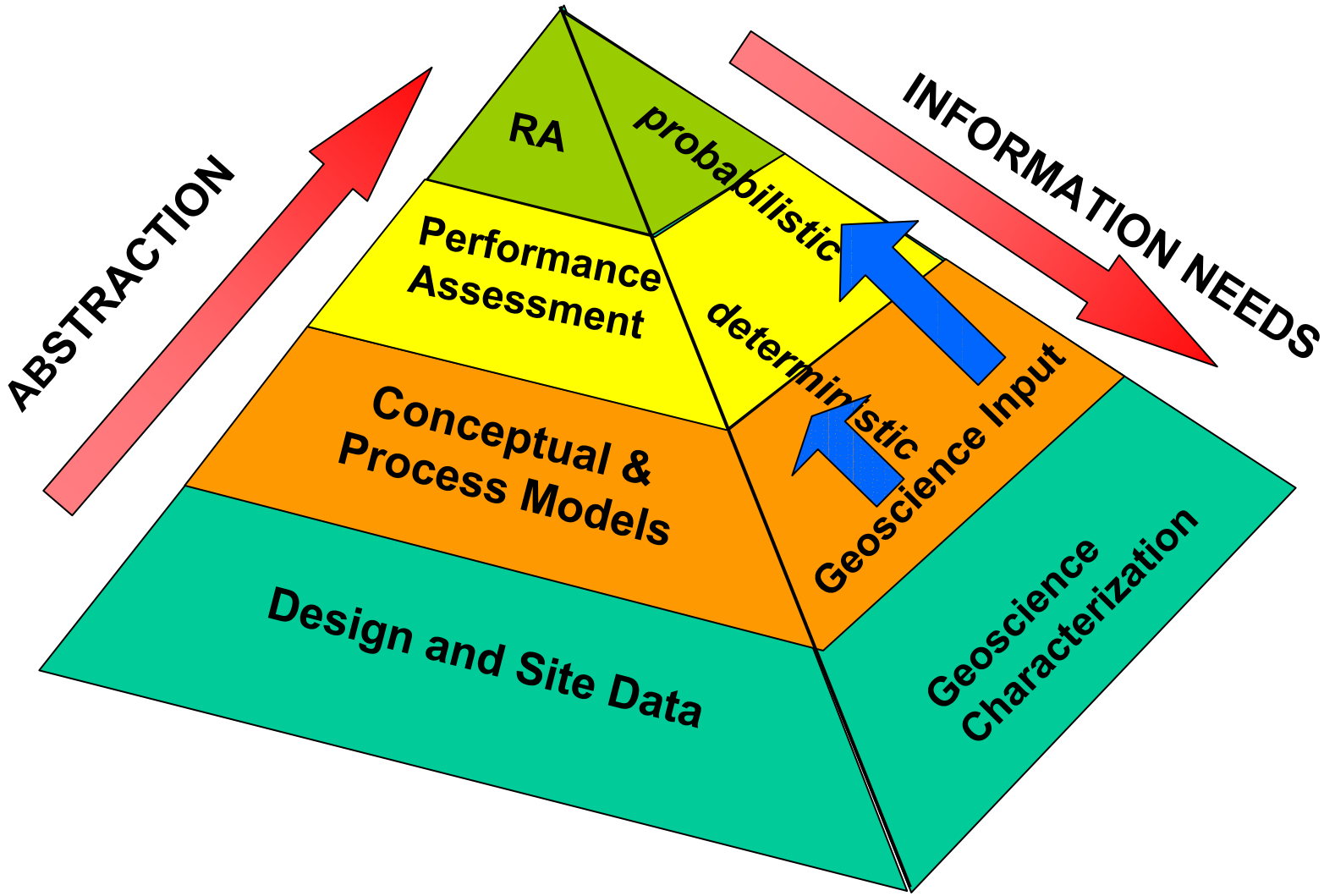
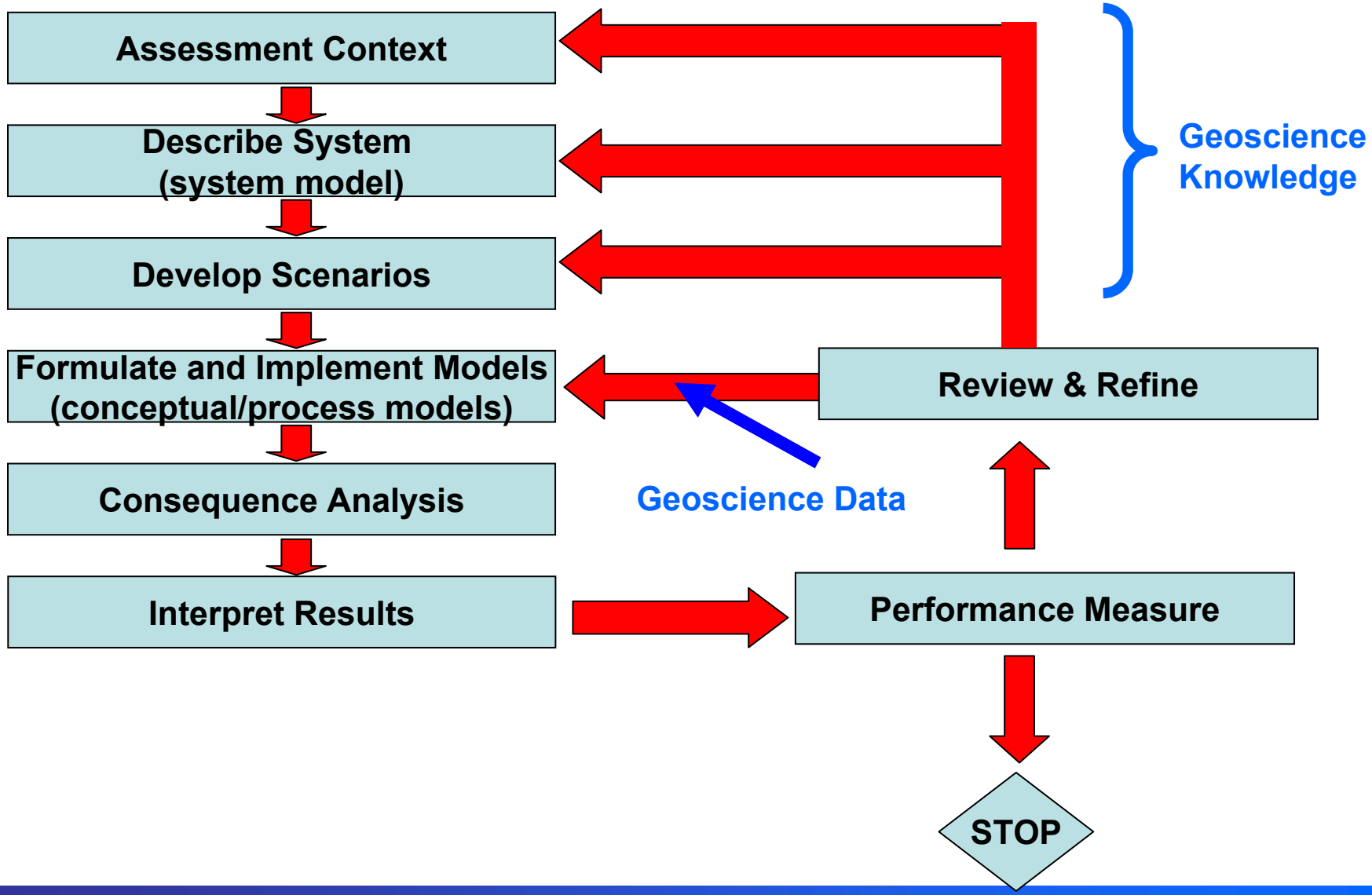
Geoscience Input to Long-Term Assessment of Fate of CO_2 In Geosphere

- Identify potential transport pathways
  - Preferential pathways
    - Depositional features
    - Faults
    - Fracture zones
  - At, above and below reservoir level
- Identify main traps (mechanisms)
  - At and above reservoir level
- Identify associated transport properties
  - Porosity, permeability, fracture distribution, formation water flow velocity

