Fourth Annual Conference on Carbon Capture & Sequestration

Developing Potential Paths Forward Based on the Knowledge, Science and Experience to Date

Geologic – Coal Seams (1)

Geologic CO_2 Sequestration Potential of Coal Deposits in the Northern Great Plains

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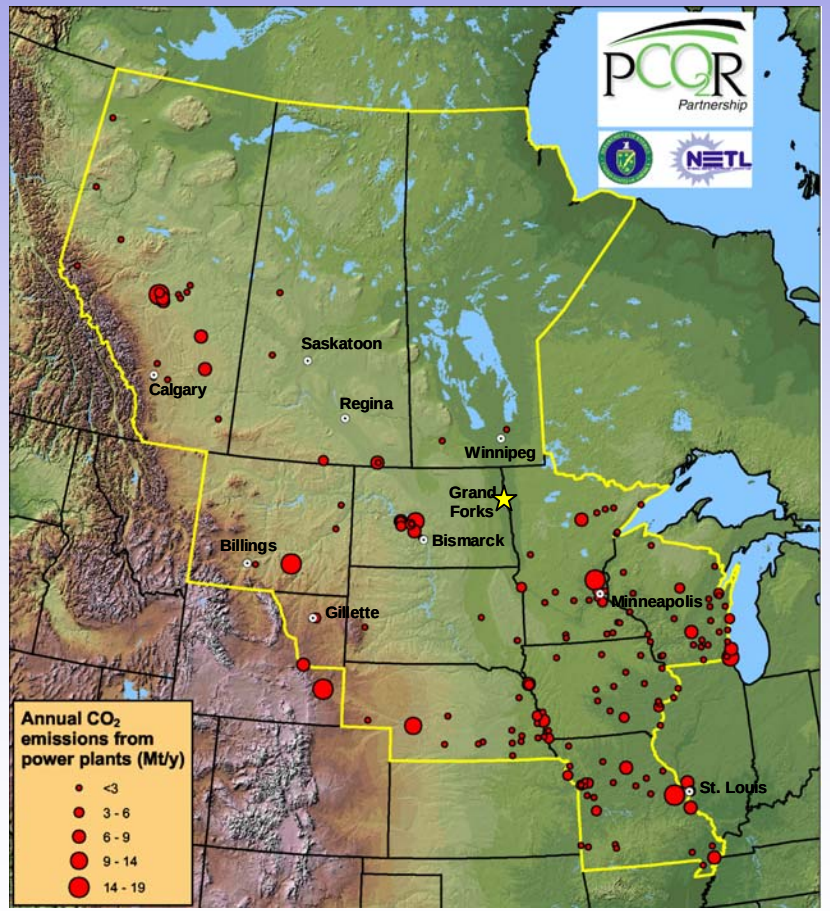
University of North Dakota

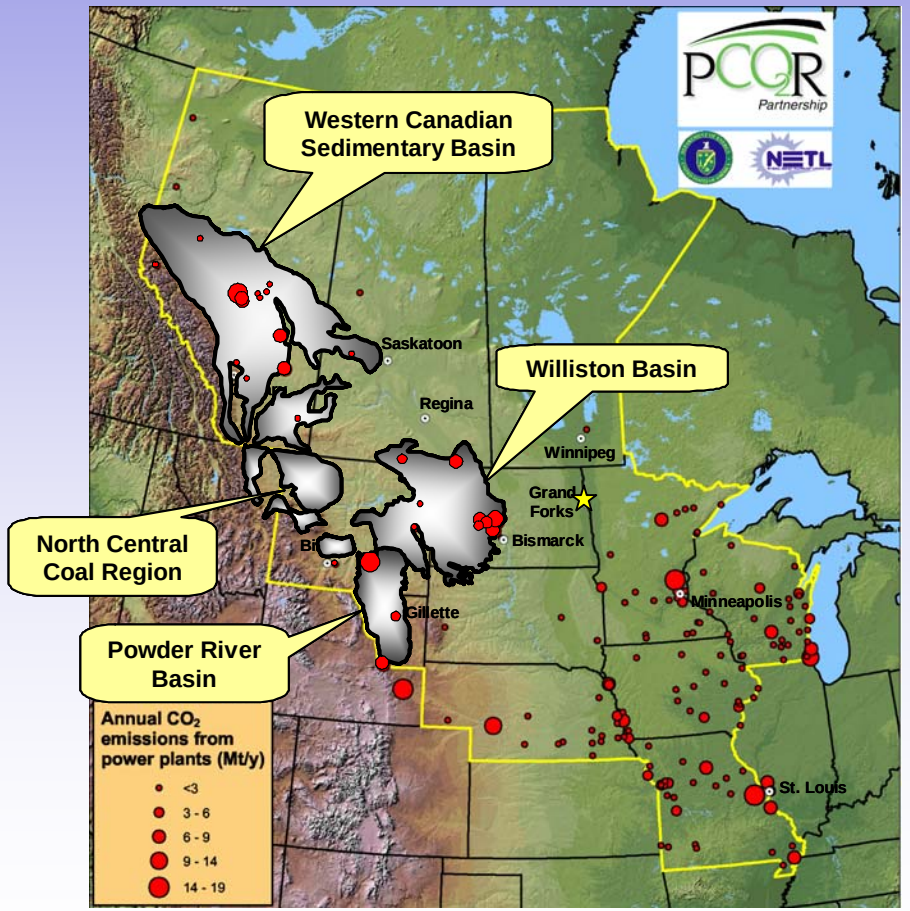
May 2-5, 2005, Hilton Alexandria Mark Center, Alexandria Virginia

