Role of Hydrodynamic and Geochemical Trapping in Secure Geological Storage of Carbon Dioxide

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CO_2 Trapping Mechanisms

I Hydrostratigraphic

1. Closed Stratigraphic/Structural Traps
2. Open Traps

II Geochemical

1. Solubility Traps
2. Ionic Traps
3. Mineral Traps

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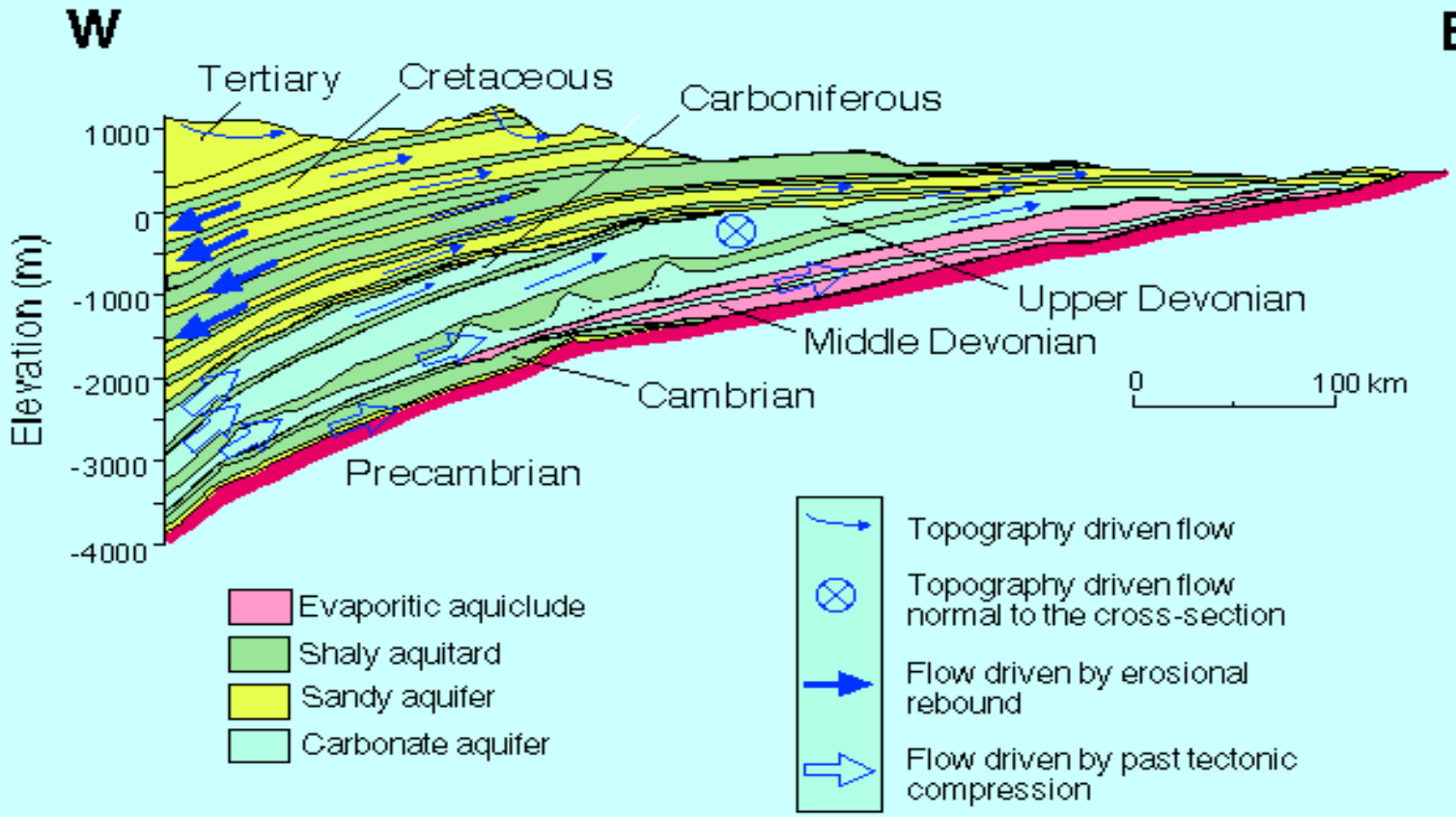
Present Flow Pattern in the South-Central Part of the Alberta Basin



