

Geology of Coal and Coalbed Methane in the Powder River Basin

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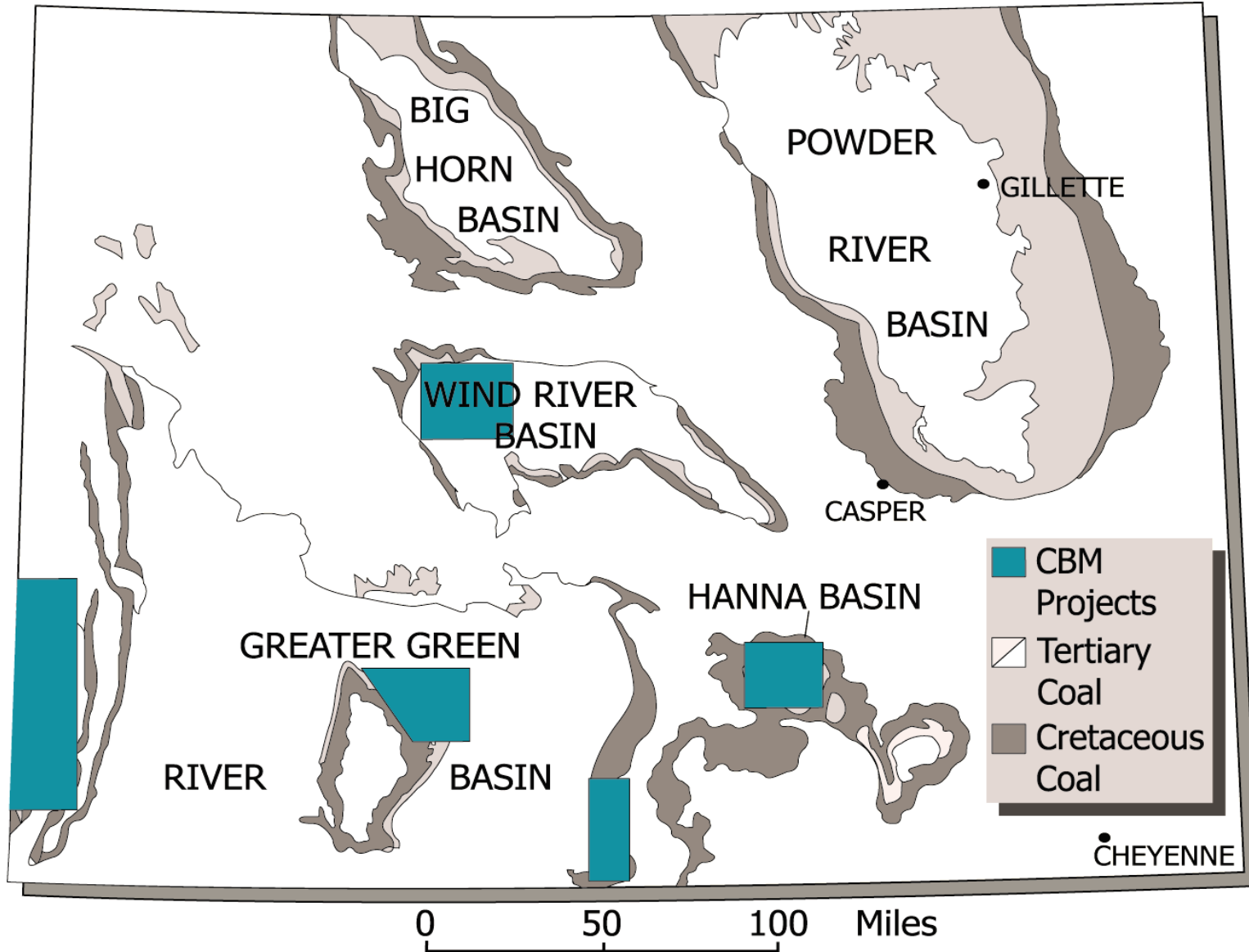
**USGS CBM Field Conference
Casper, WY
May 9-10, 2001**



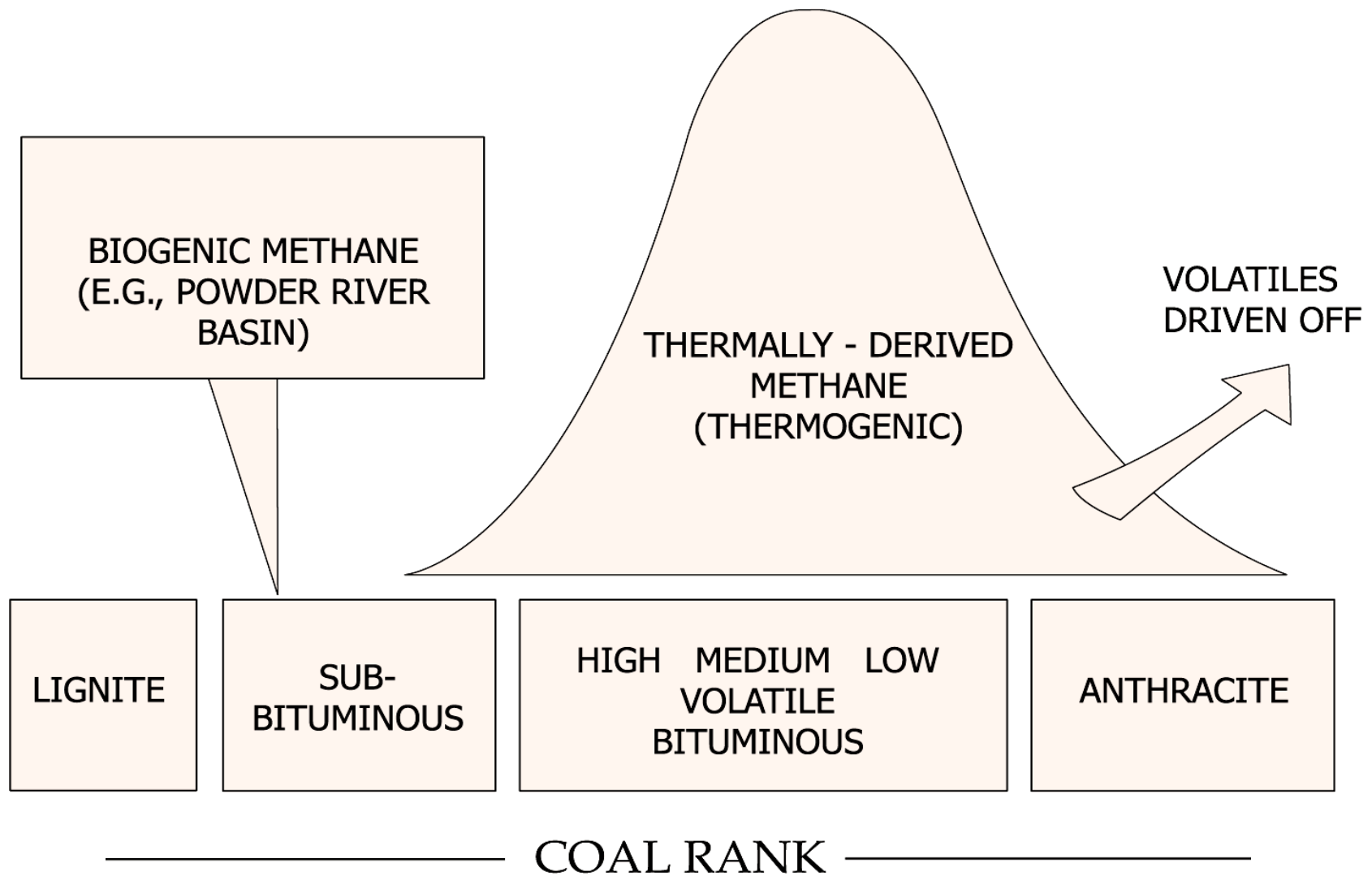
GEOLOGICAL OVERVIEW OF COALBED METHANE (CBM)

