STATE OF NORTH DAKOTA
BAKKEN FORMATION RESOURCE STUDY PROJECT

By
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This paper presents the results and methodology of a project by the North Dakota Department of Mineral Resources (DMR) Oil and Gas Division (OGD) and Geological Survey (NDGS) to estimate the original oil in place (OOIP) and recoverable reserves in the Bakken Formation within the State of North Dakota.

The original oil in place in the Bakken Formation within the thermally mature portion of the State of North Dakota is estimated to be **149.2 billion barrels**. The estimates are presented by County and separated into the total Bakken Formation, upper Bakken shale member, middle Bakken member, and lower Bakken shale member to make them more useful for resource evaluation and planning (Tables 1-4) and (Figures 3-6).

OOIP is defined as the total hydrocarbon content of an oil reservoir and refers to the oil in place before the commencement of production. OOIP is measured in stock tank barrels, meaning the volume of oil is corrected for shrinkage that occurs when the oil is brought to the surface to be sold at standard pressure and temperature. OOIP must not be confused with *oil reserves* which are the technically and/or economically recoverable portion of the oil volume in the reservoir and is referred to in this publication as estimated ultimate recovery (EUR).

The estimates of Bakken Formation OOIP and EUR provided in this publication are valuable for economic forecasting and infrastructure planning. These estimates also highlight the enormous potential for increasing recovery through continued development and deployment of new technology.

Previous publications on the Bakken Formation from Dow (1974) to Flannery and Kraus (2006) focused on the potential of the formation as a source rock. These investigators made estimates of the volume of oil that the Bakken Formation has generated ranging from 10 to 500 billion barrels. This paper differs from those publications in that it uses a wealth of public geology and engineering data generated since 2004 to estimate OOIP in the Bakken Formation. This estimate validates the highest oil generation estimates of Price (unpublished) and Flannery and Kraus (2006).

The Bakken Formation EUR using current drilling and completion practices within the thermally mature portion of the state of North Dakota has also been estimated. The estimated ultimate recovery is approximately **1.4%** of original oil in place, which is equal to **2.1 billion barrels.** The estimated recovery factors are also presented by county to show the high degree of variability in the geology and productivity of the Bakken Formation (Table 1). Note the recovery factors range from a low of 0.7% in Divide County to a high of 3.7% in Billings County.

The process of estimating Bakken Formation OOIP began with the compiling of a database containing all rock property, oil property, EUR, well cost, and well performance data presented to the Industrial Commission as expert testimony from June 2004 through December 2007. This database contains the geological and engineering data from 496 cases representing over 2,100 square miles of the Bakken resource broadly distributed across the state and is included as an Excel™ spreadsheet on the CD version of this publication. The data was sorted by county and evaluated using standard statistical methods to eliminate outliers and to determine mean, minimum, and maximum values. Well performance and economic data was also included and can be analyzed to evaluate the effectiveness of variations in well spacing and well bore geometry.

The rock properties in the case exhibit database yield statistically representative porosity and oil saturation values for the middle Bakken member for each county within the thermally mature region of the Bakken in western North Dakota. Additional data was required to evaluate the upper and lower Bakken shale members. A total of 601 core derived porosity analyses from the Bakken Formation are included in OGD well files (data is included as an Excel™ spreadsheet on the CD). The average effective porosity from the entire Bakken Formation was found to be approximately 5.5%. The upper Bakken shale member and lower Bakken shale member were found to contain an average effective porosity of 7% based on 60 analyses from seven wells in the upper Bakken shale member and 104 analyses from 13 wells in the lower Bakken shale member. Plug analyses of the middle member obtained from 437 samples from sixteen wells yielded an average effective porosity of 5.4%. A water saturation of 30% was selected for the mean value because it represents irreducible saturation and reflects the typically water free production from the Bakken shales. Minimum and maximum values of 20% and 40% were selected as representative of the same range above and below the mean as the middle Bakken member water saturation data.