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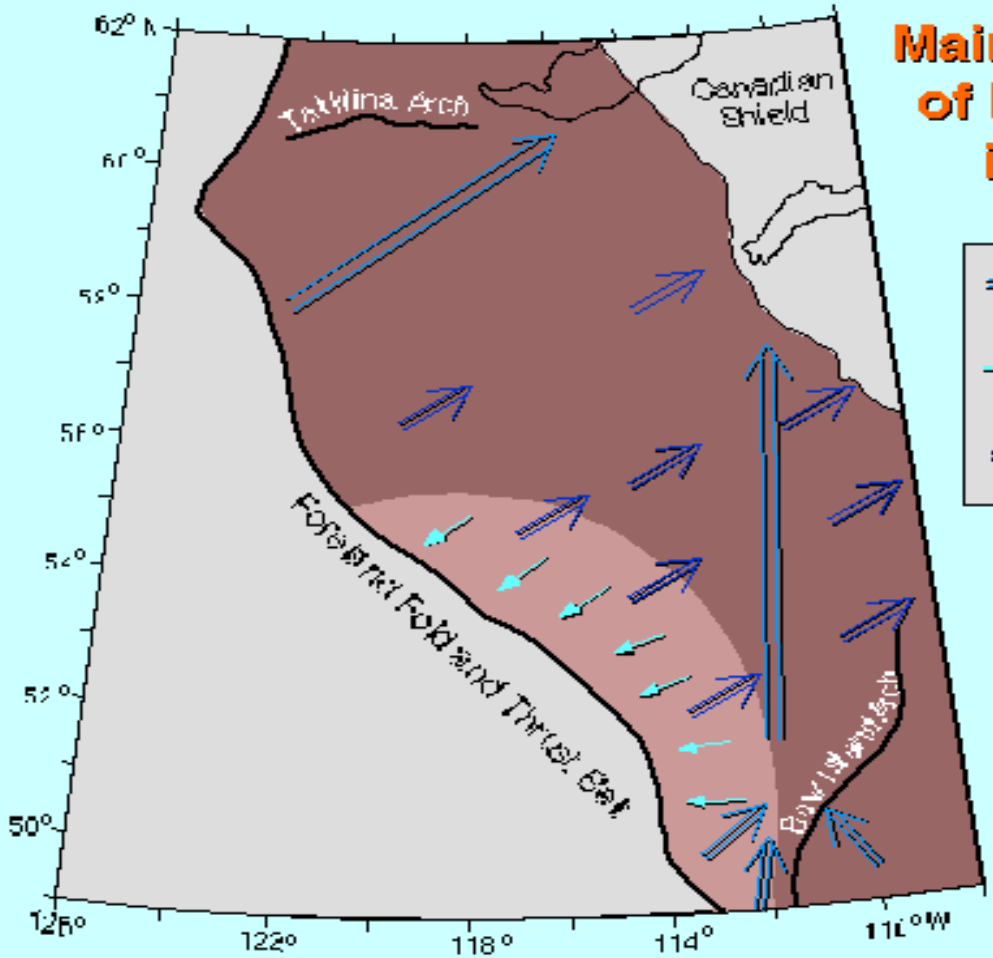
Main Types and Directions of Formation Water Flow in the Alberta Basin



- Topography-driven basin-scale flow
- Inward flow driven by erosional rebound
- Basin-scale flow driven by past tectonic compression