Plains CO_2 Reduction Partnership
(DOE-NETL Regional Partnership Program)



- ★ Led by EERC, Univ. ND
- Nine states and three Canadian provinces
- 13.1% of annual U.S. & Canadian CO_2 emissions
  - 664 Mt/y (U.S. PCOR)
  - 247 Mt/y (Canada PCOR)
- 65% of annual stationary U.S. PCOR area CO_2 emissions are from electric utilities
- Diverse geological CO_2 sequestration options
  - Enormous coal resources

Sedimentary Basins in the Northern Great Plains Region

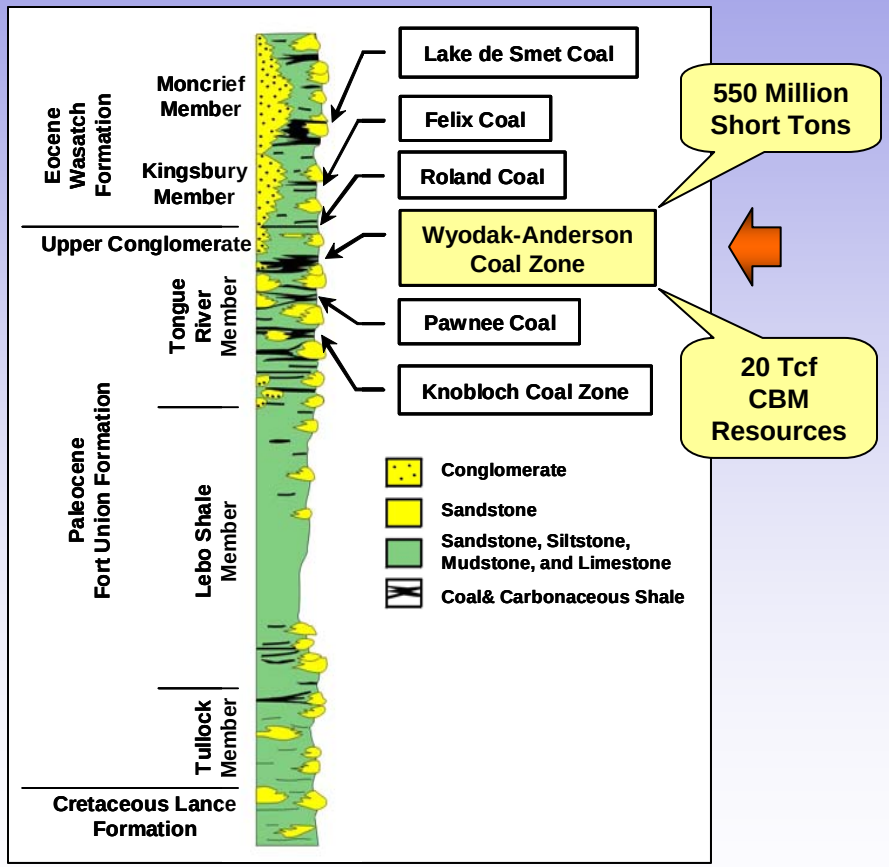


- **Western Canadian Sedimentary Basin**
  - **2.2 trillion short tons**
  - **Lignite & subbit. coal**
- **North Central Coal Region**
  - **0.48 trillion short tons**
  - **Lignite – high vol bit. coal**
- **Williston Basin**
  - **>0.36 trillion short tons**
  - **Lignite coal**
- **Powder River Basin**
  - **1.3 trillion short tons**
  - **Lignite & subbit. coal**