Modeling Hierarchy



System Assessment Process



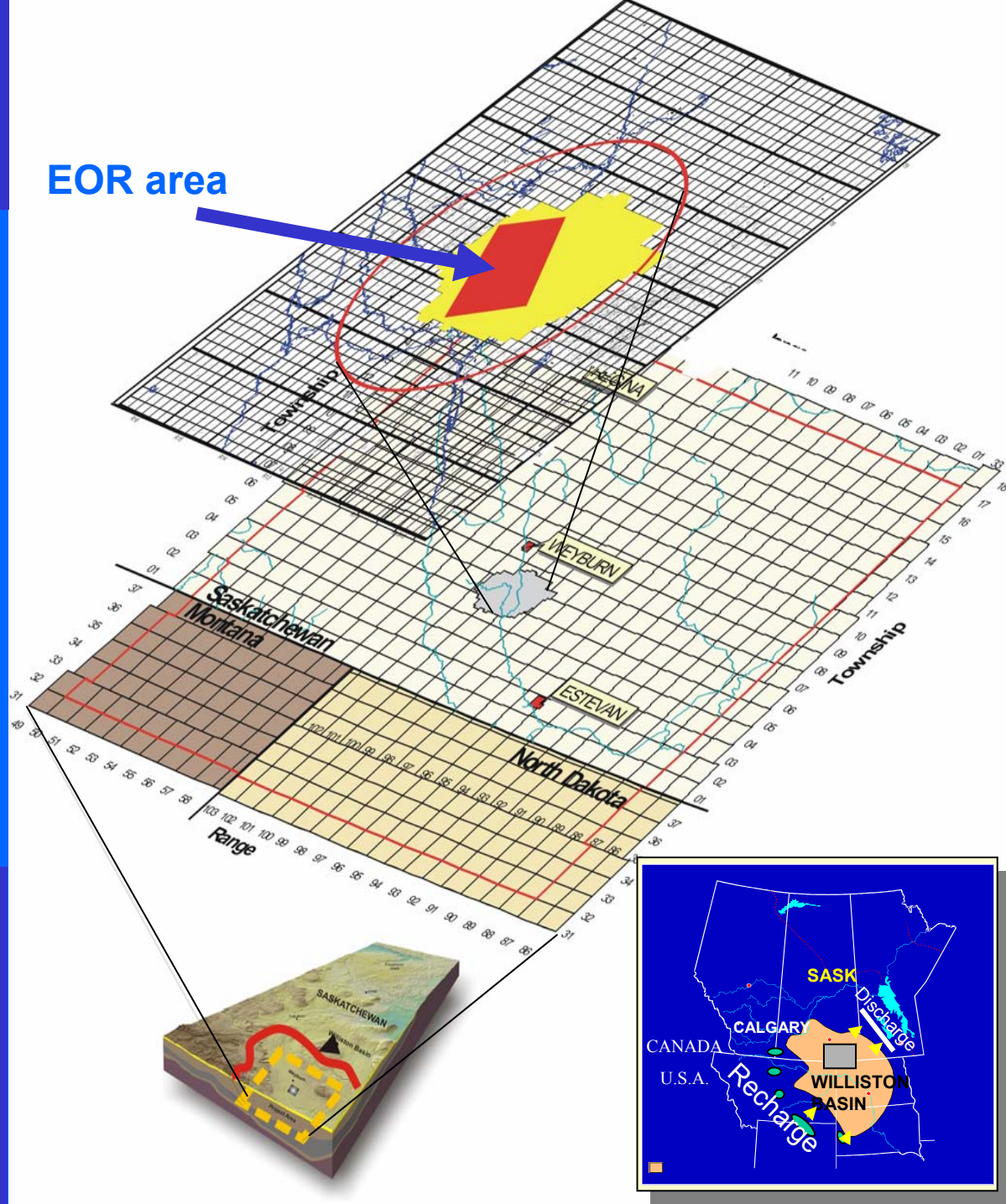
Spatial Extent

- System Assessment
  - 1,250 km²
  - 10 km perimeter around EOR area
- Geoscience Investigation
  - 40,000 km²