The rock volume in each County was determined by using Petra™ software to planimeter isopach maps developed by Lefever (2008) as NDGS publication GI-59. Only the rock volume within the thermally mature region as determined through Time Temperature Index (TTI) mapping by Nordeng (2008) as NDGS publication GI-61, was included in this analysis (Figure 1). The TTI mapping was confirmed by comparison with a recent update of the work of Schmoker and Hester (1989). In this study it was proposed that the eastward limits where the upper and lower members of the Bakken Formation in North Dakota are thermally mature can be determined from resistivity measurements. Neset (2007) evaluated resistivity measurements of wells drilled after 1989 using resistivity logs obtained from the OGD website to evaluate and confirm or modify the thermal maturity boundaries of the Bakken Formation. Logs with a geometric average deep resistivity reading of 35 ohm-m or greater were classified as thermally mature and those with a reading less than 35 ohm-m were classified as thermally immature. Neset's results confirm Schmoker and Hester's previous maturity boundary and extended it to the south and west (figure 2).

We estimate that additional resources of **10.5-17.6 billion barrels** OOIP have migrated from thermally mature areas into areas of the Bakken Formation that are not thermally mature. This is evidenced by significant production from the upper Three Forks Formation in the Sinclair Field located in southwestern Manitoba more than 70 miles from the leading edge of oil generation in the Bakken Formation. Possible migration pathways include major lineament trends such as the Brockton-Froid or through Bakken Formation "thicks" associated with sub-basins in southern Renville and central Bottineau Counties. OOIP was calculated for the area that is not thermally mature using rock volume, average porosity, and tight sand irreducible oil saturation estimates for the Bakken Formation middle member only. This resource volume is estimated separately because it represents an unconventional tight formation oil play that requires oil migration together with structural or stratigraphic trapping mechanisms. The uncertainty of encountering accumulations of this resource is much greater than for the unconventional resource play within the thermally mature Bakken Formation region. There is currently no data from which to estimate EUR for this migrated resource.

Figure 1 – Thermally Mature Bakken Formation in North Dakota

Figure 2 - 35 ohm-m Contours Indicate Eastward Limits of Thermally Mature upper and lower Bakken shales

Figure 3 – Williston Basin with major structural features and modern Bakken / Three Forks production areas.

Table 1 & Figure 4 – Thermally Mature Total Bakken OOIP, EUR, and Recovery Factor.

Table 2 & Figure 5 – Thermally Mature upper Bakken shale member acres, acre-feet, porosity, Water Saturation (Sw), Formation Volume Factor (Bo), and OOIP

Table 3 & Figure 6 – Thermally Mature middle Bakken member acres, acre-feet, porosity, Sw, Bo, and OOIP

Table 4 & Figure 7 – Thermally Mature lower Bakken shale member acres, acre-feet, porosity, Sw, Bo, and OOIP

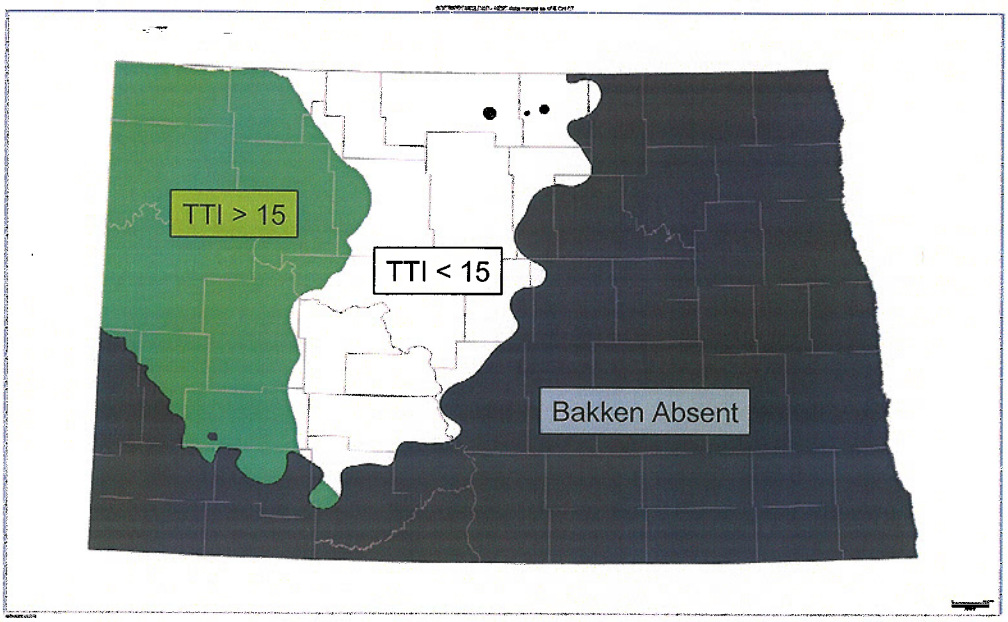


Figure 1 – Thermally Mature Area (green area TTI > 15) of the Bakken Formation, Nordeng(2008) used a TTI of 15 as the limit for the onset of oil generation. TTI < 15 indicates the area of potential migrated oil potential in North Dakota.