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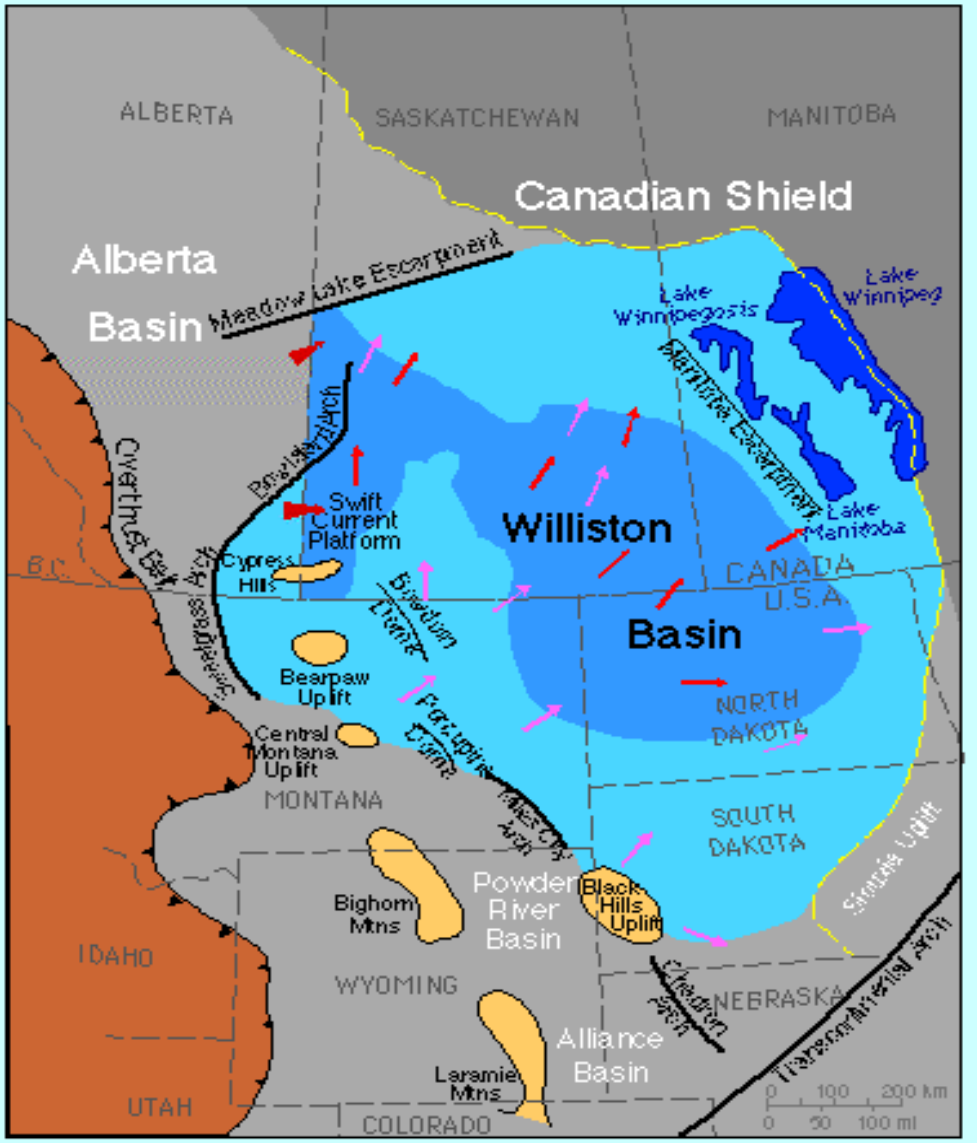

Areal Diagram of Basin-Scale Flow of Formation Waters in the Williston Basin

- Freshwater flow direction
- Brine flow direction
- Inter-basin flow from theAlberta basin
- Brines (>100,000 mg/l salinity)