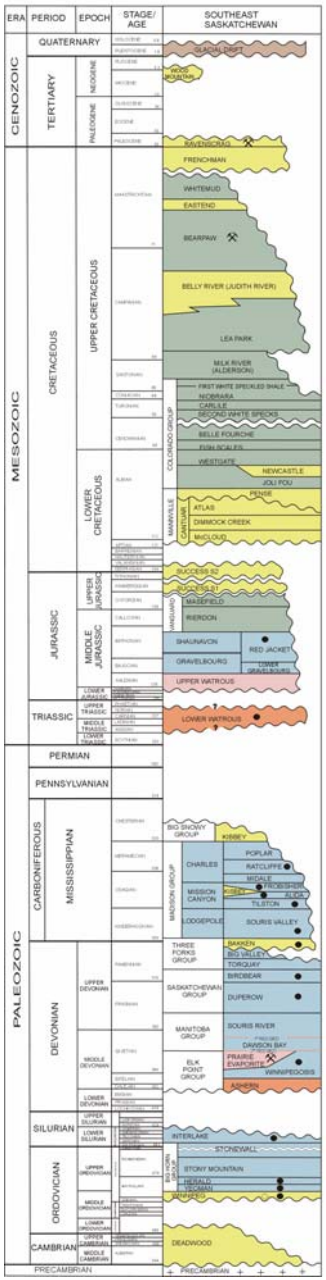
Options

Time

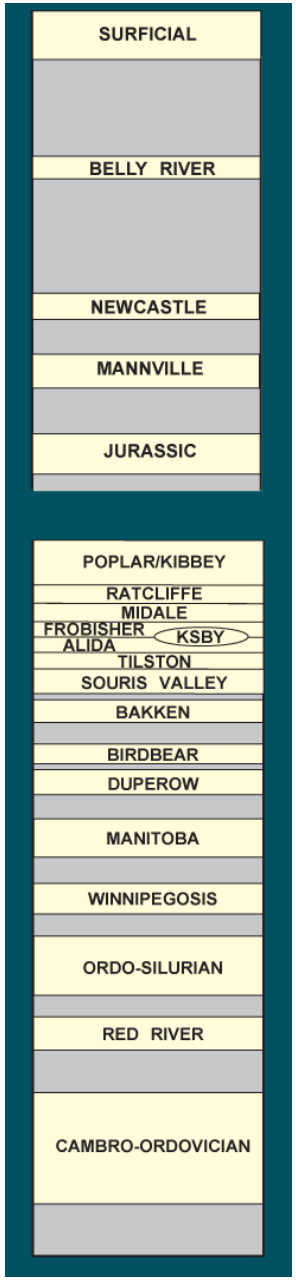
CO_2 Fate



STRATIGRAPHY



HYDROSTRATIGRAPHY



Geology
Geophysics
Hydrogeology

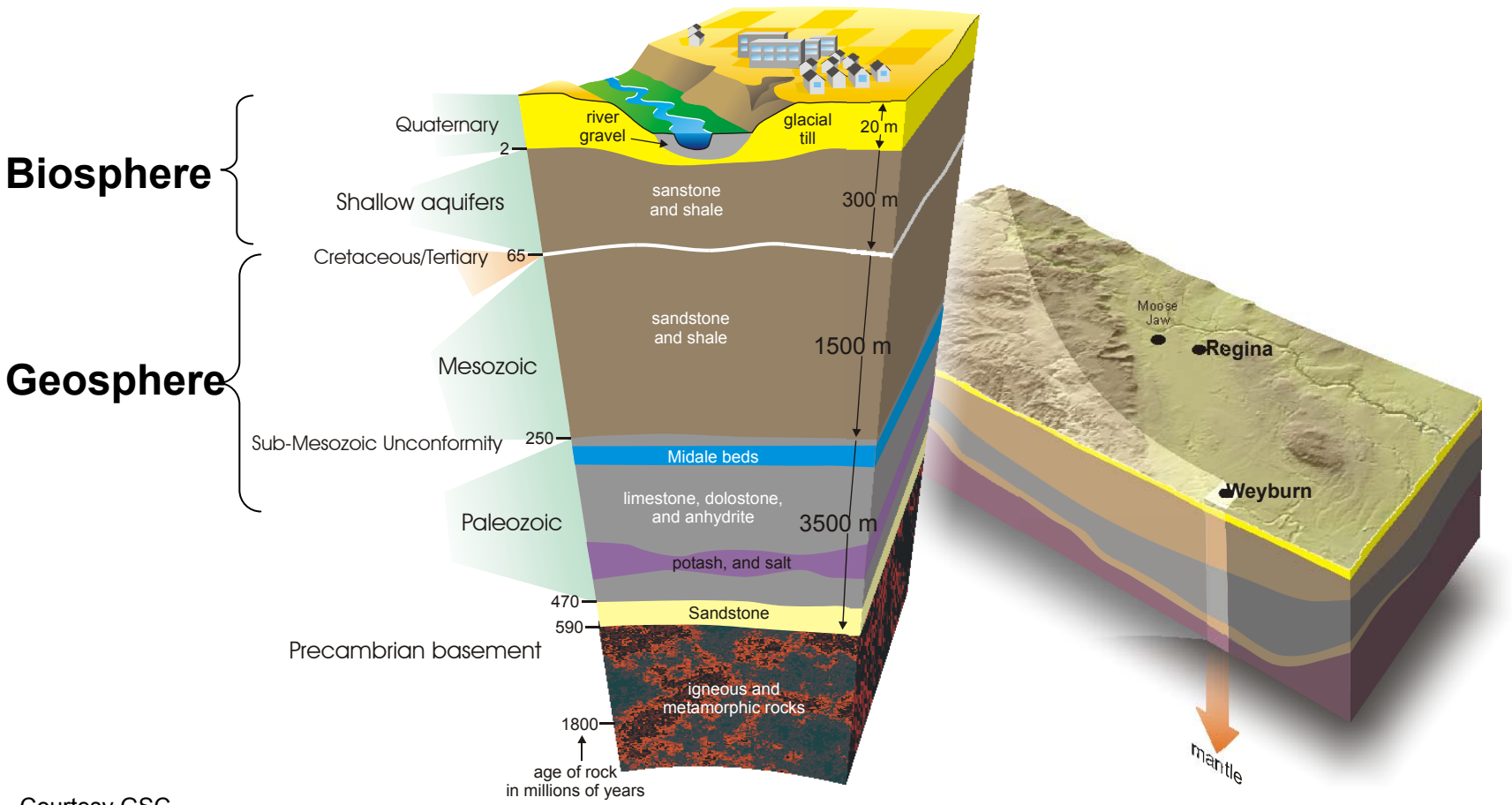
VERTICAL EXTENT OF SYSTEM MODEL

Transport parameters

- Porosity
- Permeability
- Formation water flow velocity
- Pathways
- Thickness
- Lateral continuity
- Subcrop
- Salt dissolution
- Presence of cross-formational flow

System Model

Based on extents of system assessment



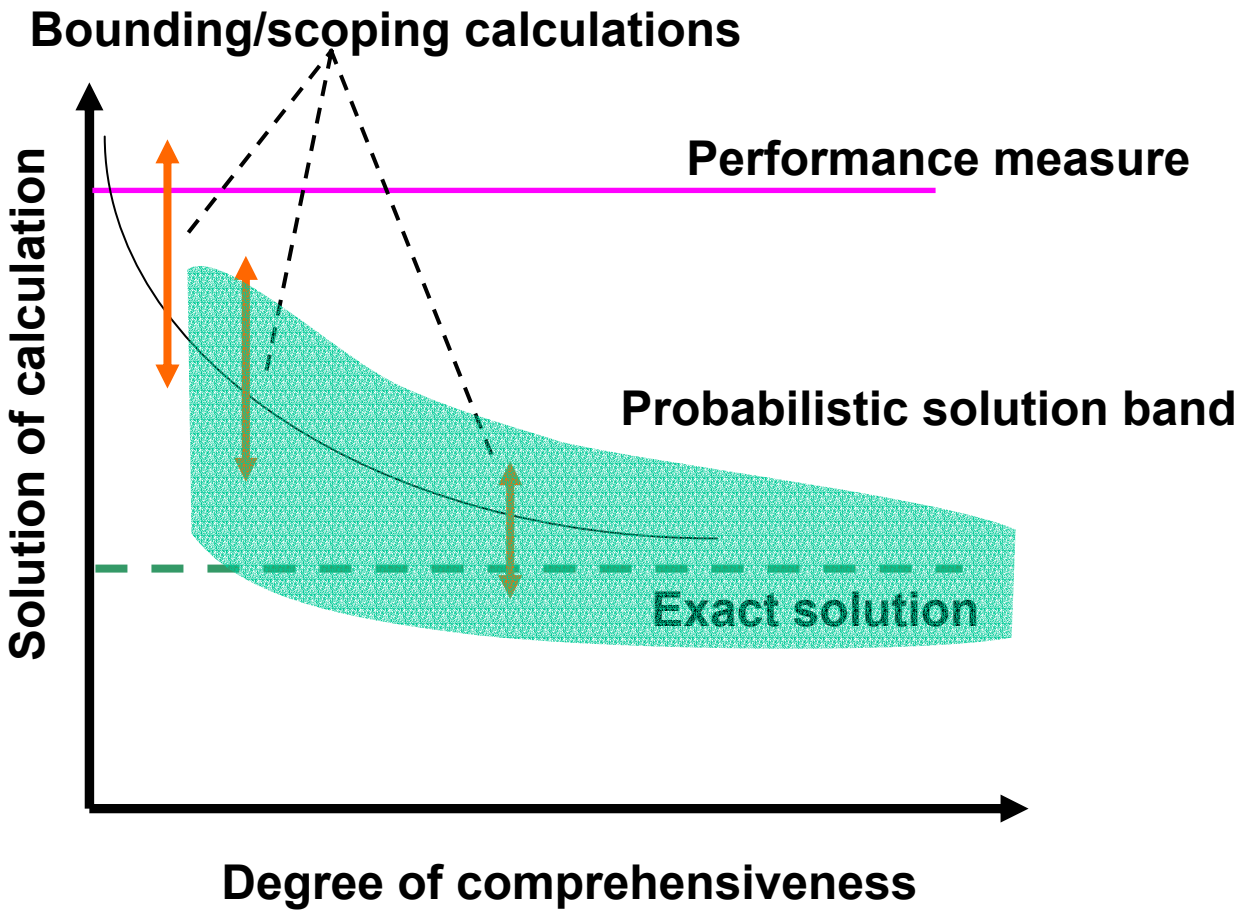
Courtesy GSC

Independent of modeling tools

Features include faults, fracture zones, well bores etc.