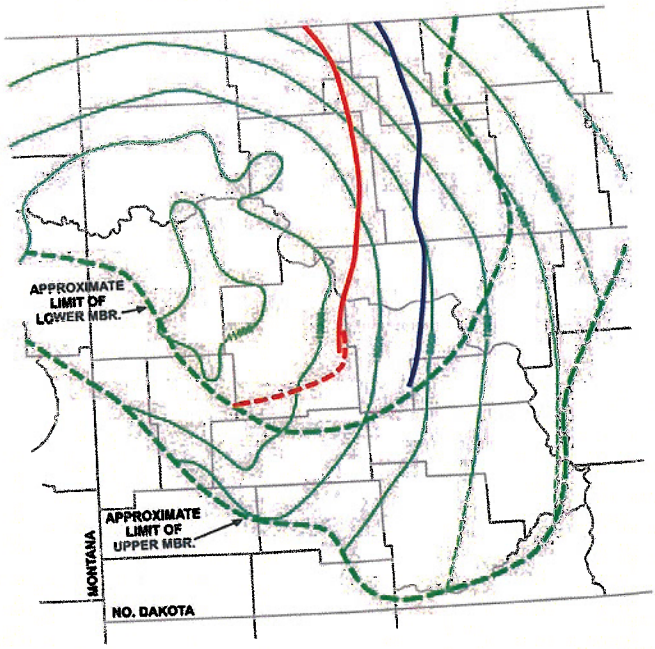


Figure 2. Green contours are Bakken structure on top of the upper shale member. The red line indicates the eastward limit where the lower shale resistivity exceeds 35 ohm-m and the blue line indicates the upper shale thermal maturity boundary. The red dashed line is the extension from data collected in the Neset study (modified from Neset, 2007).