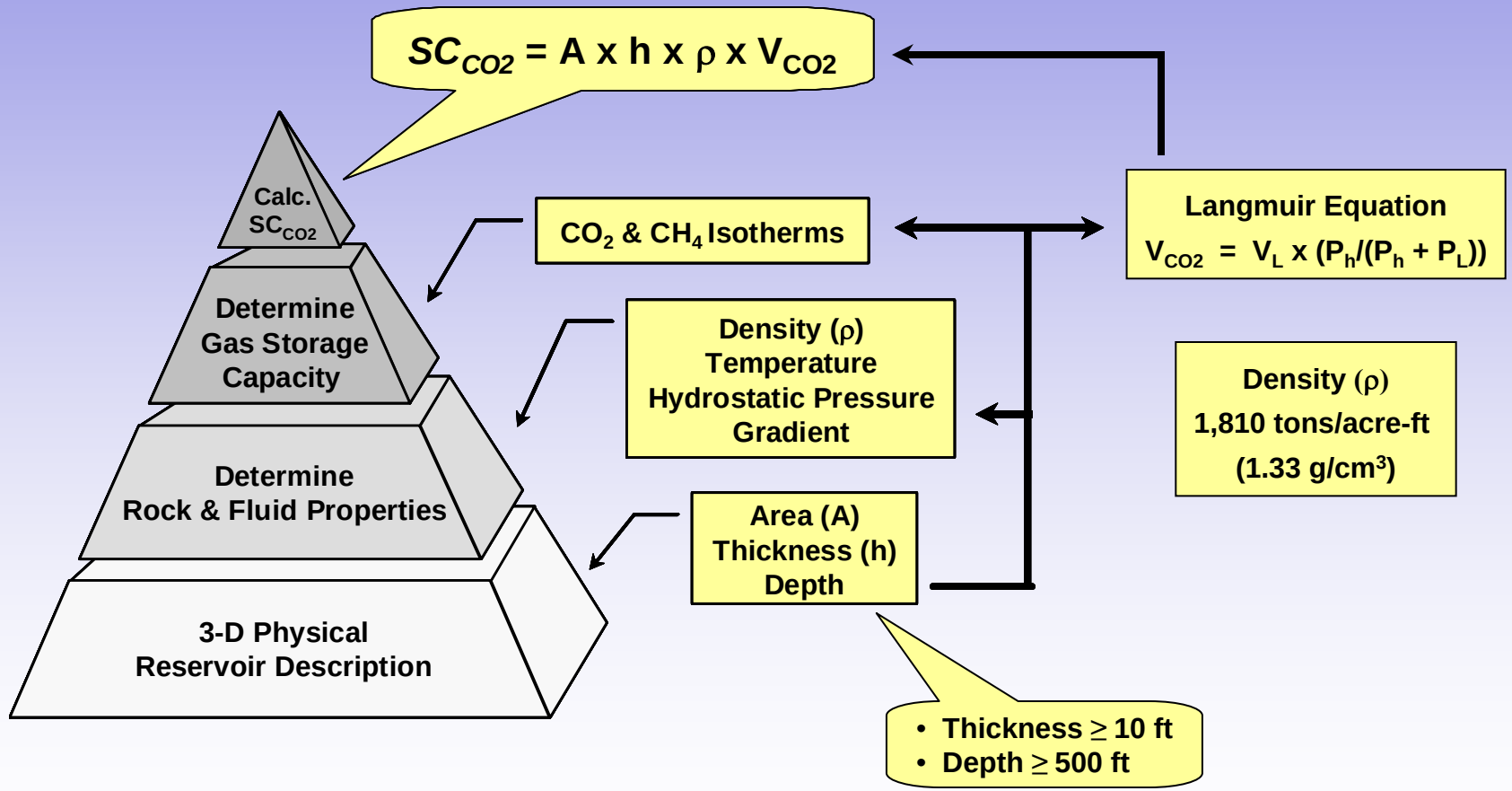
Powder River Basin

- Number one coal producing area in U.S.
  - 18 surface mines
  - 36% U.S. coal production in 2002
- 8 Coal-fired electric power plants located within 60 miles
  - 46.6 Mt/y CO_2 emissions
  - 7% annual U.S. PCOR total
- Giant coalbed gas play area
  - 340 Bcf in 2004
  - 13,880 wells
  - 150+ ft thick coal seams
  - Darcy-level permeability