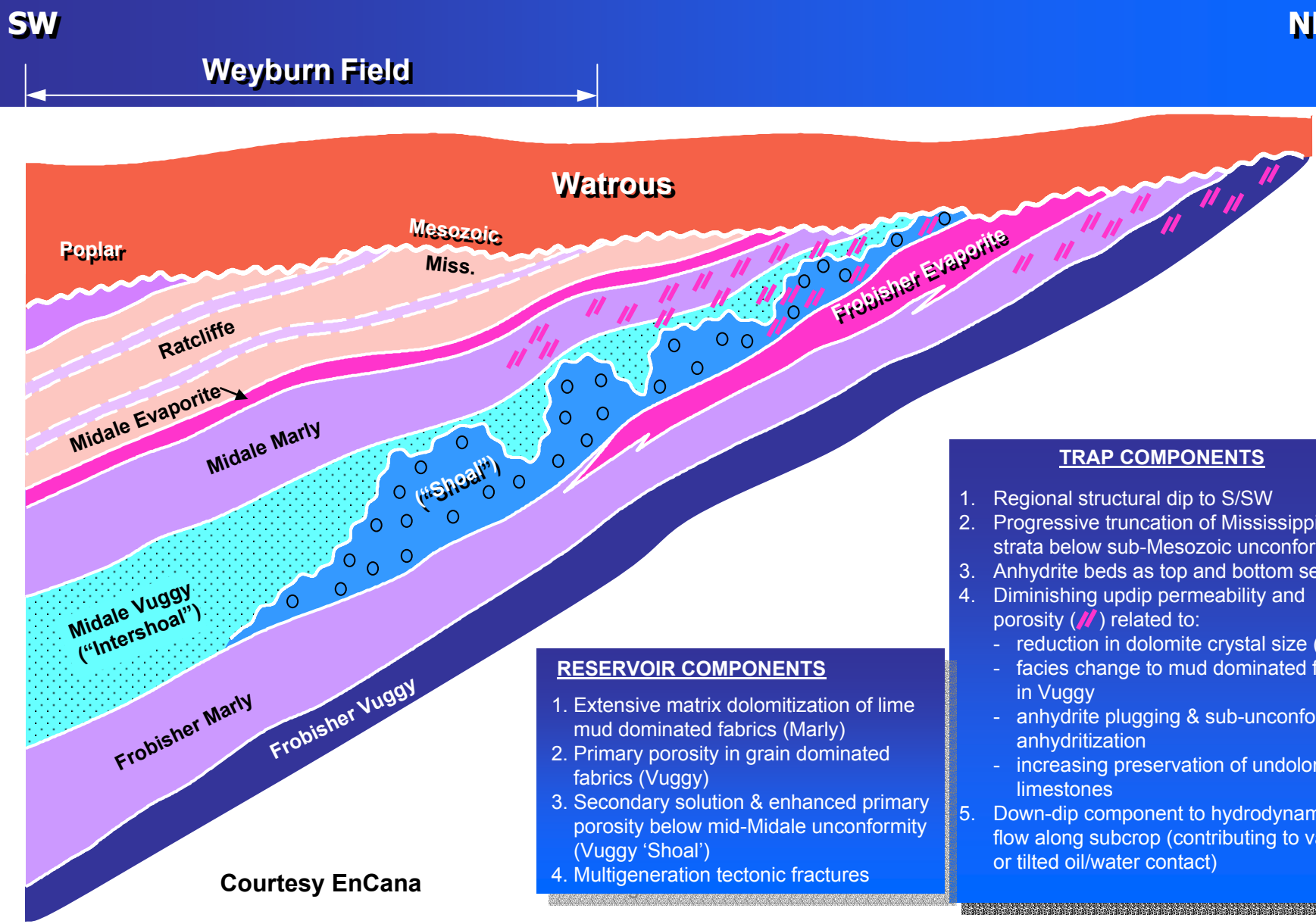
Iterative Assessment

- "Exact" solution exists, but is *impossible to know*
- Start from bounding calculation
- Gradually refine model and parameters if needed



Geoscience Characterization

Reservoir and Trapping Components



Courtesy EnCana

RESERVOIR COMPONENTS

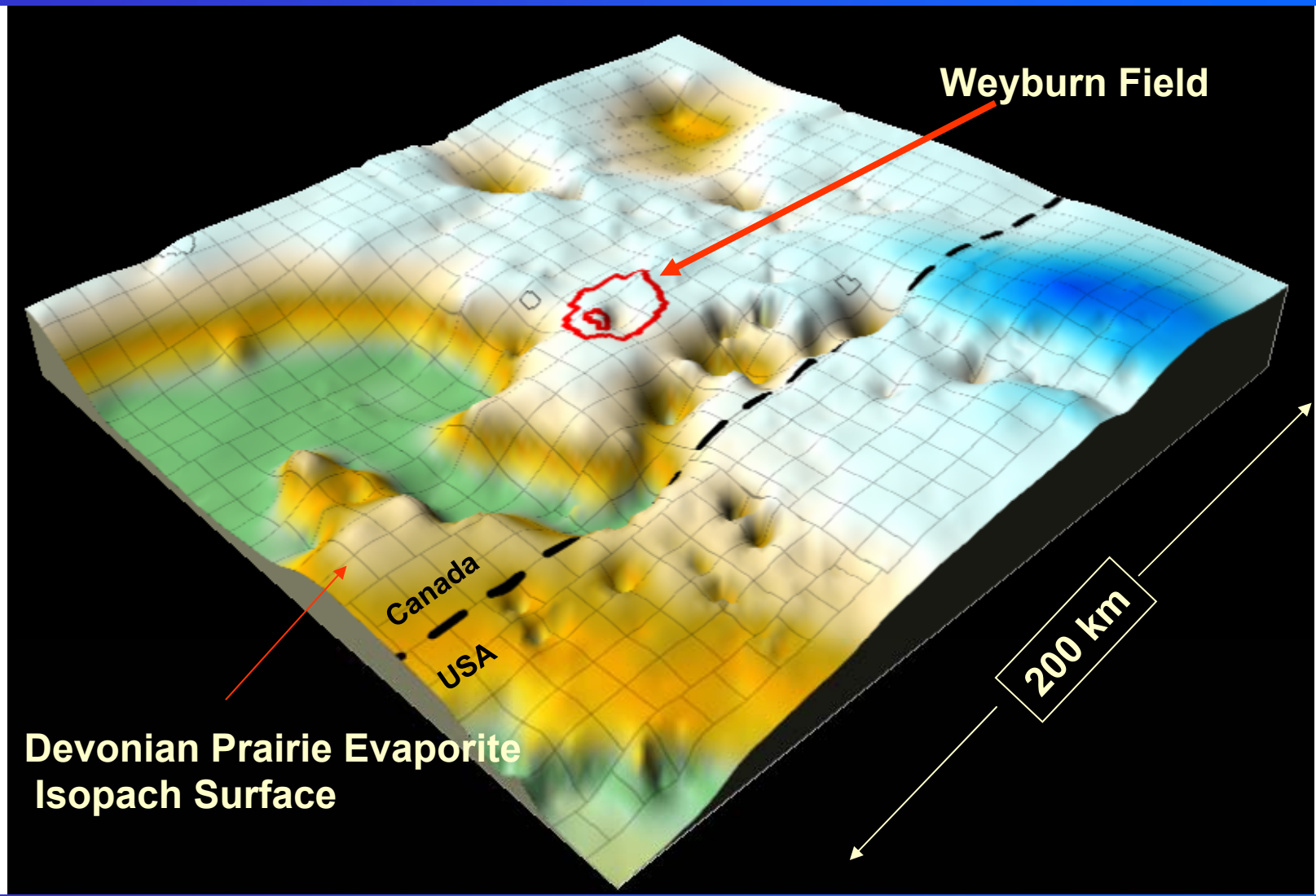
1. Extensive matrix dolomitization of lime mud dominated fabrics (Marly)
2. Primary porosity in grain dominated fabrics (Vuggy)
3. Secondary solution & enhanced primary porosity below mid-Midale unconformity (Vuggy 'Shoal')
4. Multigeneration tectonic fractures

TRAP COMPONENTS

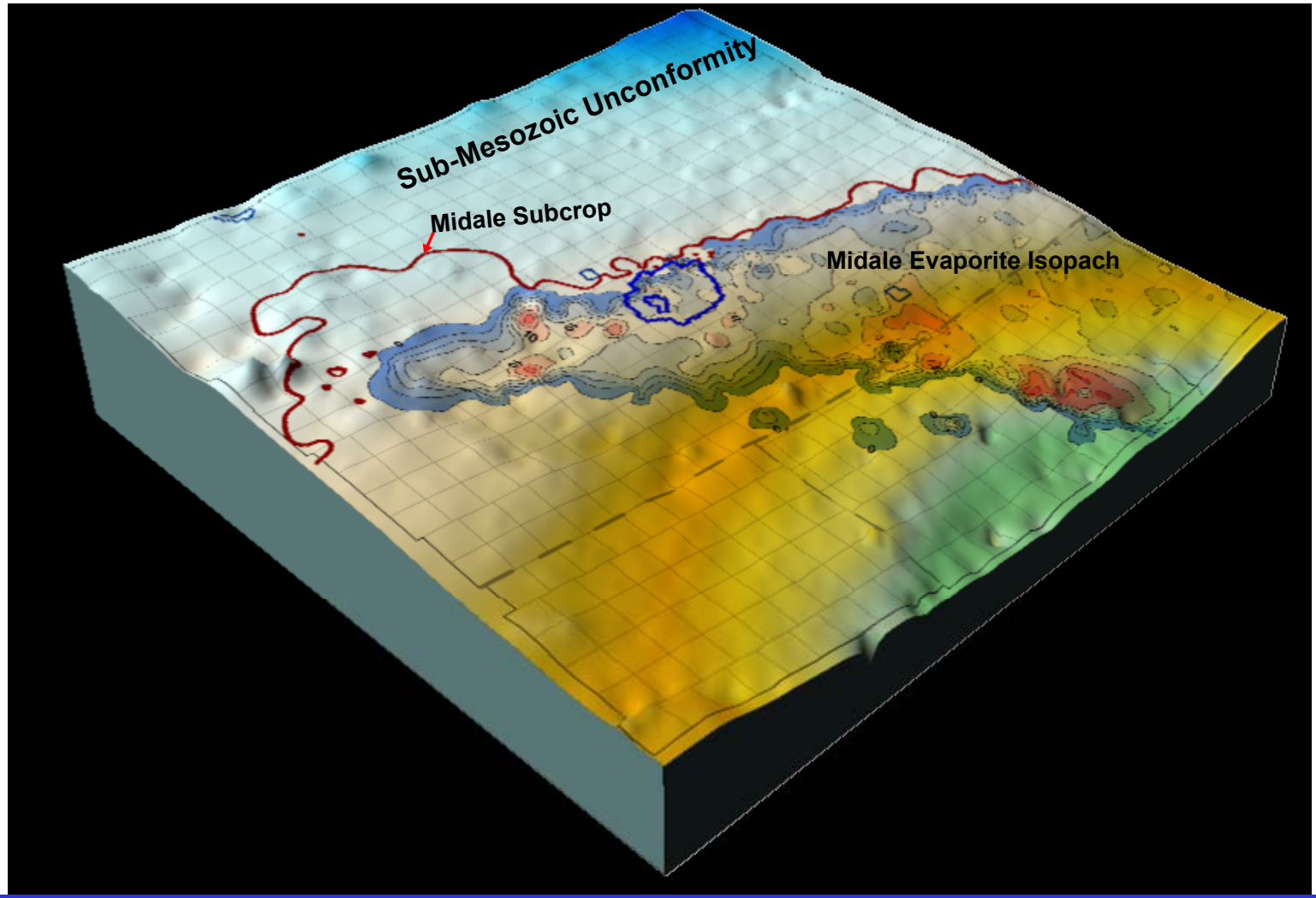
1. Regional structural dip to S/SW
2. Progressive truncation of Mississippian strata below sub-Mesozoic unconformity
3. Anhydrite beds as top and bottom seal
4. Diminishing updip permeability and porosity (//) related to:
   - reduction in dolomite crystal size (Marly)
   - facies change to mud dominated fabrics in Vuggy
   - anhydrite plugging & sub-unconformity anhydritization
   - increasing preservation of undolomitized limestones
5. Down-dip component to hydrodynamic flow along subcrop (contributing to variable or tilted oil/water contact)