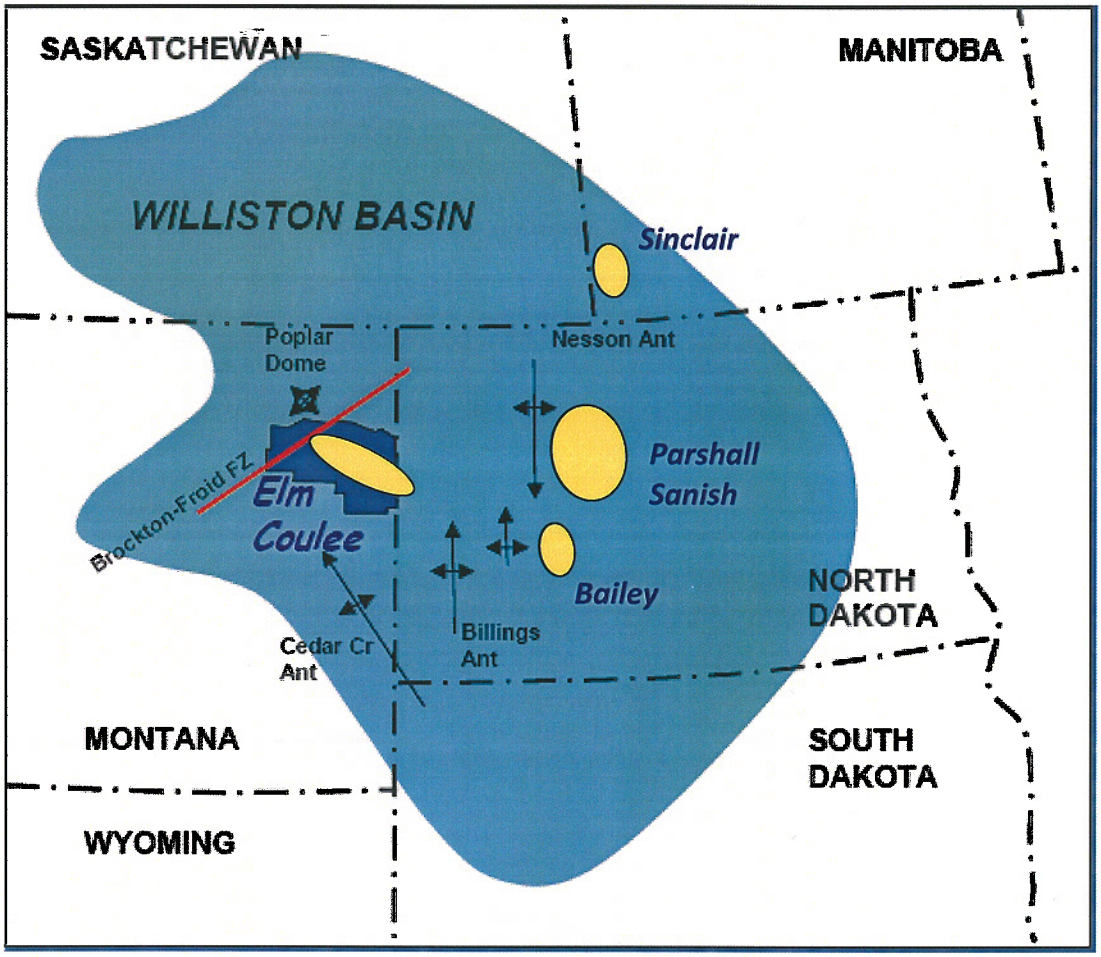


Figure 3 – Williston Basin with major structural features and modern Bakken / Three Forks production areas.

Table 1
Bakken Formation Oil In Place and Recoverable Reserves (barrels)
June 18, 2008

	Mean Values				
County	OOIP per County	OOIP per 640	EUR per County	EUR per 640	Rec Factor
McKenzie	32,438,937,580	11,698,740	382,654,320	138,000	1.18
Mountrail	27,242,795,837	14,043,773	424,826,873	219,000	1.56
Williams	26,263,485,095	12,235,090	474,392,108	221,000	1.81
Dunn	18,059,716,691	9,392,995	294,169,921	153,000	1.63
Divide	16,836,857,774	13,380,393	123,315,660	98,000	0.73
Burke	14,891,719,317	16,715,777	187,975,278	211,000	1.26
Ward	4,540,670,907	7,903,591			
McLean	3,253,719,118	10,742,320			
Billings	3,141,271,156	4,636,325	115,858,434	171,000	3.69
Stark	2,349,351,546	2,856,068	86,371,150	105,000	3.68
Golden Valley	66,147,411	1,209,544			
Grant	62,508,094	509,248			
Slope	10,586,089	238,919			
Total	149,157,766,614		2,089,563,745		

	Minimum Values				
County	OOIP per County	OOIP per 640	EUR per County	EUR per 640	Rec Factor
Mountrail	14,054,974,161	7,245,397	100,872,134	52,000	0.72
McKenzie	12,768,723,210	4,583,246	78,006,785	28,000	0.61
Williams	12,218,256,790	5,691,989	422,874,413	197,000	3.46
Burke	10,985,956,451	12,331,605	50,780,051	57,000	0.46
Divide	8,202,264,716	6,518,660	18,874,119	15,000	0.23
Dunn	7,486,735,279	3,890,845	38,483,854	20,000	0.51
Ward	2,261,265,978	3,936,009			
McLean	1,277,048,035	4,216,239			
Billings	1,242,100,878	1,836,073	10,147,480	15,000	0.82
Stark	1,046,331,232	1,349,654	62,020,731	80,000	5.93
Golden Valley	24,538,677	484,981			
Grant	23,265,040	189,538			
Slope	3,922,551	88,529			
Total	71,595,382,997		782,059,568		