- WYOMING RESOURCE POTENTIAL
- POWDER RIVER BASIN (PRB): BLM-USGS COOPERATIVE PROJECT
 1. Coal Geology
 2. Origin of CBM

COAL MAP OF WYOMING



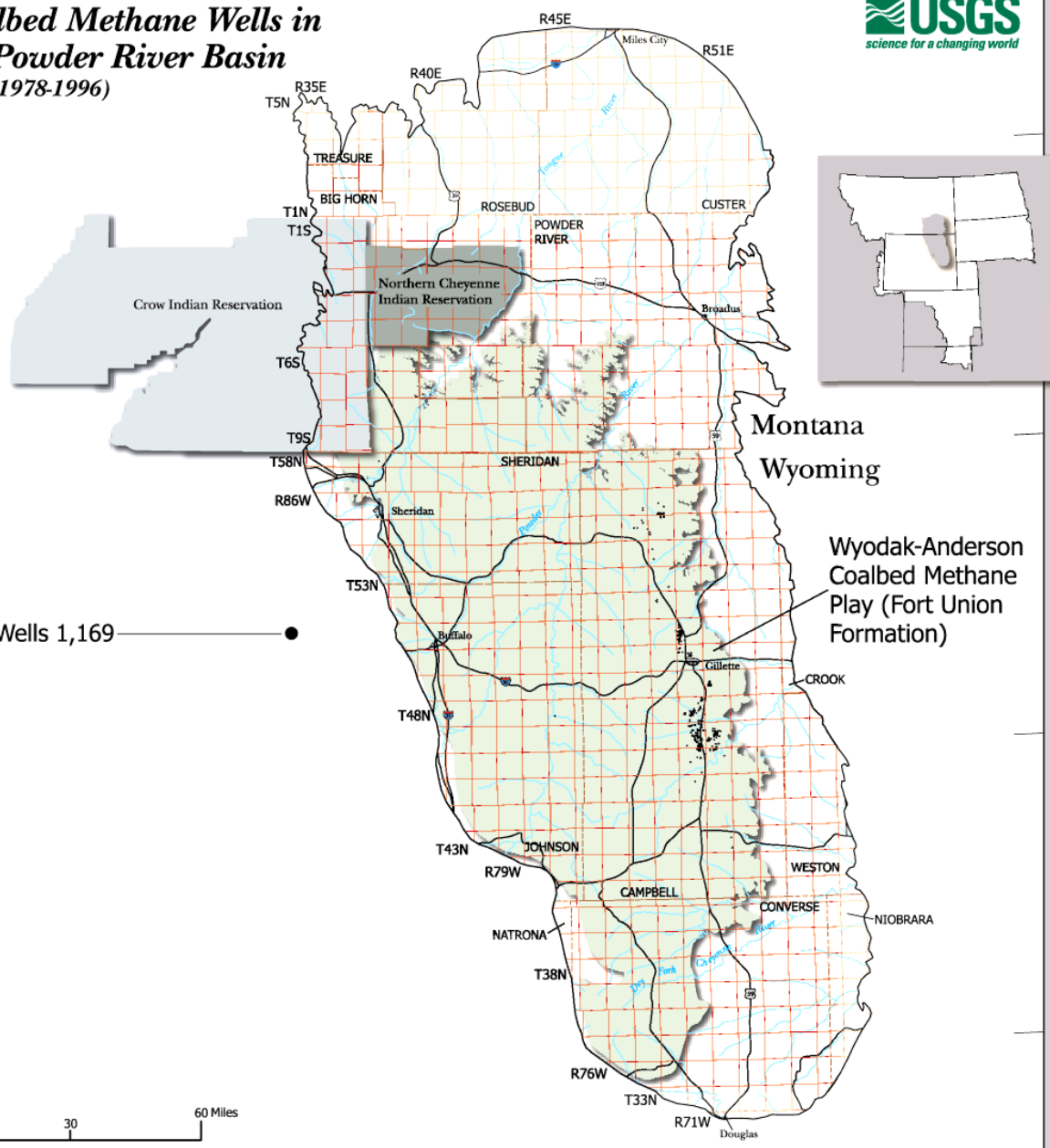
COALBED METHANE GENERATION MODEL



109° 108° 107° 106° 105° 104°

Coalbed Methane Wells in the Powder River Basin

(from 1978-1996)