Geological Characterization

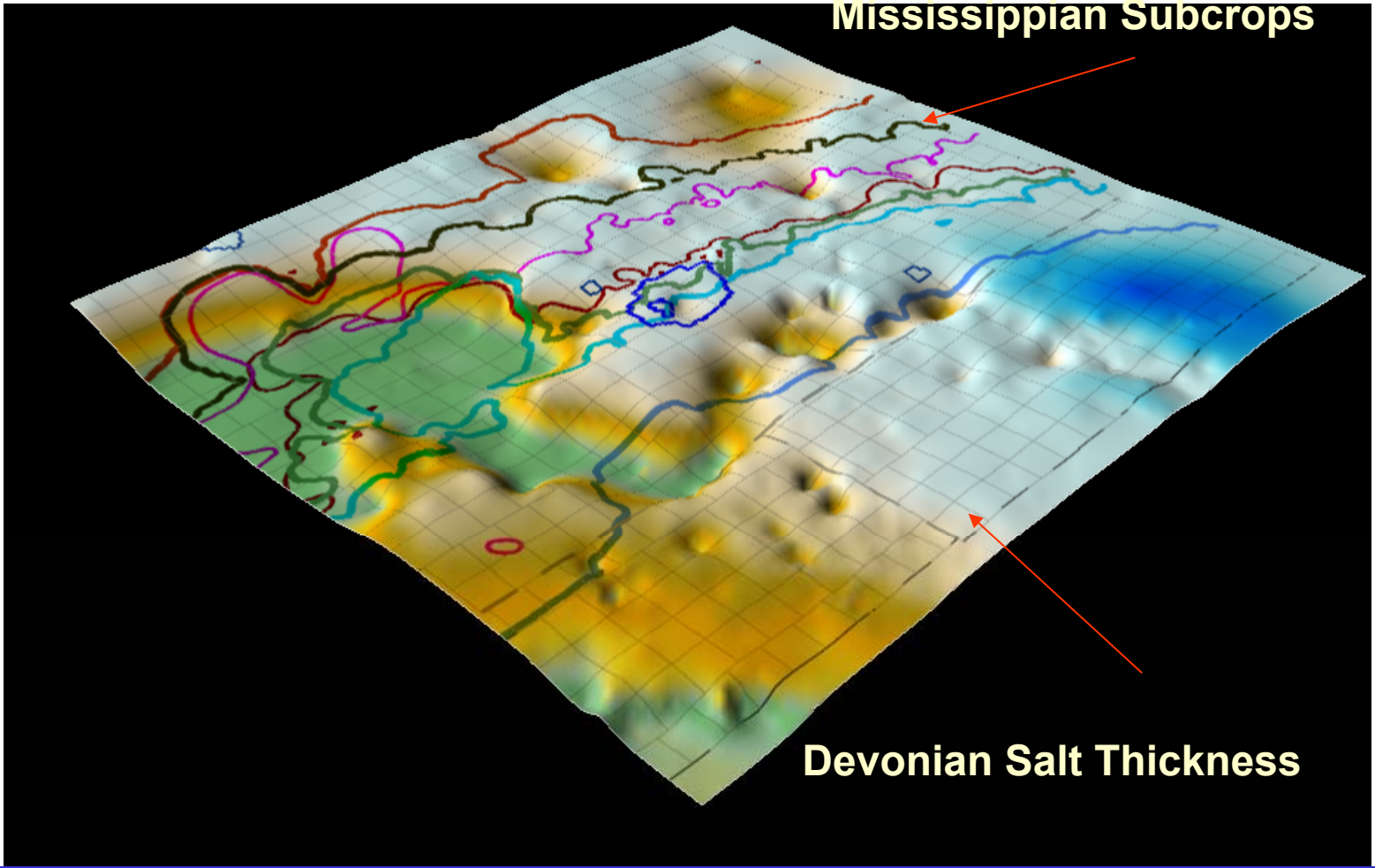
Devonian Salt Thickness



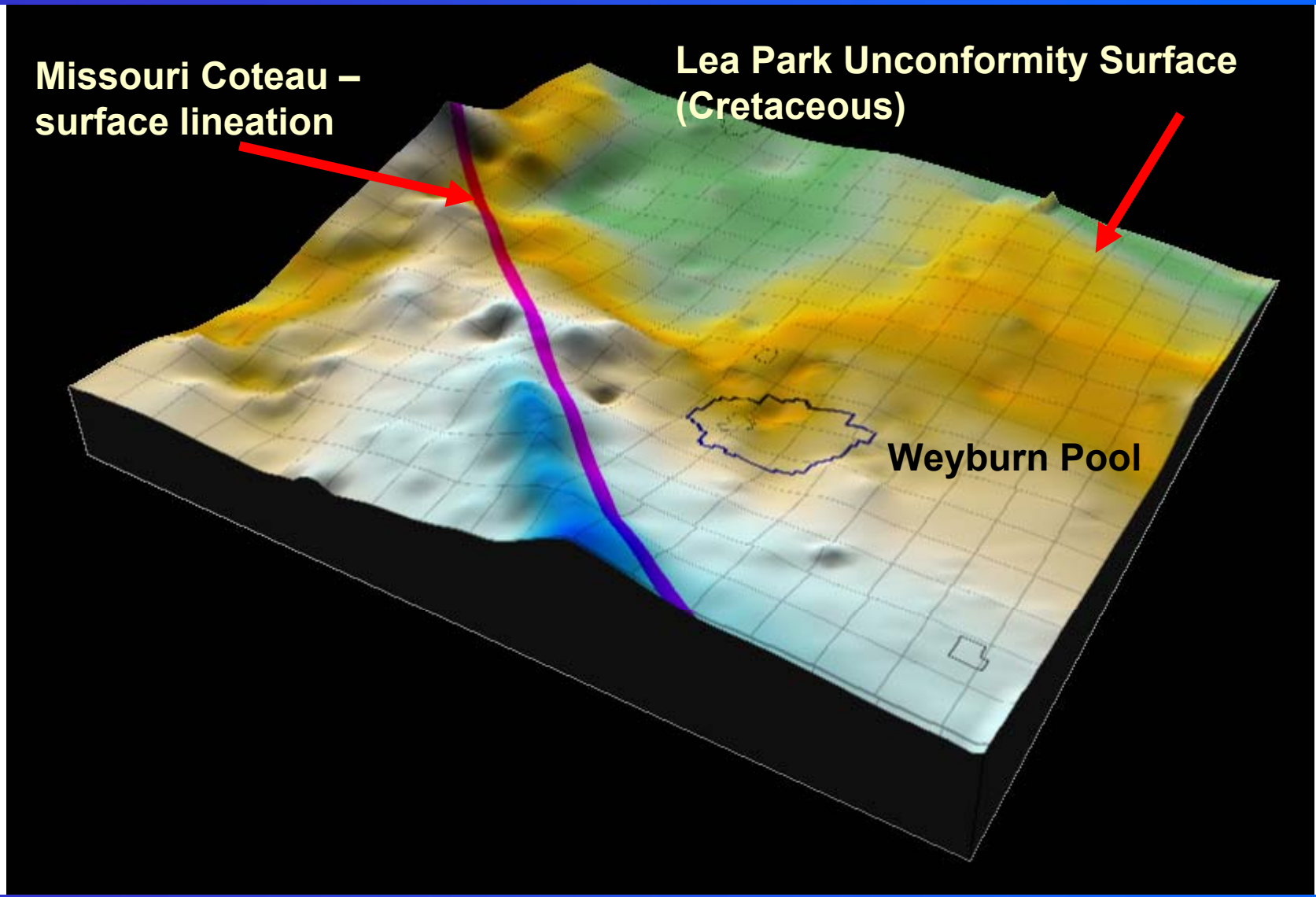
Subcrop and Isopach of Reservoir Unit and Upper Seal