	Maximum Values				
County	OOIP per County	OOIP per 640	EUR per County	EUR per 640	Rec Factor
McKenzie	61,092,805,333	22,094,637	904,171,770	327,000	1.48
Williams	52,407,038,986	24,414,309	804,963,984	375,000	1.54
Mountrail	48,066,522,137	24,778,490	739,082,368	381,000	1.54
Dunn	38,148,811,183	19,834,738	569,306,630	296,000	1.49
Divide	33,046,783,554	26,262,104	241,602,214	192,000	0.73
Burke	22,189,139,910	24,907,044	199,556,693	224,000	0.90
Ward	7,454,033,280	12,974,653			
McLean	6,871,671,997	22,687,176			
Billings	5,796,035,234	8,564,872	206,400,129	305,000	3.56
Stark	4,479,035,609	5,317,672	108,655,741	129,000	2.43
Golden Valley	130,056,732	2,239,223			
Grant	126,677,986	1,032,035			
Slope	21,249,293	479,578			
Total	279,829,861,234		3,773,739,530		

Table 2
upper Bakken shale member Resource Area, Volume, and Oil In Place (barrels)
April 7, 2008

	Mean Values						
County	acres	acre-ft	porosity	Sw	Bo	OOIP per County	OOIP per 640
McKenzie	1,826,692	26,799,229	7.06	30	1.400	7,339,167,061	2,571,351
Williams	1,373,805	22,163,100	7.06	30	1.500	5,664,893,694	2,639,044
Dunn	1,233,355	18,315,725	7.06	30	1.400	5,015,896,693	2,602,798
Mountrail	1,241,503	20,850,610	7.06	30	1.600	4,996,332,036	2,575,630
Burke	570,162	7,377,558	7.06	30	1.200	2,357,132,090	2,645,853
Divide	806,065	9,061,937	7.06	30	1.500	2,316,233,185	1,839,044
Stark	738,655	6,023,577	7.06	30	1.500	1,539,627,844	1,333,995
Billings	492,496	4,156,380	7.06	30	1.300	1,225,813,668	1,592,949
Ward	367,685	4,331,664	7.06	30	1.600	1,037,975,913	1,806,723
McLean	193,848	3,325,726	7.06	30	1.400	910,774,749	3,006,969
Grant	78,557	244,554	7.06	30	1.500	62,508,094	509,248
Golden Valley	63,599	191,189	7.06	30	1.350	54,297,863	546,403
Slope	28,357	38,655	7.06	30	1.400	10,586,089	238,919
					Total	32,531,238,982	

	Minimum Values						
County	acres	acre-ft	porosity	Sw	Bo	OOIP per County	OOIP per 640
McKenzie	1,826,692	26,799,229	3.27	40	1.600	2,549,476,943	893,235
Williams	1,373,805	22,163,100	3.27	40	1.640	2,057,005,427	958,275
Mountrail	1,241,503	20,850,610	3.27	40	1.640	1,935,190,345	997,599
Dunn	1,233,355	18,315,725	3.27	40	1.600	1,742,420,204	904,159
Burke	570,162	7,377,558	3.27	40	1.250	898,362,087	1,008,401
Divide	806,065	9,061,937	3.27	40	1.660	830,924,783	659,738
Stark	738,655	6,023,577	3.27	40	1.600	573,037,832	496,503
Billings	492,496	4,156,380	3.27	40	1.400	451,893,441	587,237
Ward	367,685	4,331,664	3.27	40	1.640	402,031,120	699,784
McLean	193,848	3,325,726	3.27	40	1.600	316,384,571	1,044,560
Grant	78,557	244,554	3.27	40	1.600	23,265,040	189,538
Golden Valley	63,599	191,189	3.27	40	1.500	19,400,884	195,232
Slope	28,357	38,655	3.27	40	1.500	3,922,551	88,529
					Total	11,803,315,229	

	Maximum Values						
County	acres	acre-ft	porosity	Sw	Bo	OOIP per County	OOIP per 640
McKenzie	1,826,692	26,799,229	10.85	20	1.200	15,038,708,708	5,268,963
Williams	1,373,805	22,163,100	10.85	20	1.200	12,437,089,556	5,793,934
Dunn	1,233,355	18,315,725	10.85	20	1.200	10,278,088,597	5,333,401
Mountrail	1,241,503	20,850,610	10.85	20	1.410	9,957,931,770	5,133,355
Divide	806,065	9,061,937	10.85	20	1.200	5,085,214,500	4,037,561
Burke	570,162	7,377,558	10.85	20	1.200	4,140,005,371	4,647,106
Stark	738,655	6,023,577	10.85	20	1.300	3,120,187,177	2,703,456
Billings	492,496	4,156,380	10.85	20	1.150	2,433,811,594	3,162,746
Ward	367,685	4,331,664	10.85	20	1.410	2,068,736,273	3,600,887
McLean	193,848	3,325,726	10.85	20	1.200	1,866,271,205	6,161,590
Grant	78,557	244,554	10.85	20	1.300	126,677,986	1,032,035
Golden Valley	63,599	191,189	10.85	20	1.175	109,571,000	1,102,619
Slope	28,357	38,655	10.85	20	1.225	21,249,293	479,578
					Total	66,683,543,030	