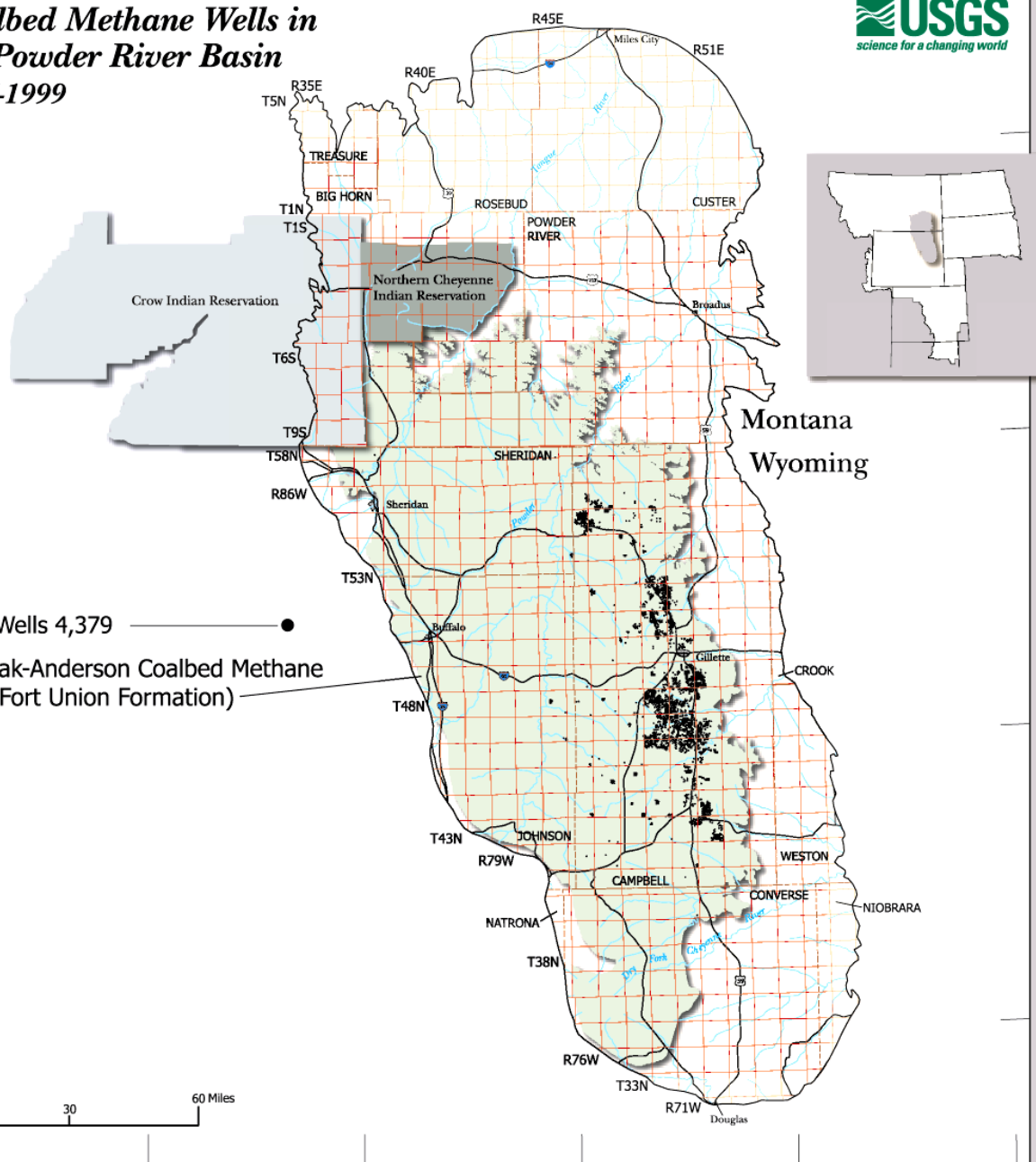


Total Wells 1,169

46°
45°
44°
43°

109° 108° 107° 106° 105° 104°

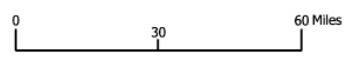
Coalbed Methane Wells in the Powder River Basin 1997-1999



46°
45°
44°
43°

Total Wells 4,379 ●

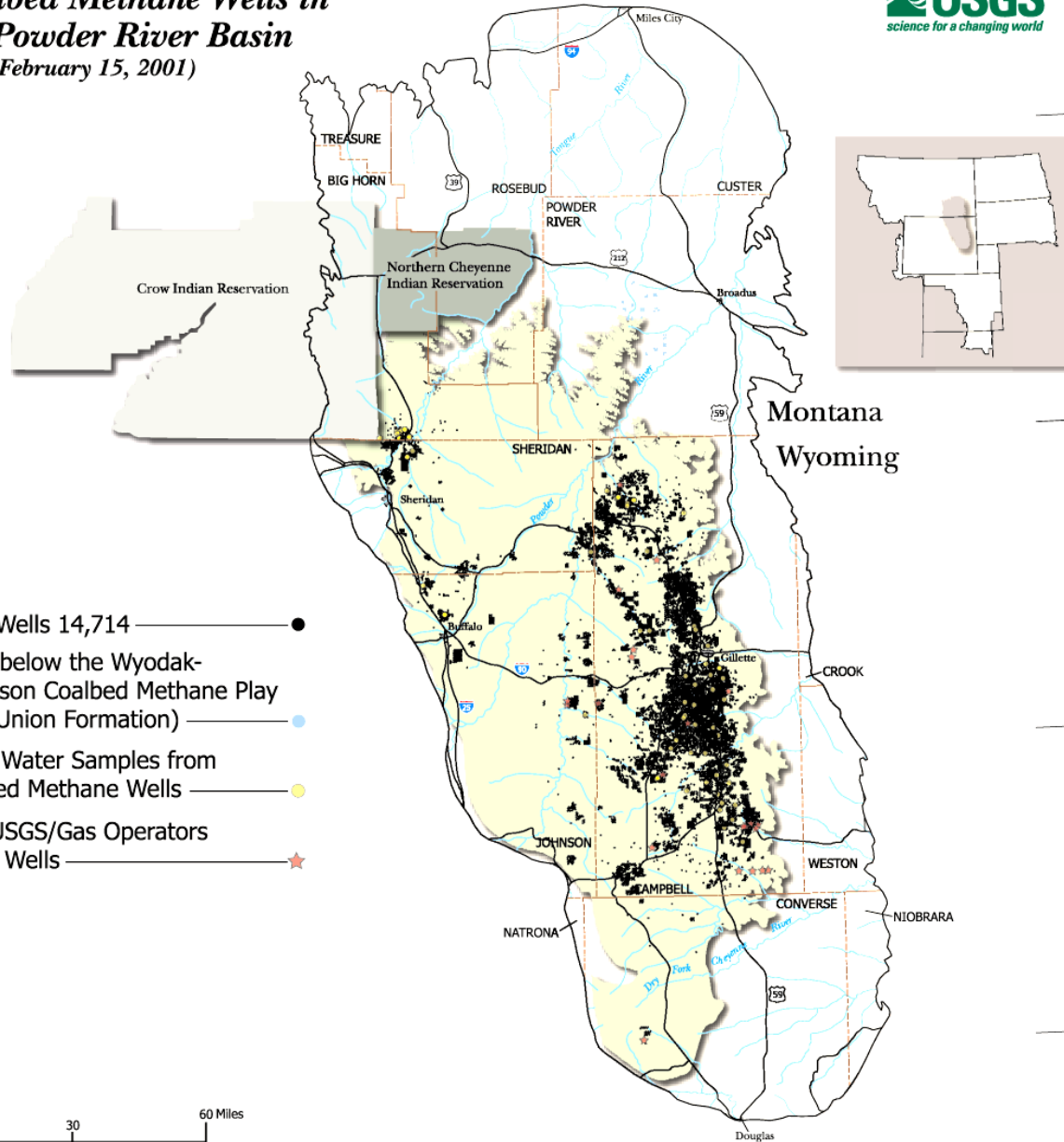
Wyodak-Anderson Coalbed Methane Play (Fort Union Formation)