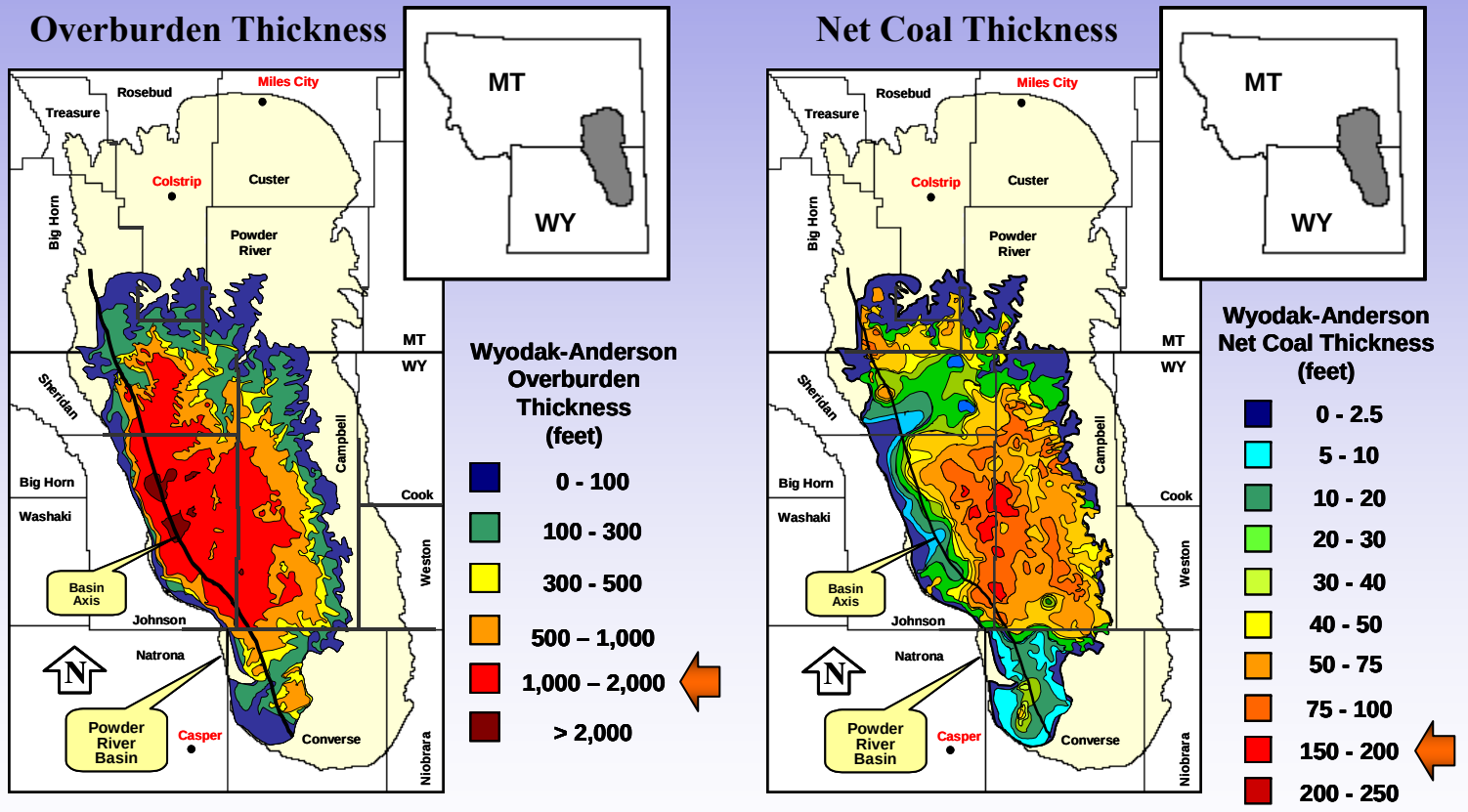
Coal-Bearing Formations