Table 3
middle Bakken member Resource Area, Volume, and Oil In Place (barrels)
June 18, 2008

	Middle Bakken OOIP Mean Values						
County	acres	acre-ft	porosity	Sw	Bo	OOIP per County	OOIP per 640
McKenzie	1,818,731	58,794,758	6.70	30	1.400	15,389,491,328	5,415,465
Williams	1,373,805	62,906,006	5.80	29	1.500	13,435,647,982	6,259,122
Mountrail	1,241,503	52,667,884	6.20	24	1.600	12,033,194,776	6,203,161
Divide	805,209	48,861,367	5.50	32	1.500	9,465,290,116	7,523,245
Burke	570,162	29,551,776	6.00	25	1.200	8,597,350,325	9,650,423
Dunn	1,233,355	37,991,535	4.90	28	1.400	7,386,142,503	3,832,742
Ward	367,685	8,846,722	6.20	24	1.600	2,021,237,904	3,518,211
Billings	421,876	5,206,097	7.00	27	1.300	1,583,245,050	2,401,835
McLean	193,848	5,047,835	4.90	28	1.400	981,377,177	3,240,067
Stark	377,719	2,886,374	7.00	38	1.500	653,114,200	1,106,626
Golden Valley	11,042	37,000	6.85	29	1.350	10,413,908	603,581
Grant	0	0	7.00	38	1.500		
Slope	0	0	7.00	33	1.400		
					Total	71,556,505,269	

	Middle Bakken OOIP Minimum Values						
County	acres	acre-ft	porosity	Sw	Bo	OOIP per County	OOIP per 640
Mountrail	1,241,503	52,667,884	5.00	30	1.640	8,720,067,439	4,495,231
Burke	570,162	29,551,776	6.00	25	1.250	8,253,456,312	9,264,406
Williams	1,373,805	62,906,006	4.00	36	1.640	7,617,948,034	3,548,892
McKenzie	1,818,731	58,794,758	5.00	50	1.600	7,127,027,052	2,507,956
Divide	805,209	48,861,367	5.00	50	1.660	5,708,832,597	4,537,521
Dunn	1,233,355	37,991,535	4.00	43	1.600	4,200,021,176	2,179,432
Ward	367,685	8,846,722	5.00	30	1.640	1,464,725,799	2,549,534
Billings	421,876	5,206,097	4.00	42	1.400	669,301,843	1,015,353
McLean	193,848	5,047,835	4.00	43	1.600	558,045,681	1,842,416
Stark	377,719	2,886,374	6.00	50	1.600	419,859,129	711,402
Golden Valley	11,042	37,000	4.50	46	1.500	4,650,139	269,518
Grant	0	0	6.00	50	1.600		
Slope	0	0	5.00	46	1.500		
					Total	36,023,867,762	

	Middle Bakken OOIP Maximum Values						
County	acres	acre-ft	porosity	Sw	Bo	OOIP per County	OOIP per 640
McKenzie	1,818,731	58,794,758	9.00	25	1.200	25,657,297,387	9,028,640
Williams	1,373,805	62,906,006	7.00	20	1.200	22,774,490,477	10,609,709
Mountrail	1,241,503	52,667,884	8.00	20	1.410	18,546,267,039	9,560,677
Dunn	1,233,355	37,991,535	9.00	20	1.200	17,684,299,689	9,176,557
Divide	805,209	48,861,367	7.00	25	1.200	16,584,158,693	13,181,497
Burke	570,162	29,551,776	6.00	25	1.200	8,597,350,325	9,650,423
Ward	367,685	8,846,722	8.00	20	1.410	3,115,250,656	5,422,473
Billings	421,876	5,206,097	10.00	25	1.150	2,634,058,978	3,995,954
McLean	193,848	5,047,835	9.00	20	1.200	2,349,666,026	7,757,542
Stark	377,719	2,886,374	8.00	25	1.300	1,033,499,393	1,751,144
Golden Valley	11,042	37,000	9.50	25	1.175	17,405,957	1,008,834
Grant	0	0	8.00	25	1.300		
Slope	0	0	9.00	25	1.225		
					Total	118,993,744,621	