109° 108° 107° 106° 105° 104°

Coalbed Methane Wells in the Powder River Basin

(as of February 15, 2001)



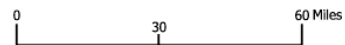
46°

45°

44°

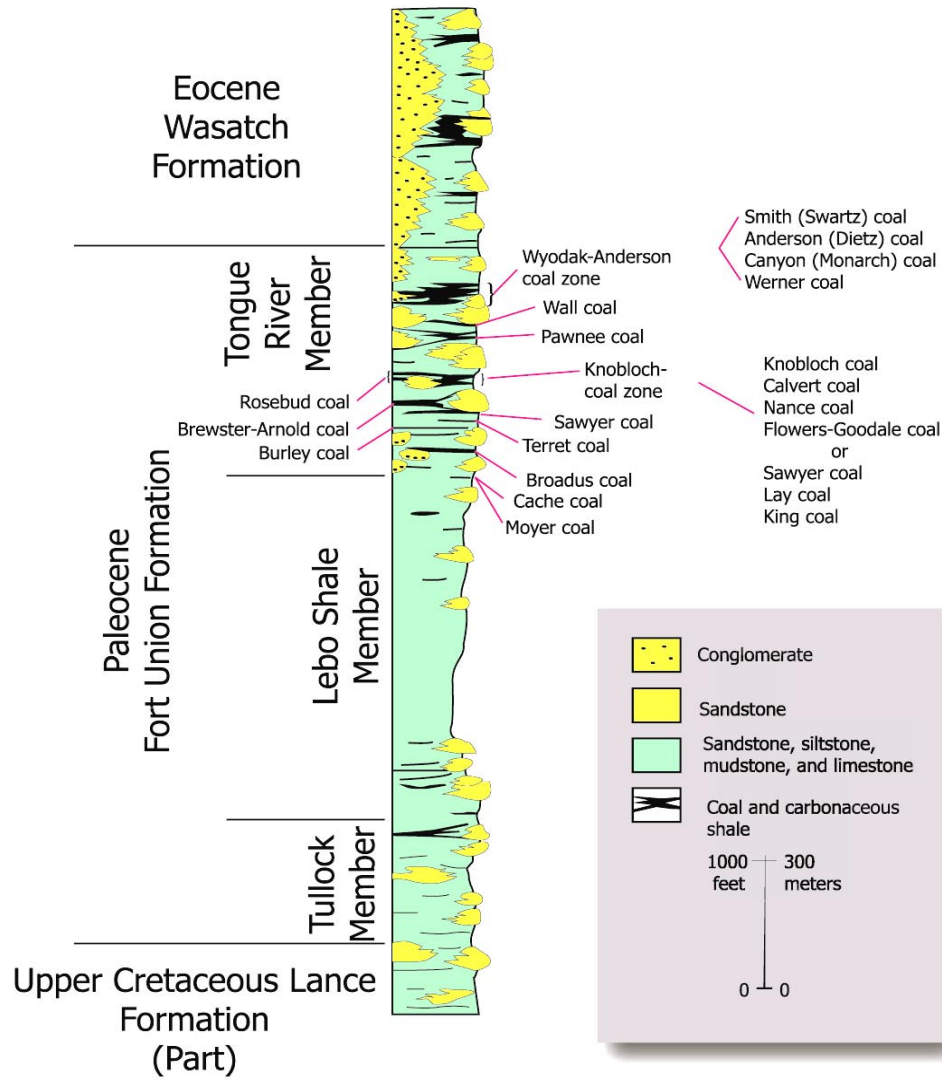
43°

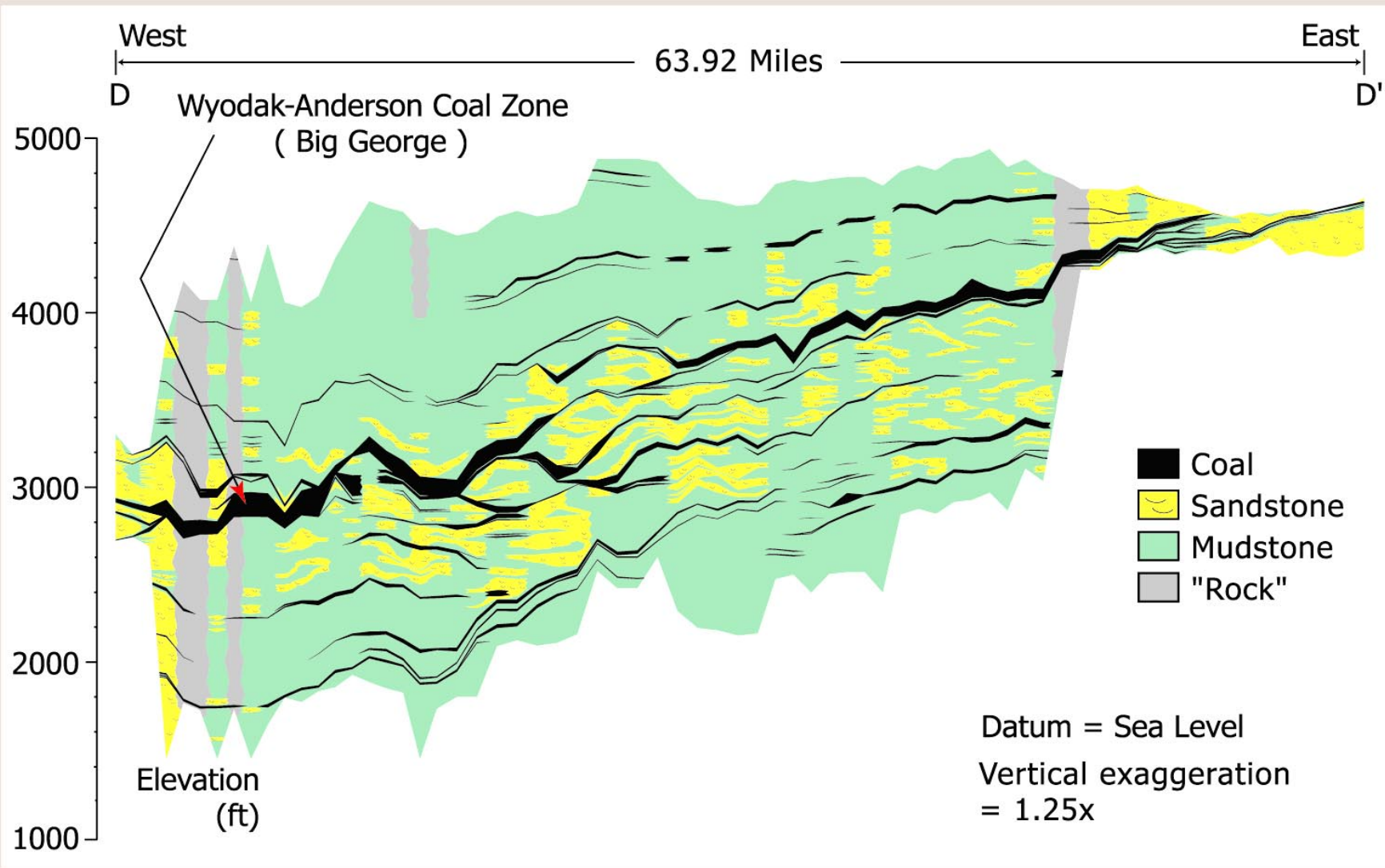
- Total Wells 14,714 ●
- Wells below the Wyodak-Anderson Coalbed Methane Play (Fort Union Formation) ●
- USGS Water Samples from Coalbed Methane Wells ●
- BLM/USGS/Gas Operators Cored Wells ★



COAL AND COALBED METHANE MODEL (POWDER RIVER BASIN)

- COAL RESOURCES: >1 TRILLION SHORT TONS OF SUBBITUMINOUS COAL (TERTIARY FORT UNION AND WASATCH FMS)
- COAL-BED THICKNESS: 20 BEDS (20-250 FT)
- DEPTHS: 250-3,000 FT
- COALBED METHANE (CBM): MAINLY LATE BIOGENIC.