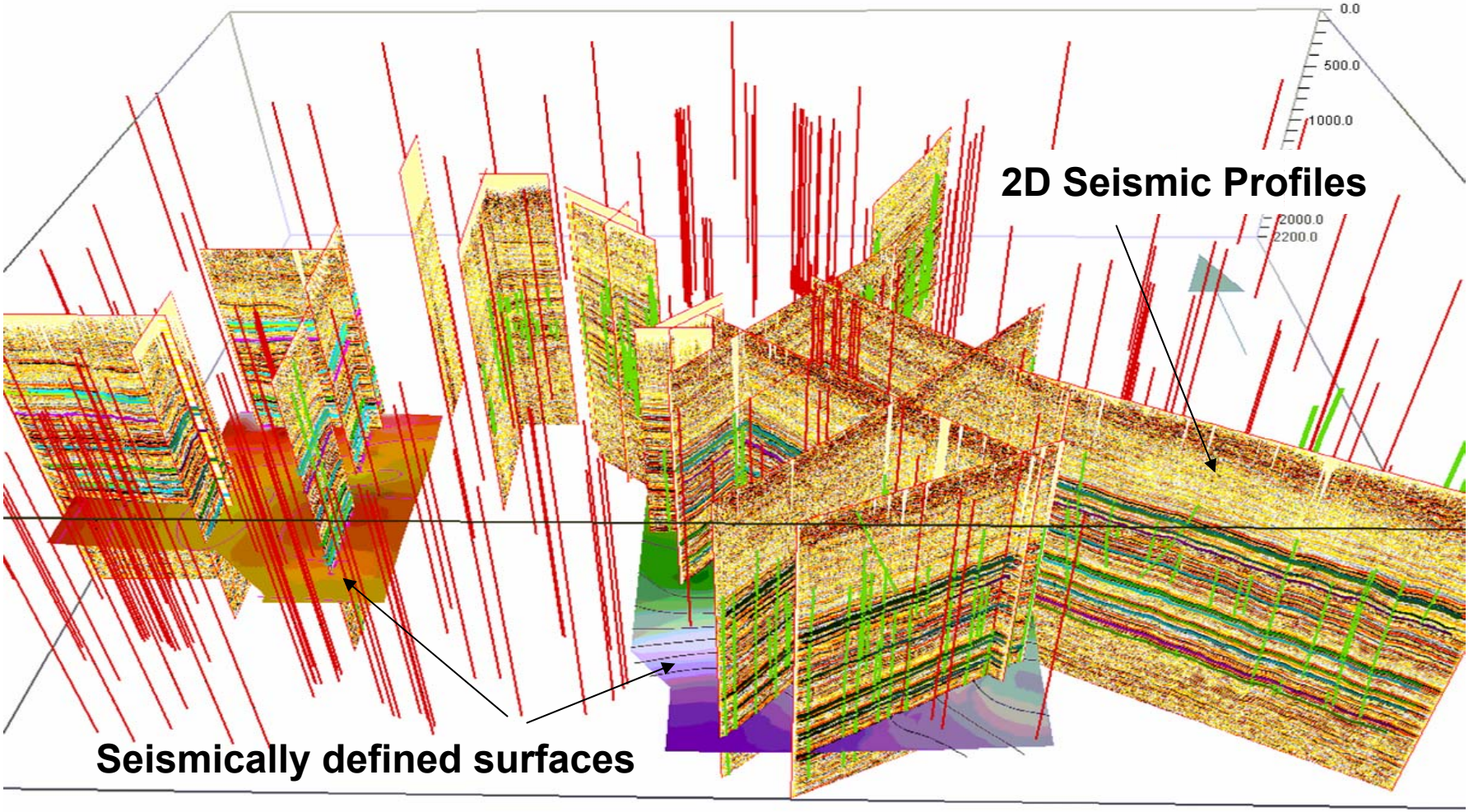
Mississippian Subcrops on Isopach Surface of Devonian Prairie Evaporite



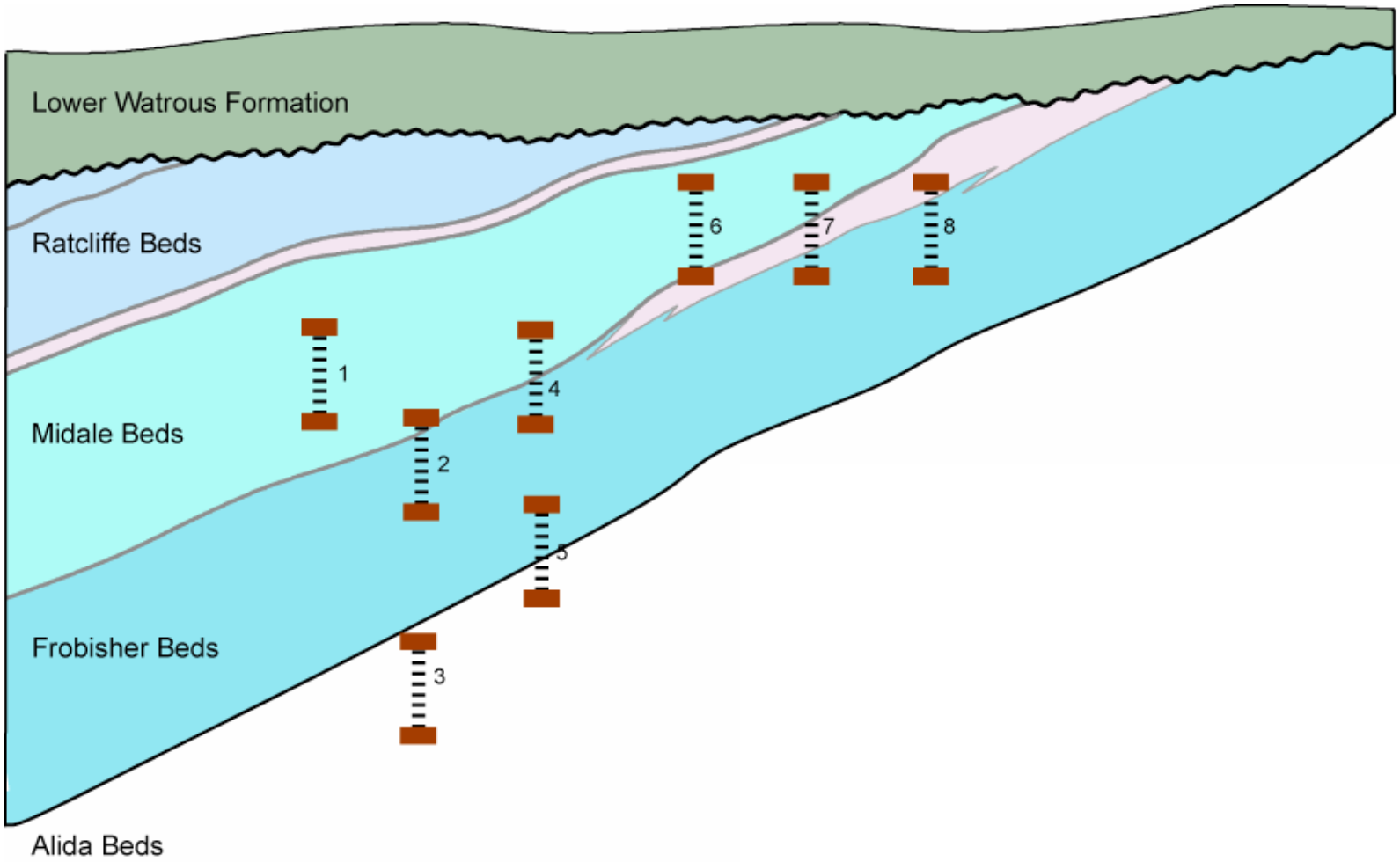
Overlying Strata and Subsurface Features