Table 4
lower Bakken shale member Resource Area, Volume, and Oil In Place (barrels)
April 7, 2008

	Lower Bakken OOIP Mean Values						
County	acres	acre-ft	porosity	Sw	Bo	OOIP per County	OOIP per 640
Mountrail	1,241,503	41,303,562	6.83	30	1.500	10,213,269,025	5,264,982
McKenzie	1,674,220	36,651,456	6.83	30	1.400	9,710,279,191	3,711,924
Williams	1,373,805	30,898,898	6.83	30	1.600	7,162,943,418	3,336,924
Dunn	1,224,334	18,304,207	6.83	30	1.200	5,657,677,494	2,957,455
Divide	805,209	20,444,318	6.83	30	1.500	5,055,334,474	4,018,104
Burke	570,162	16,984,118	6.83	30	1.600	3,937,236,901	4,419,501
Ward	367,685	4,792,938	6.83	30	1.200	1,481,457,090	2,578,656
McLean	193,848	4,772,148	6.83	30	1.300	1,361,567,191	4,495,284
Billings	331,414	1,253,936	6.83	30	1.400	332,212,438	641,542
Stark	241,258	633,346	6.83	30	1.500	156,609,501	415,447
Golden Valley	15,427	5,419	6.83	30	1.400	1,435,639	59,560
Grant	0	0	6.83	30	1.500		
Slope	0	0	6.83	30	1.450		
					Total	45,070,022,363	

	Lower Bakken OOIP Minimum Values						
County	acres	acre-ft	porosity	Sw	Bo	OOIP per County	OOIP per 640
Mountrail	1,241,503	41,303,562	2.90	40	1.640	3,399,716,377	1,752,568
McKenzie	1,674,220	36,651,456	2.90	40	1.600	3,092,219,215	1,182,055
Williams	1,373,805	30,898,898	2.90	40	1.640	2,543,303,329	1,184,822
Burke	570,162	16,984,118	2.90	40	1.250	1,834,138,052	2,058,798
Divide	805,209	20,444,318	2.90	40	1.660	1,662,507,337	1,321,402
Dunn	1,224,334	18,304,207	2.90	40	1.600	1,544,293,899	807,253
McLean	193,848	4,772,148	2.90	40	1.600	402,617,782	1,329,263
Ward	367,685	4,792,938	2.90	40	1.640	394,509,058	686,691
Billings	331,414	1,253,936	2.90	40	1.400	120,905,594	233,483
Stark	241,258	633,346	2.90	40	1.600	53,434,271	141,748
Golden Valley	15,427	5,419	2.90	40	1.500	487,655	20,231
Grant	0	0	2.90	40	1.600		
Slope	0	0	2.90	40	1.500		
					Total	15,048,132,568	

	Lower Bakken OOIP Maximum Values						
County	acres	acre-ft	porosity	Sw	Bo	OOIP per County	OOIP per 640
McKenzie	1,674,220	36,651,456	10.76	20	1.200	20,396,799,238	7,797,034
Mountrail	1,241,503	41,303,562	10.76	20	1.410	19,562,323,329	10,084,458
Williams	1,373,805	30,898,898	10.76	20	1.200	17,195,458,953	8,010,665
Divide	805,209	20,444,318	10.76	20	1.200	11,377,410,361	9,043,046
Dunn	1,224,334	18,304,207	10.76	20	1.200	10,186,422,897	5,324,780
Burke	570,162	16,984,118	10.76	20	1.200	9,451,784,214	10,609,515
McLean	193,848	4,772,148	10.76	20	1.200	2,655,734,766	8,768,044
Ward	367,685	4,792,938	10.76	20	1.410	2,270,046,350	3,951,292
Billings	331,414	1,253,936	10.76	20	1.150	728,164,662	1,406,173
Stark	241,258	633,346	10.76	20	1.300	325,349,039	863,072
Golden Valley	15,427	5,419	10.76	20	1.175	3,079,774	127,769
Grant	0	0	10.76	20	1.300		
Slope	0	0	10.76	20	1.225		
					Total	94,152,573,583	