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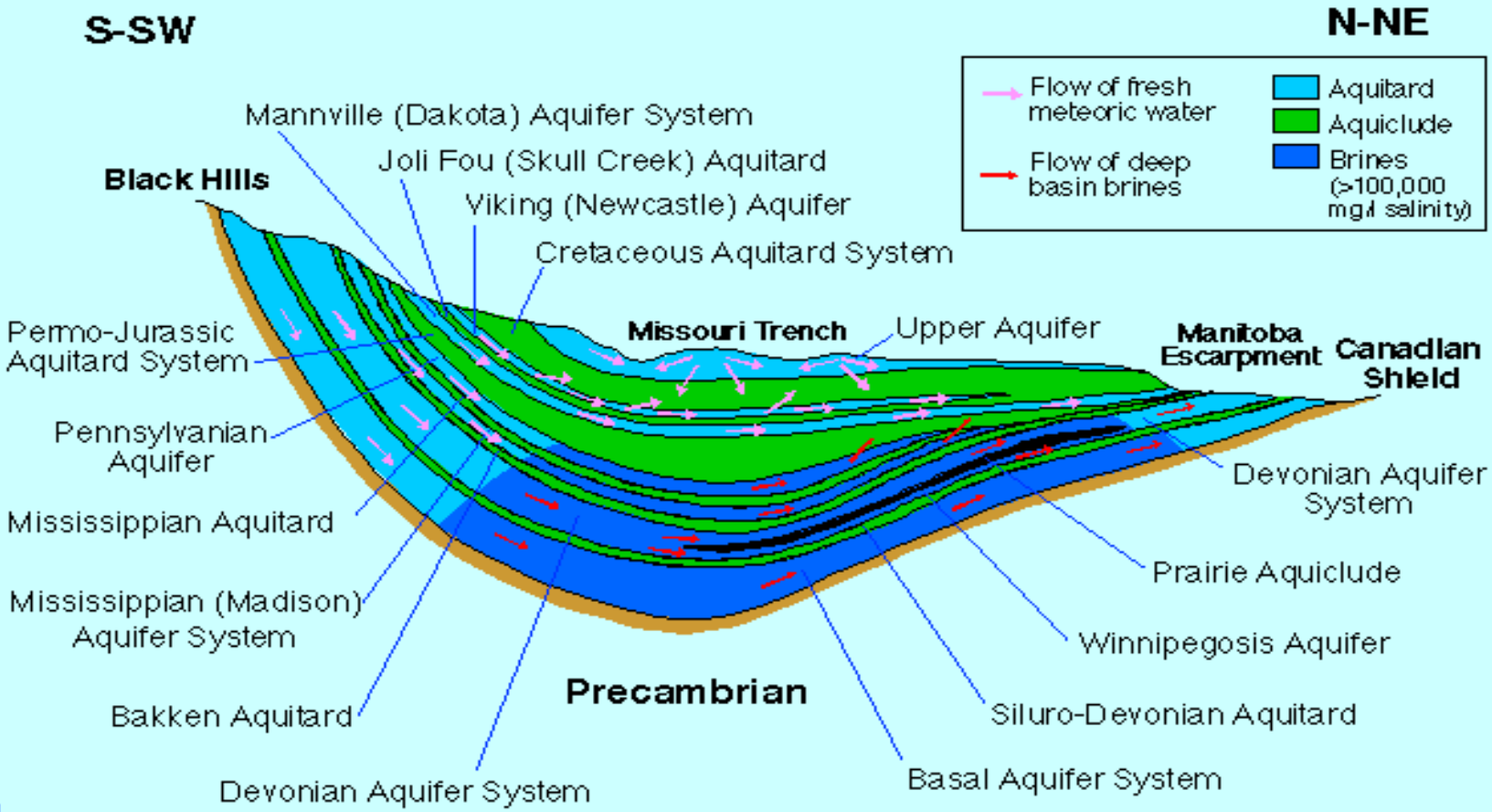
Cross-Sectional Diagram of Basin-Scale Flow of Formation Waters in the Williston Basin