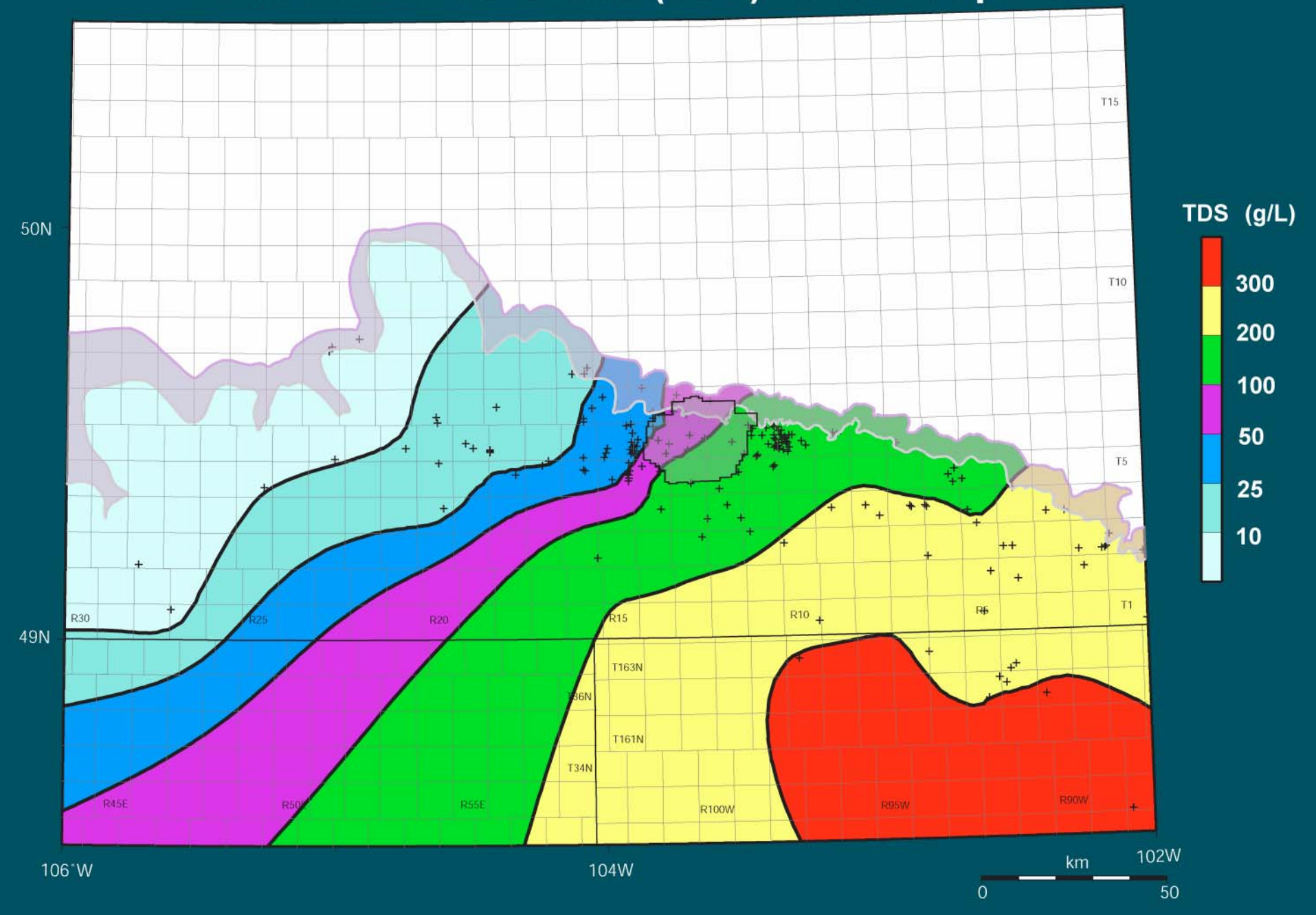
Regional Seismic Investigations



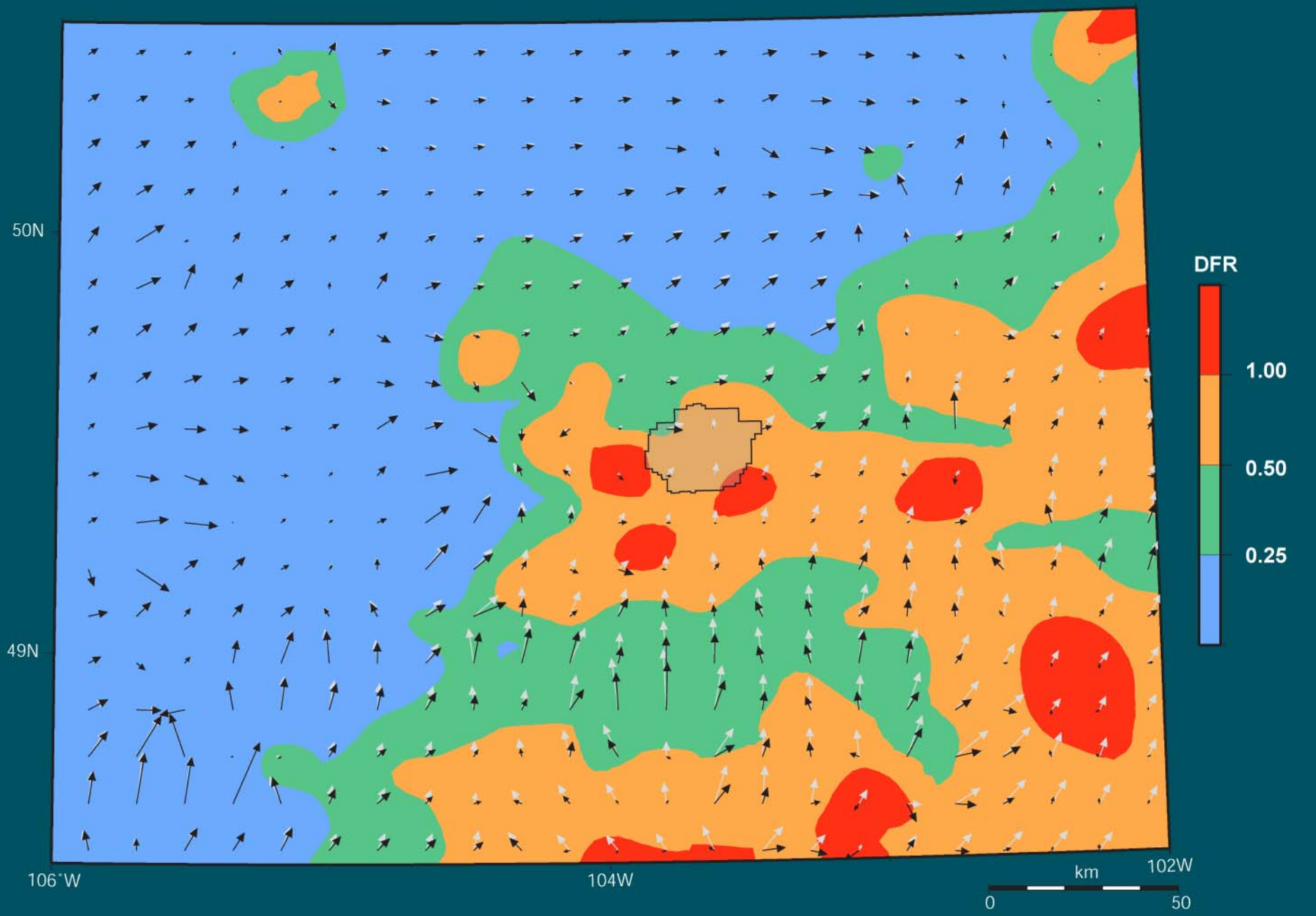
HYDROGEOLOGICAL CHARACTERIZATION
DRILL STEM TEST (DST) ASSIGNMENT



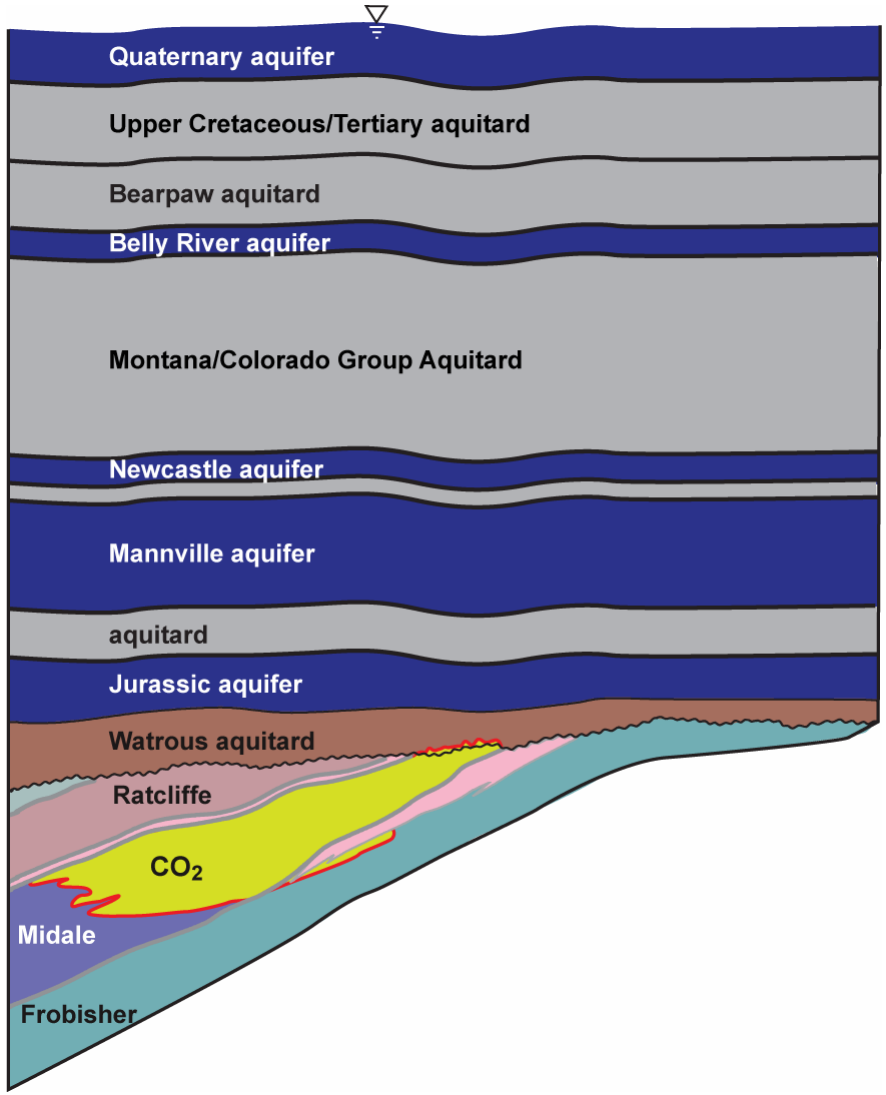
Total Dissolved Solids (TDS): Midale Aquifer



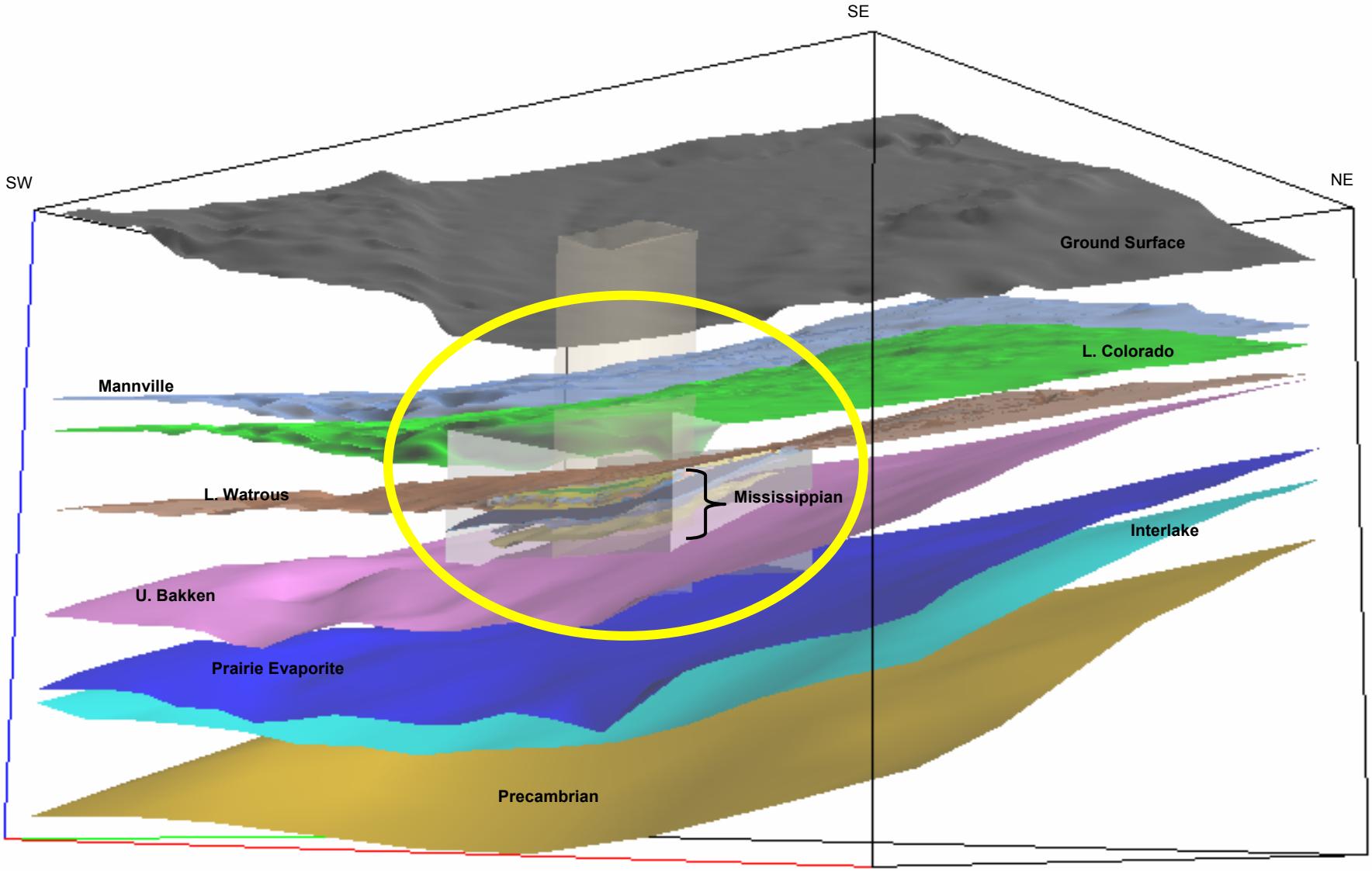
Water Driving Force: Birdbear Aquifer



Weyburn System Model



Geological Model



Geoscience Characterization for Long-Term Storage of CO_2

- Geoscience data fundamental for measuring system performance and risk assessment for CO_2 storage
- Level of detail requirements for RA diminishes outward from spatial extent of System model