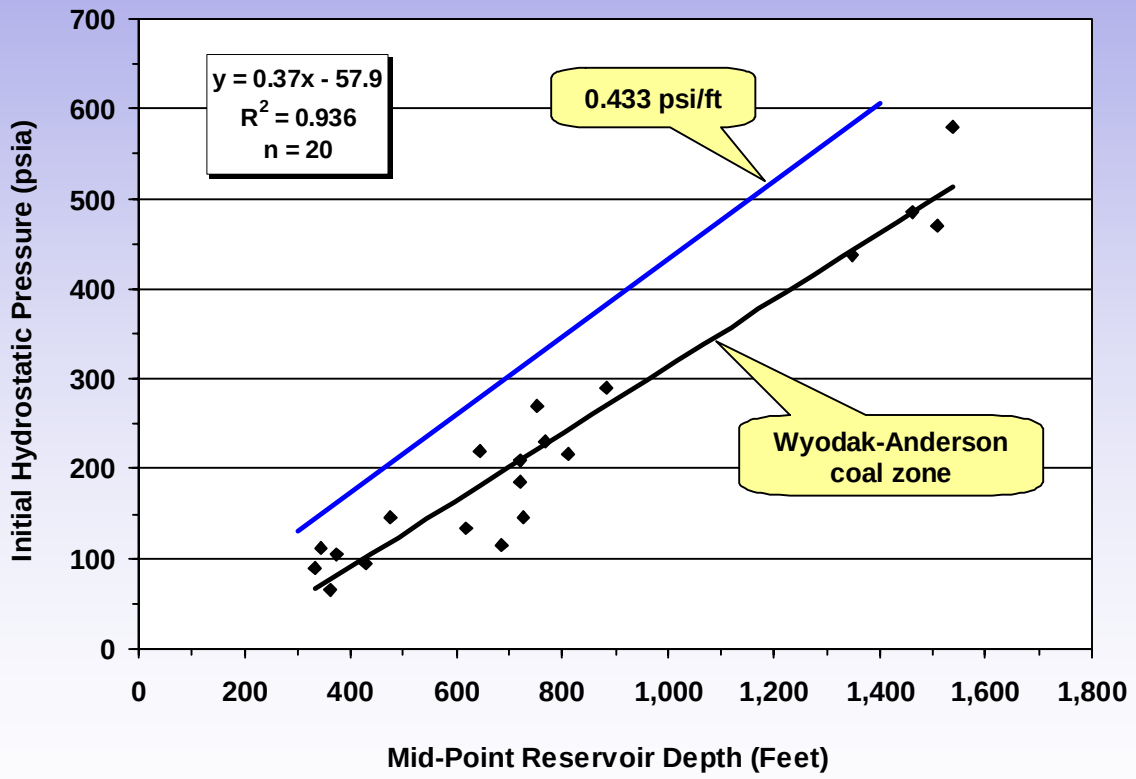
Volumetric CO_2 Storage Capacity Assessment