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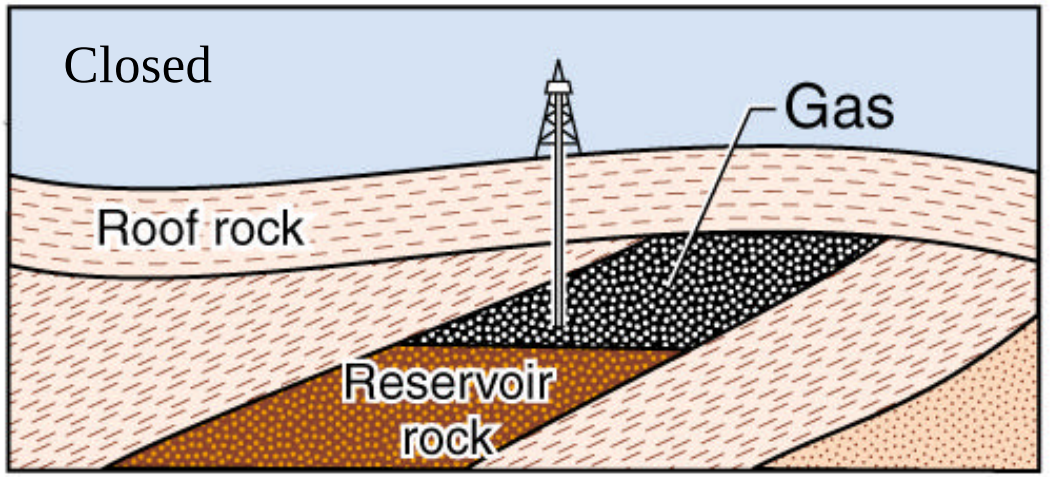
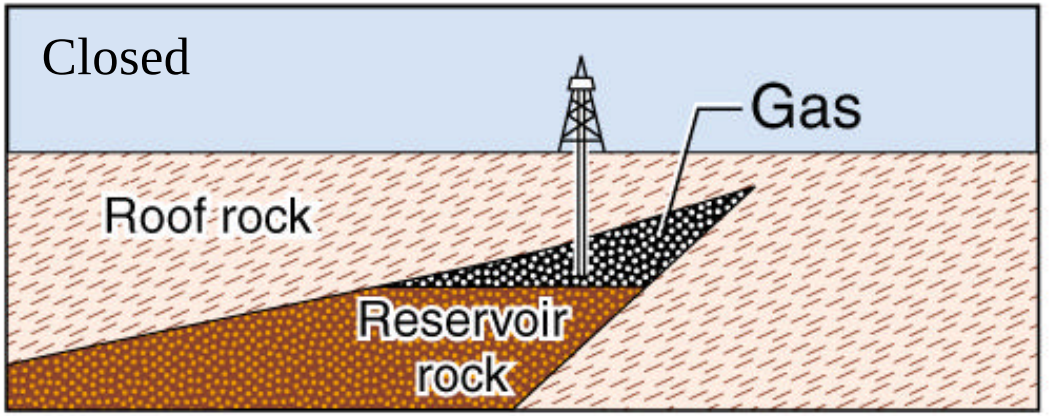
Hydrostratigraphic Traps