108°

106°

46°

POWDER
RIVER
BASIN

Montana
Wyoming



Net Coal Thickness

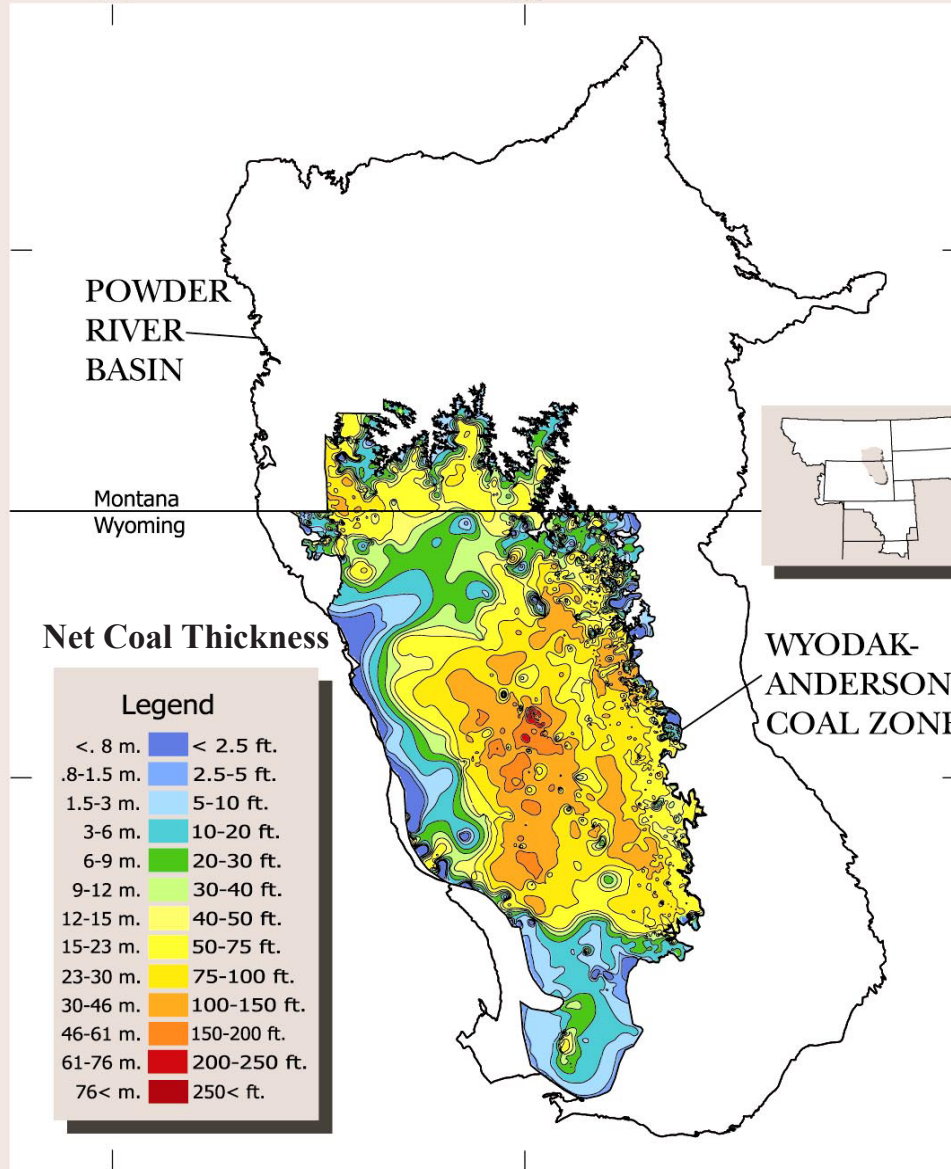
Legend

<. 8 m.	< 2.5 ft.
.8-1.5 m.	2.5-5 ft.
1.5-3 m.	5-10 ft.
3-6 m.	10-20 ft.
6-9 m.	20-30 ft.
9-12 m.	30-40 ft.
12-15 m.	40-50 ft.
15-23 m.	50-75 ft.
23-30 m.	75-100 ft.
30-46 m.	100-150 ft.
46-61 m.	150-200 ft.
61-76 m.	200-250 ft.
76< m.	250< ft.

WYODAK-