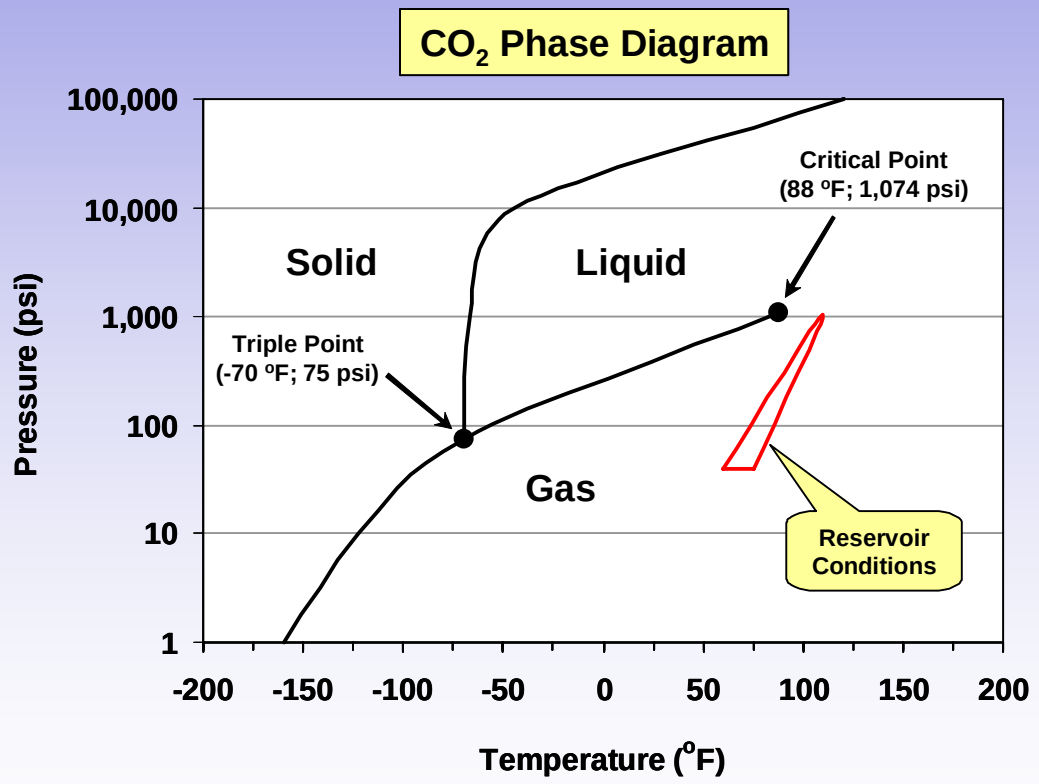
Wyodak-Anderson Coal Zone Attributes



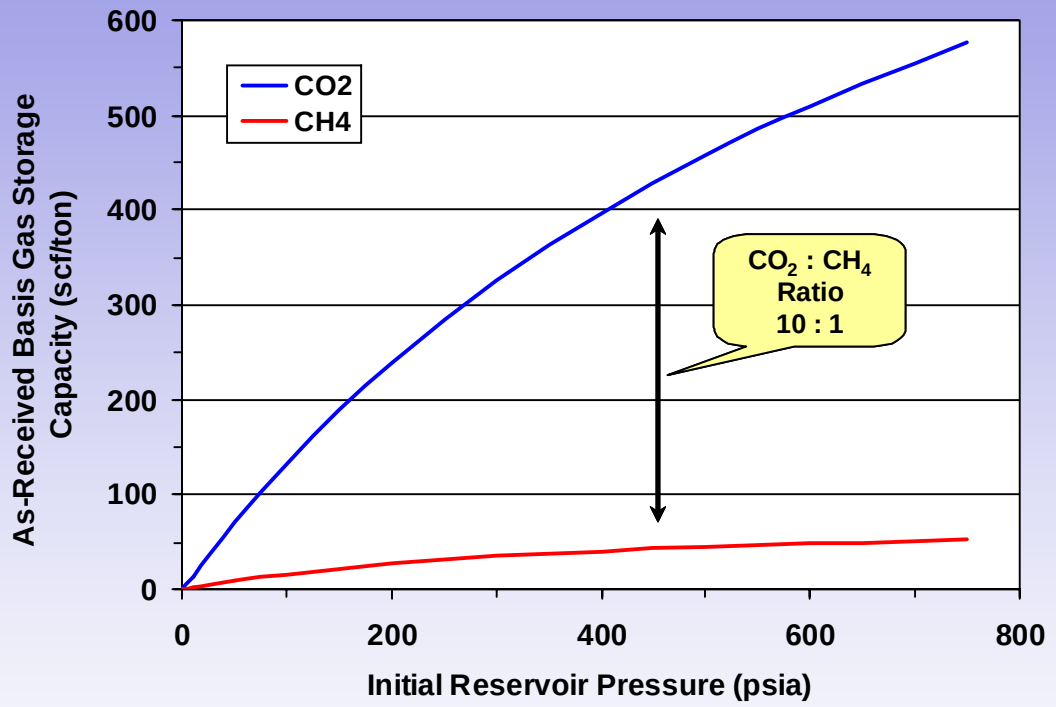
Hydrostatic Pressure Gradient in the Wyodak-Anderson Coal Zone



Temperature and Pressure Conditions in the Wyodak-Anderson Coal Zone



CO_2 and CH_4 Adsorption Isotherms



Langmuir Equation

$V_{CO2} = V_L \times (P_h/(P_h + P_L))$

Depth Interval	CO_2 Storage Capacity Equations [a,b]
500 – 1,200 ft	$SC_{CO2} = [1045 \times (P_h/(P_h + 650))]$
> 1,200 ft	$SC_{CO2} = [1100 \times (P_h/(P_h + 620))]$

[a] P_h = Initial hydrostatic pressure.

[b] SC_{CO2} = scf/ton (in-situ basis).