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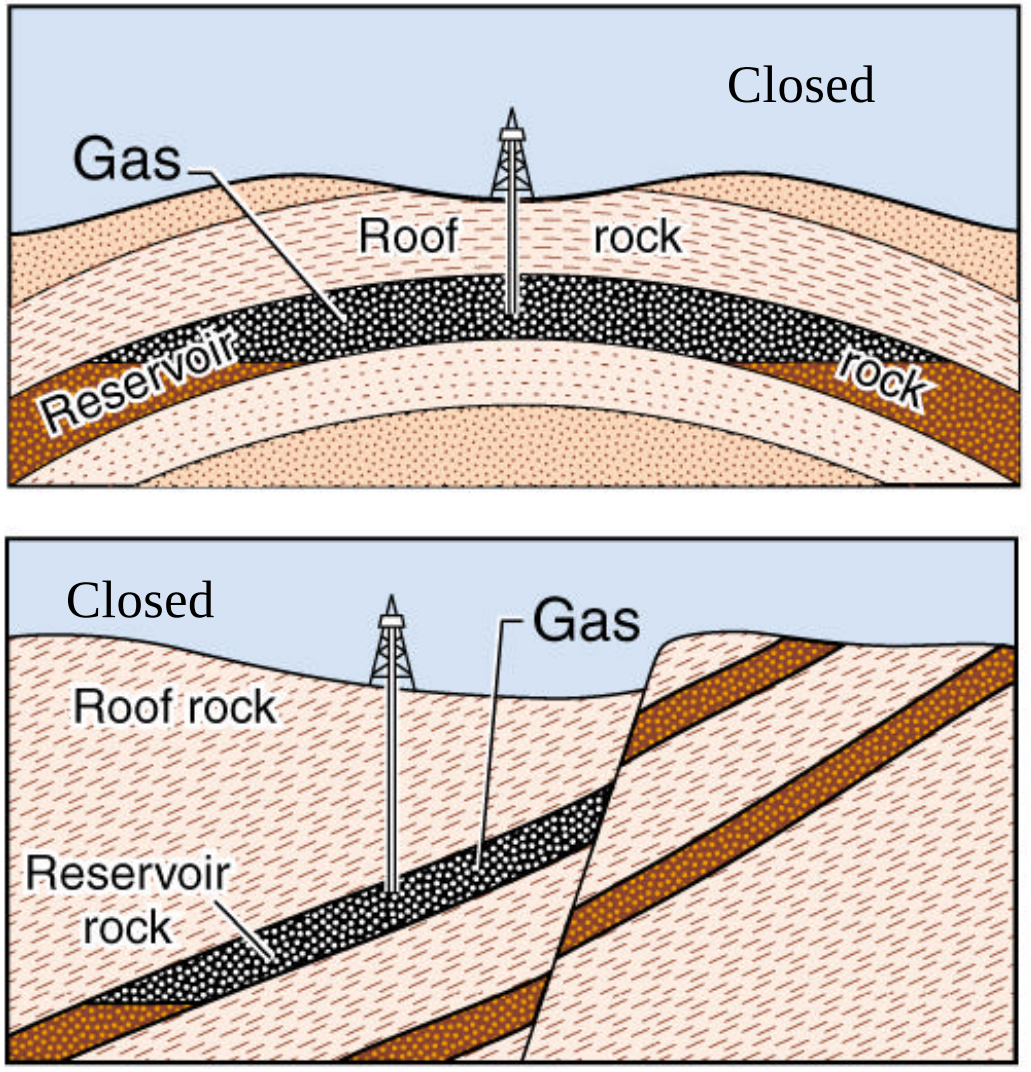
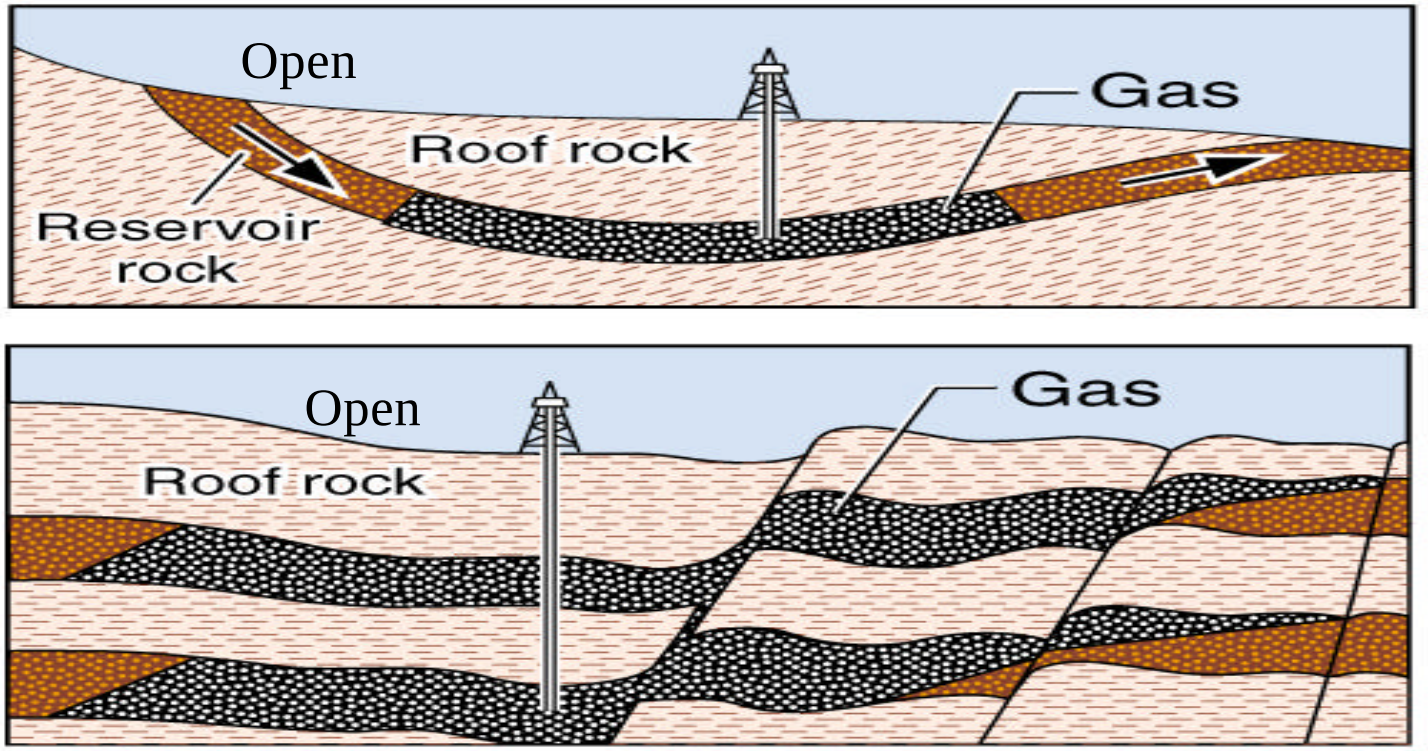
Hydrostratigraphic Traps