- Need for Geoscience Information is essential beyond the lateral and vertical extent of the System Model for adequate understanding of the system and to reduce uncertainty

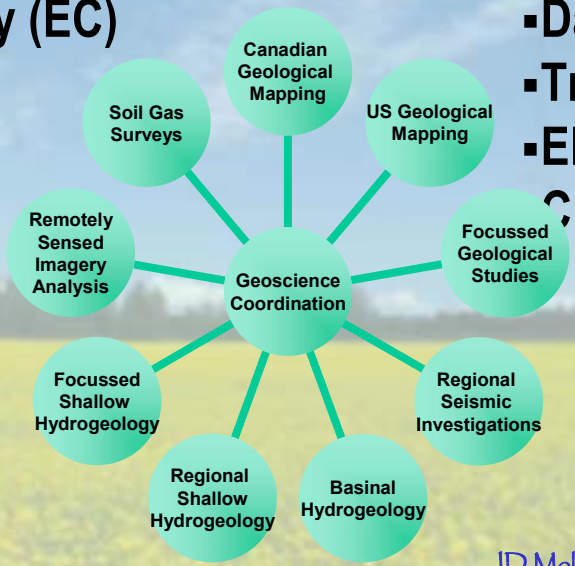
Project Sponsors

Governments

- Saskatchewan Industry & Resources (SIR)
- Natural Resources Canada (NRCan)
- Alberta Energy Research Institute (AERI)
- United States Department of Energy (USDOE)
- European Community (EC)

Industrial

- EnCana Corporation
- SaskPower
- Nexen Canada Ltd
- TotalFinaElf
- BP
- Dakota Gasification Co.
- TransAlta Utilities
- ENAA (Japan)
- ChevronTexaco



Saskatchewan Industry and Resources

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