Depth Interval	CH_4 Storage Capacity Equations [a,b]
500 – 1,200 ft	$GC = [95 \times (P_d/(P_d + 330))]$
> 1,200 ft	$GC = [150 \times (P_d/(P_d + 450))]$

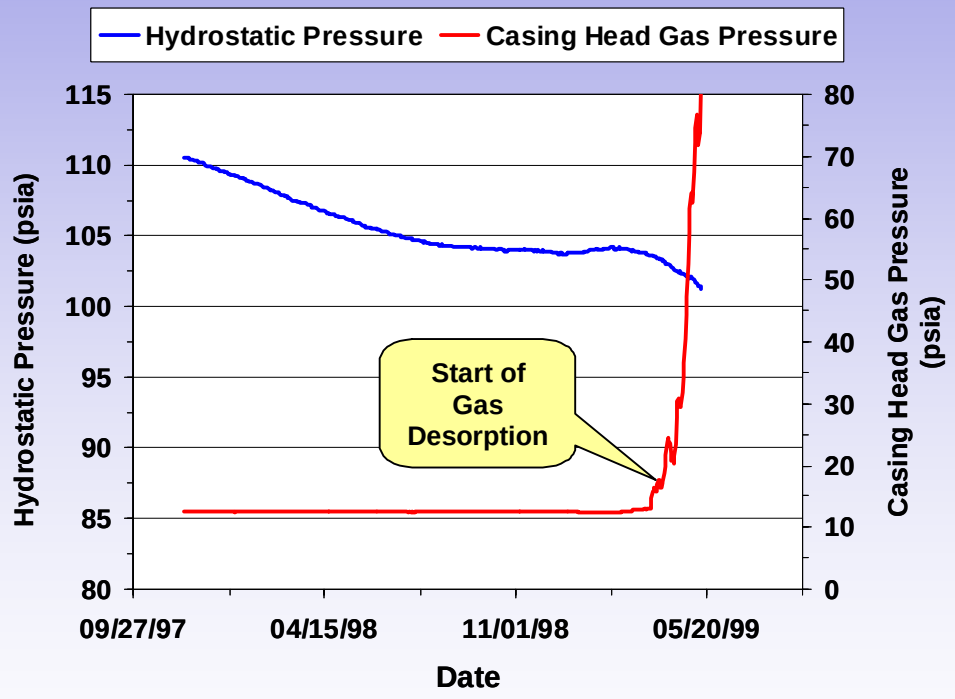
[a] P_d = Gas desorption pressure.

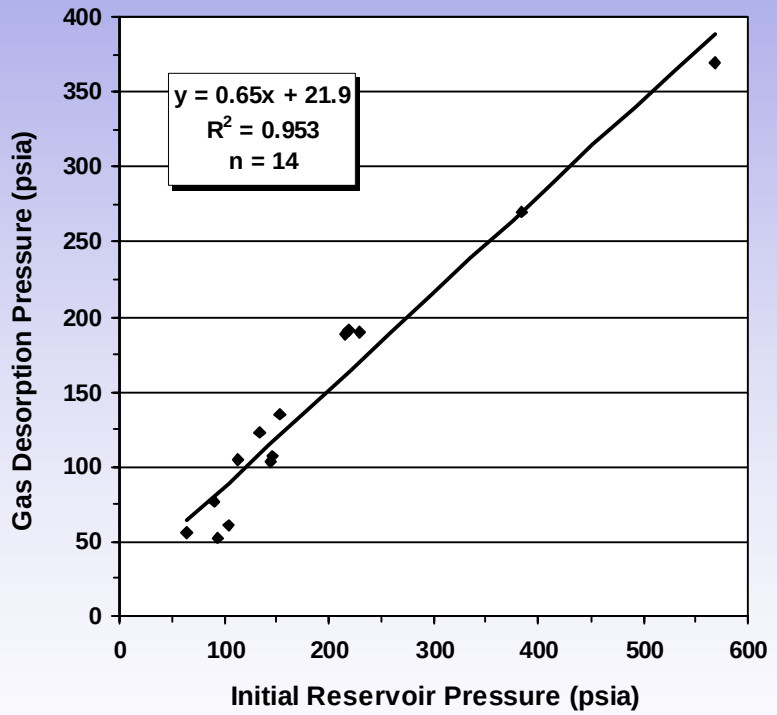
[b] GC = scf/ton (in-situ basis).