ANDERSON
COAL ZONE

44°

0 40 50 100 Miles
40 120 Kilometers



108°

106°

46°

POWDER
RIVER
BASIN

Montana
Wyoming



OVERBURDEN
WYODAK-
ANDERSON
COAL ZONE

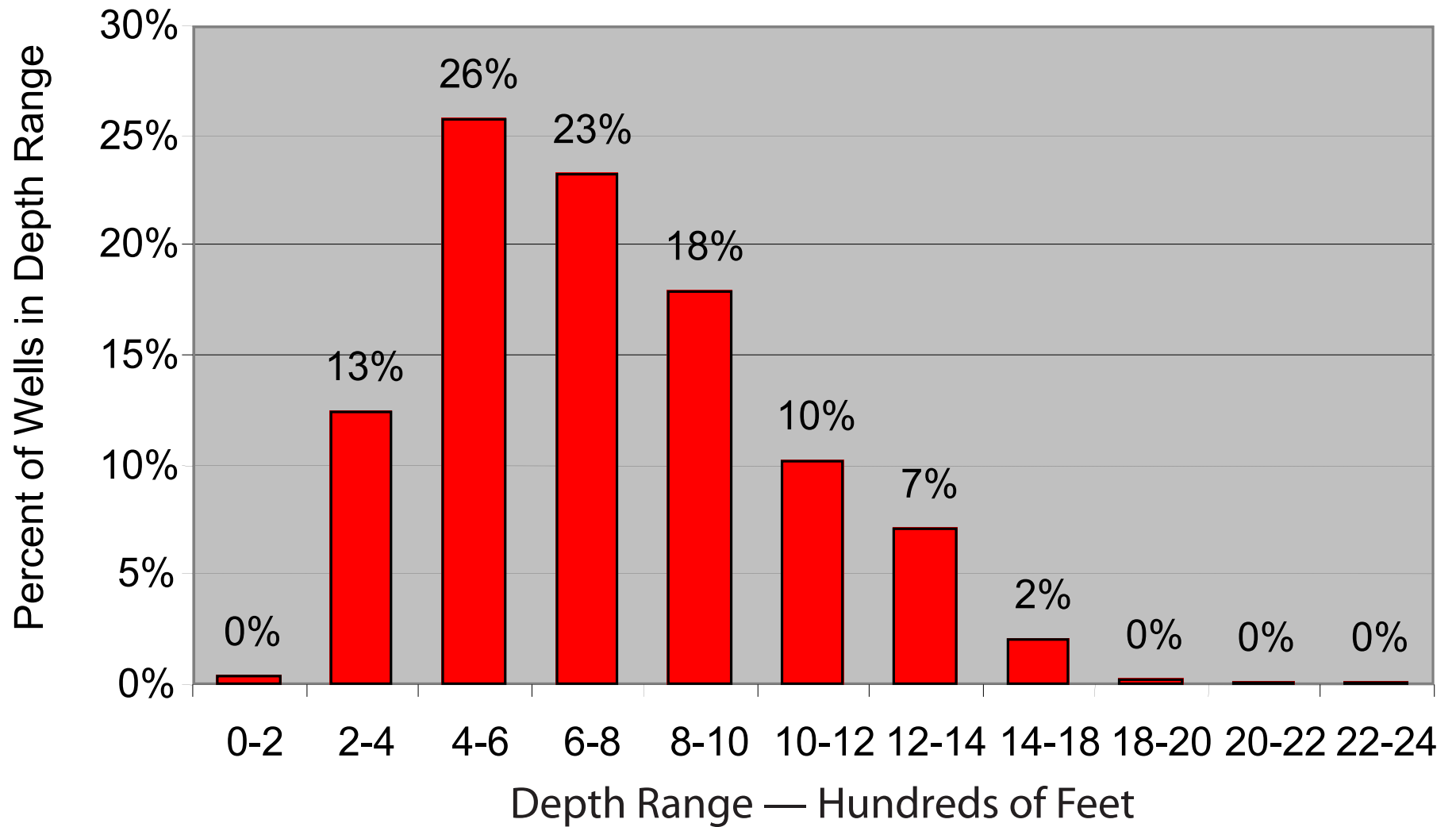
44°

Legend

<30 m.	<100 ft.
30-60 m.	100-200 ft.
60-90 m.	200-300 ft.
90-120m.	300-400 ft.
120-150 m.	400-500 ft.
150-300 m.	500-1000 ft.
300-600 m.	1000-2000 ft.
600< m.	2000< ft.