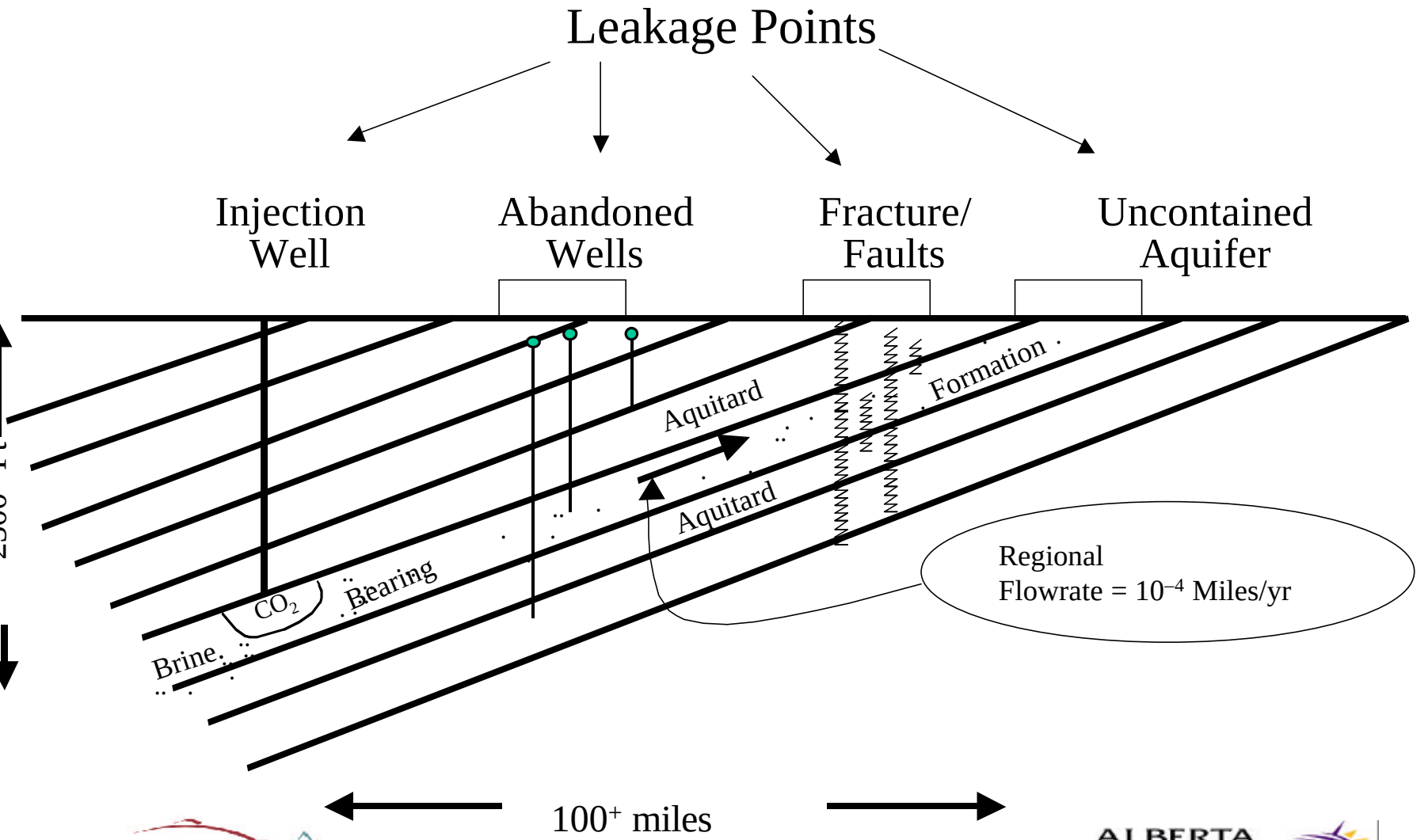


Hydrostratigraphic Traps

Single and Multiple Zones



Hydrology of CO_2 Storage in a Sedimentary Basin (worst case scenario)



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Geochemistry of CO_2 Storage

- Solubility Trapping

  CO_2 (gaseous) + H_2O → H_2CO_3 (aqueous)

- Ionic Trapping

  H_2CO_3 (aqueous) + OH^- → HCO_3^- (aqueous)

  HCO_3^- (aqueous) + OH^- → $CO_3^{=}$ (aqueous)

- Mineral Trapping

  $CO_3^{=}$ (aqueous) + Ca^{++} → $CaCO_3$ (solid)

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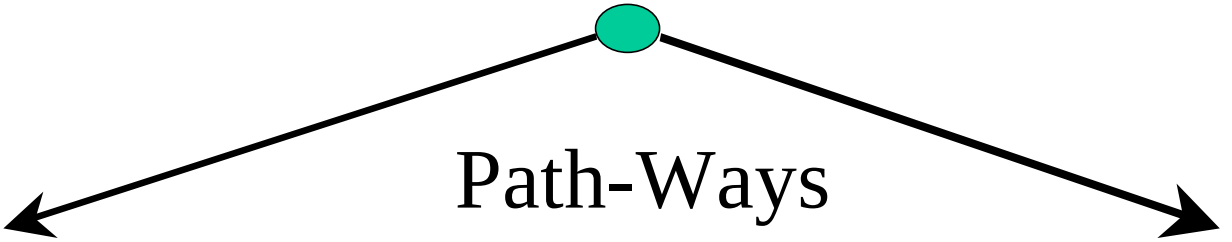
Mineral Products