Engineering Safety Factor

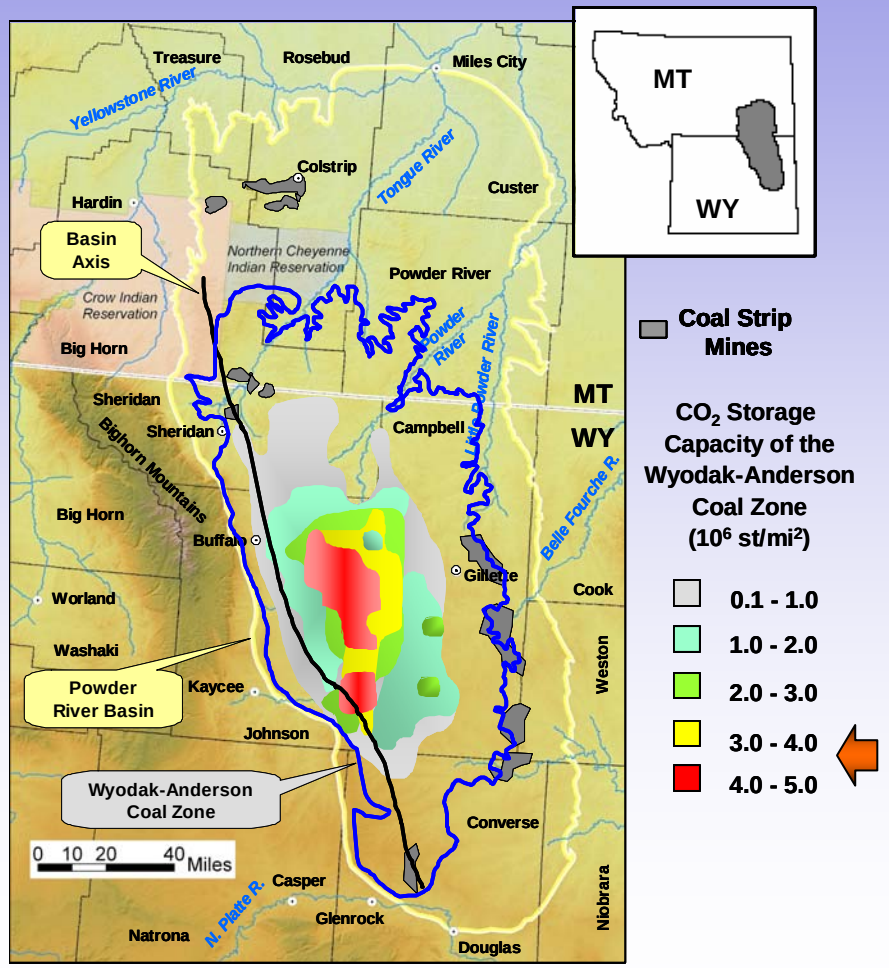
Limit maximum sorbed phase CO_2 volume such that a 20% hydrostatic pressure drop was required before CO_2 desorption would begin.

Gas Desorption Pressure in the Wyodak-Anderson Coal Zone





Geologic CO_2 Sequestration Potential and CBM Resource Estimates



Coal and CBM Resource and Geologic CO_2 Sequestration Potential Estimates for the Wyodak-Anderson Coal Zone *

Depth Interval (ft)	Coal	CBM	CO_2 Storage Capacity	
	10^9 st	Tcf	Tcf	10^9 st
500 – 1,000	178	6.2	20.3	1.18
> 1,000	217	12.7	117.3	6.80
Total	395	18.9	137.6	7.98

* Areas with net coal thickness ≥10 ft.

85 %

Summary and Conclusions

- **The Wyodak-Anderson coal zone in the Powder River Basin contains 395 billion short tons of subbituminous coal resources in areas with favorable geologic characteristics for CO_2 storage.**
- **Areas with the highest CO_2 sequestration potential (3 - 5 million short tons /mi^2) are found in the central, deeper part of the basin.**
- **In most areas, the reservoir temperature and pressure conditions will not favor supercritical CO_2 formation.**
- **The total CO_2 sequestration potential estimate for areas where the overburden thickness of the Wyodak-Anderson coal zone is >1,000 ft is 6.8 billion short tons.**
- **The coal resources that underlie these deep areas could sequester roughly 7% of the current annual U.S. PCOR region CO_2 emissions for the next 156 years.**