0 40 50 100 Miles
Kilometers

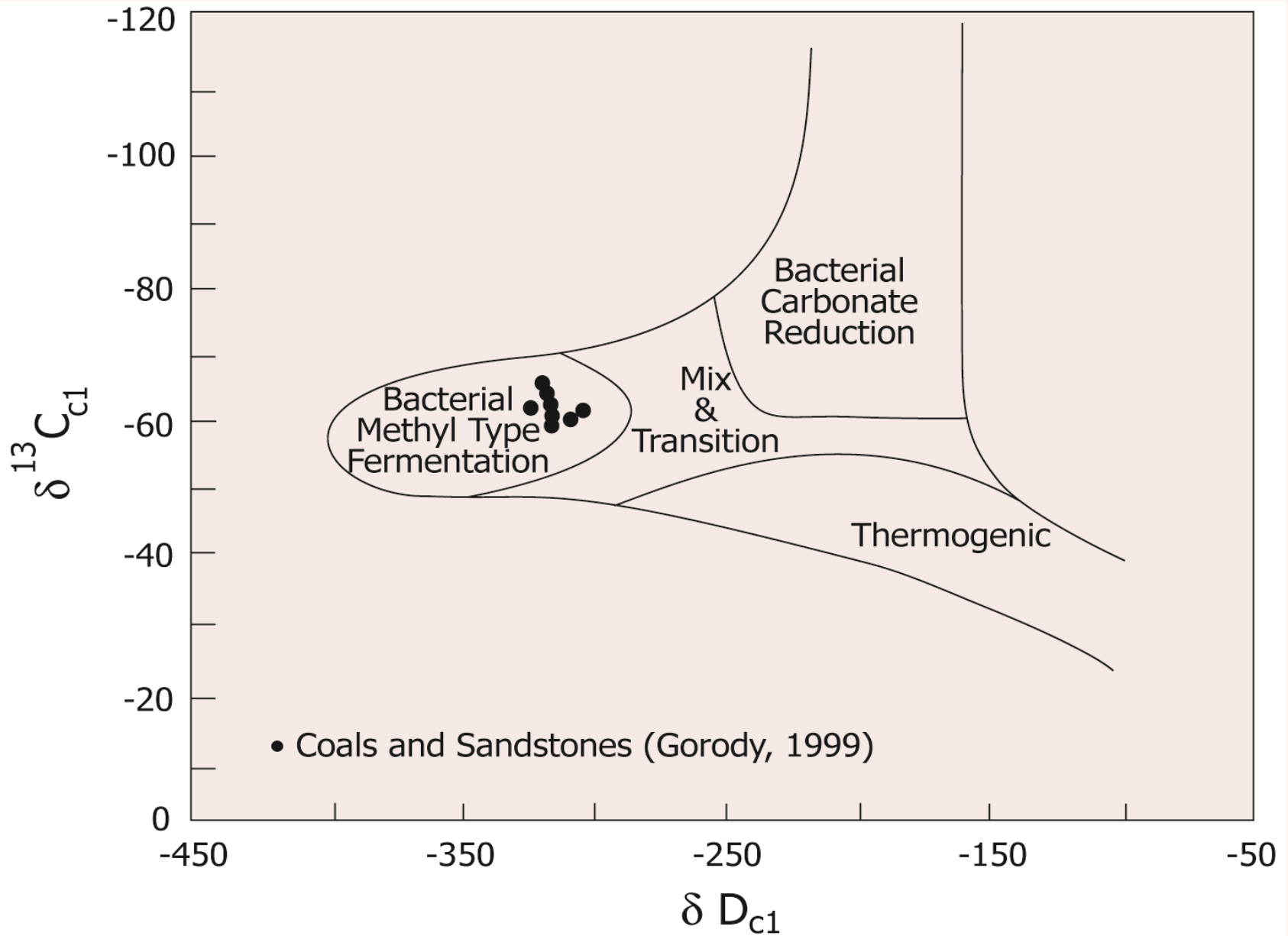
CBM Wells in the Powder River Basin, Wyoming



Data are from PI/Dwights production database

Chemical composition of coalbed methane from the “Big George” coal.
Modified from Boreck and Weaver (1984)

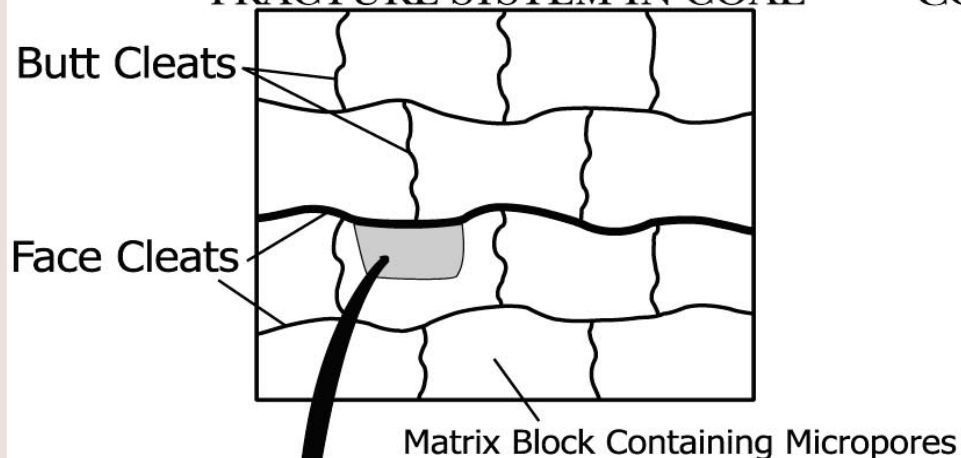
Sample	Type	N ₂ nitrogen	CO ₂ carbon dioxide	C ₁ methane	C ₂ ethane	C ₃ propane	iC ₄ isobutane	nC ₄ normal butane	iC ₅ isopentane	nC ₅ normal pentane	dc ¹³ 0/00	C ₁ / C ₁₋₅
MRBG2	Canister	37.84	4.84	57.08	0.22	0.025	-----	-----	-----	-----	-----	-----
	air-free	-----	7.79	91.81	0.35	0.04	-----	-----	-----	-----	-58.64	0.9958
MRBG3	Canister	31.95	3.93	63.71	0.29	0.04	0.01	0.06	-----	-----	-----	-----
	air-free	-----	5.78	93.63	0.43	0.06	0.02	0.08	-----	-----	-59.29	0.9936
MRBG4	Canister	34.23	6.17	59.08	0.30	0.10	0.03	0.02	0.06	0.005	-----	-----
	air-free	-----	9.38	89.83	0.45	0.15	0.05	0.03	0.10	0.01	-60.07	0.9913
MRBG5	Canister	44.42	3.90	51.45	0.14	0.09	-----	-----	-----	-----	-----	-----
	air-free	-----	7.01	92.57	0.26	0.16	-----	-----	-----	-----	-59.98	0.9955
MRBG6	Canister	43.43	6.07	50.03	0.33	0.13	0.01	-----	-----	-----	-----	-----
	air-free	-----	10.72	88.44	0.59	0.22	0.02	-----	-----	-----	-60.85	0.9907
MRBG7	Canister	67.27	1.31	30.45	0.17	0.19	0.32	0.08	0.19	0.01	-----	-----
	air-free	-----	4.00	93.04	0.53	0.58	0.97	0.24	0.59	0.04	-53.59	0.9691