$Mg_3Si_2O_5(OH)_4+3CO_2$

(Serpentine)

$3MgCO_3+SiO_2+2H_2O$

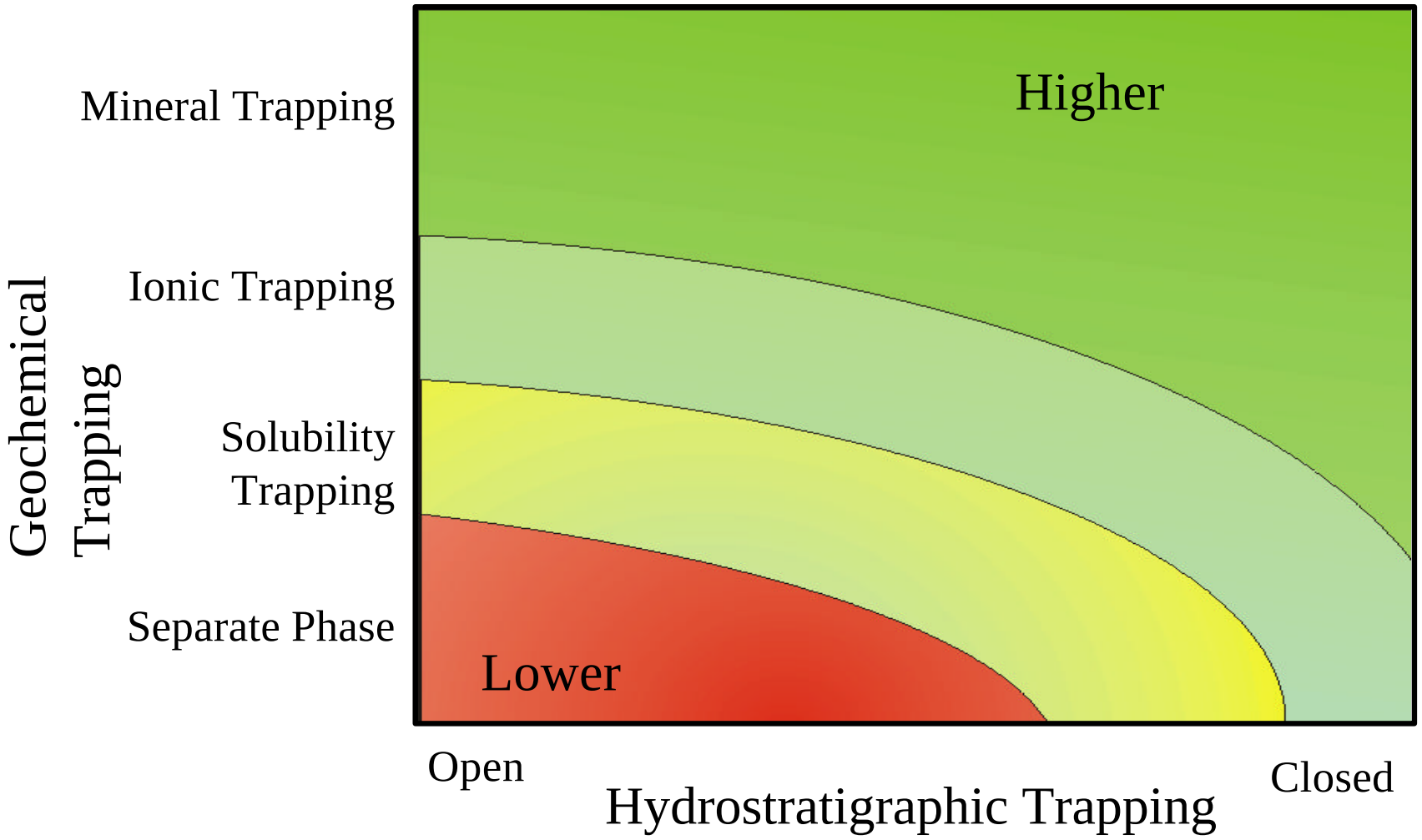
(Magnesite) (Quartz)



Aquifers

Surface Mining

Storage Security



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Summary of Geological Trapping of CO_2

- Two classes of Geological Trapping
  (1) Hydrostratigraphic
  (2) Geochemical
- Most secure form of trapping is Geochemical Trapping by carbonate minerals
- Acceptable leakage rates for other forms of trapping need to be established
- Security can be demonstrated from natural analogues
- Storage potential for CO_2 in Sedimentary Basins is huge