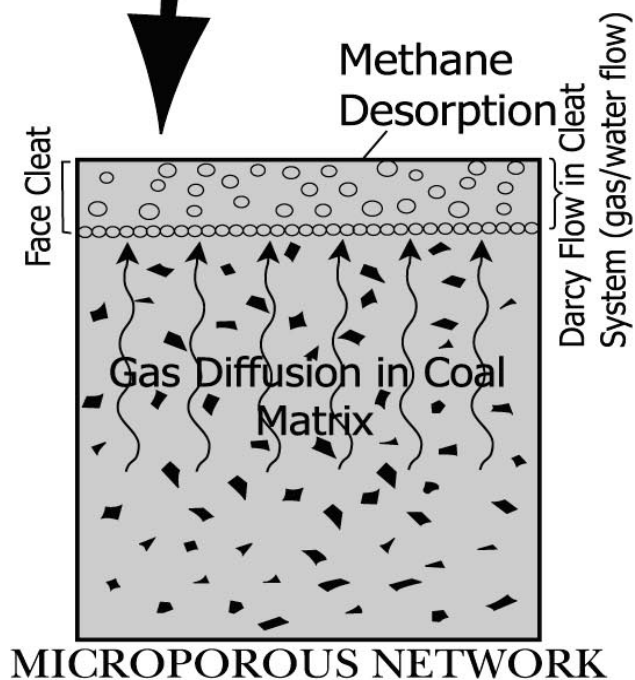
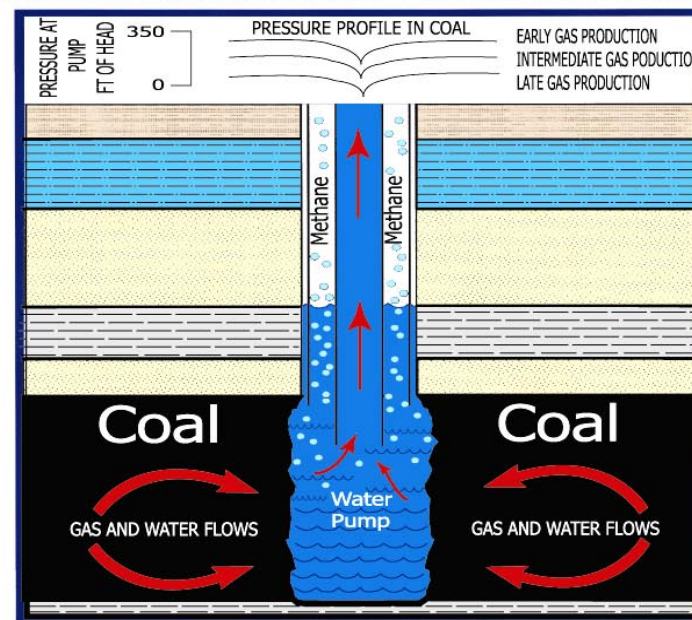


Middle Wyodak coal bed, Jacobs Ranch Coal Mine

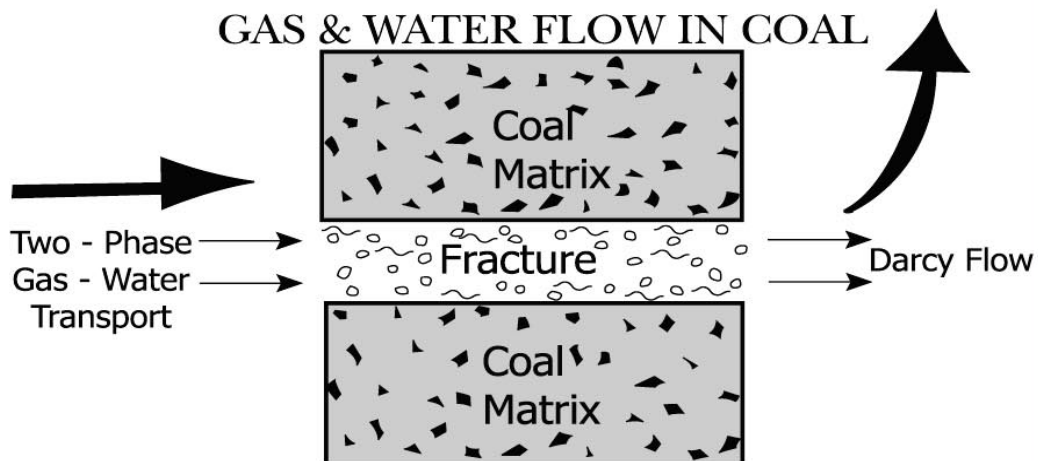
FRACTURE SYSTEM IN COAL



COALBED METHANE WELL SCHEMATIC



GAS & WATER FLOW IN COAL



WATER ISSUES

- 1) 100 TIMES GREATER THAN BITUMINOUS COAL
- 2) WATER DISPOSAL
- 3) DEPLETION OF GROUND WATER
- 4) QUALITY OF WATER

References

Boreck, D.L., and Weaver, J.N., 1984, Coalbed methane study of the 'Anderson' coal deposit, Johnson County, Wyoming - a preliminary report: U.S. Geological Survey Open-File Report 84-831, 16 p.

Gorody, A.W., 1999, The origin of natural gas in the Tertiary coal seams on the eastern margin of the Powder River Basin, in Miller, W.R., ed., Coalbed methane and the Tertiary geology of the Powder River Basin, Wyoming and Montana: Wyoming Geological Association, Fiftieth Field Conference Guidebook, p. 89-101.