Figure 4 - Thermally Mature Bakken Formation - Total

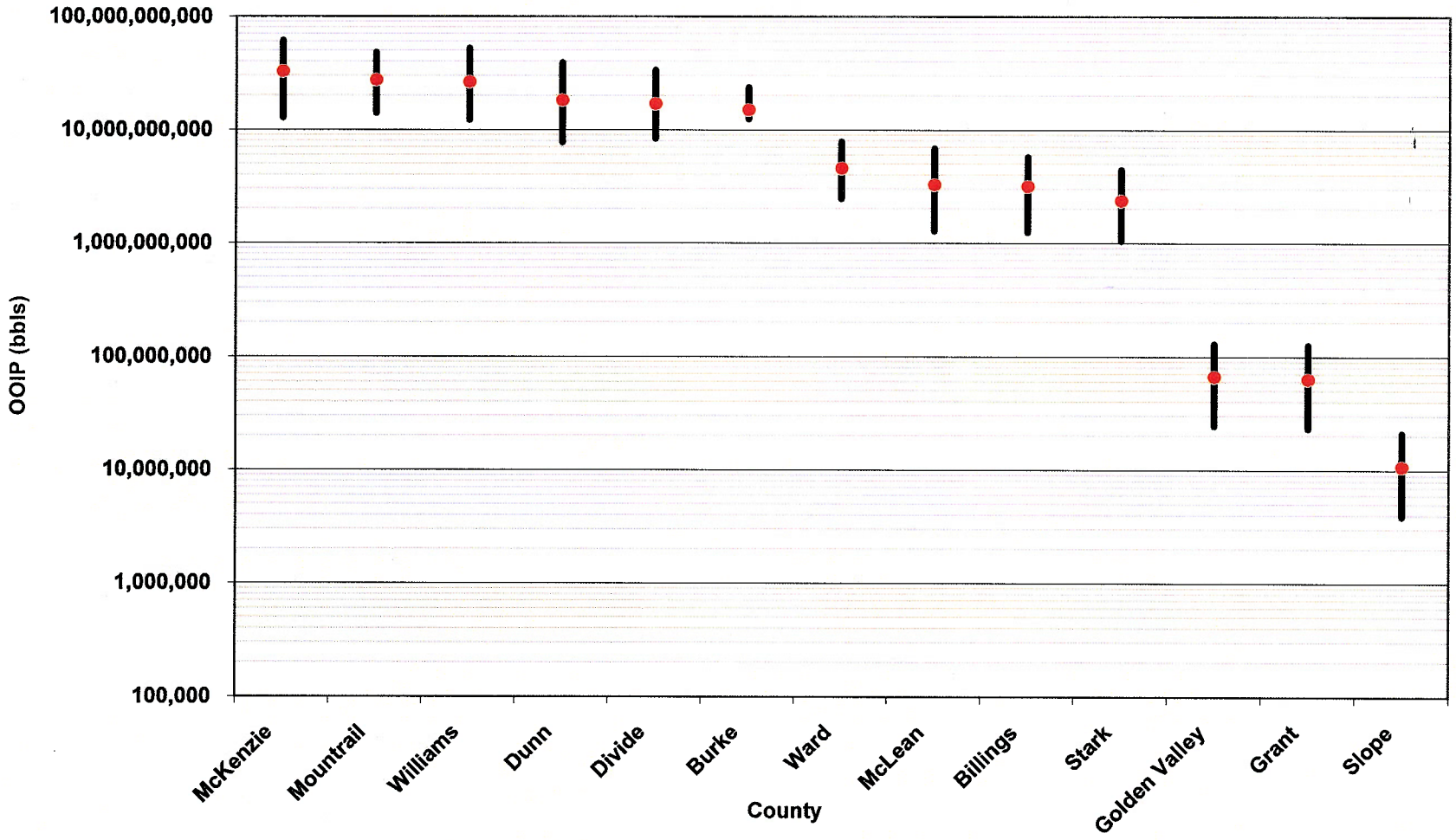


Figure 5 - Thermally Mature Bakken Formation - upper shale member

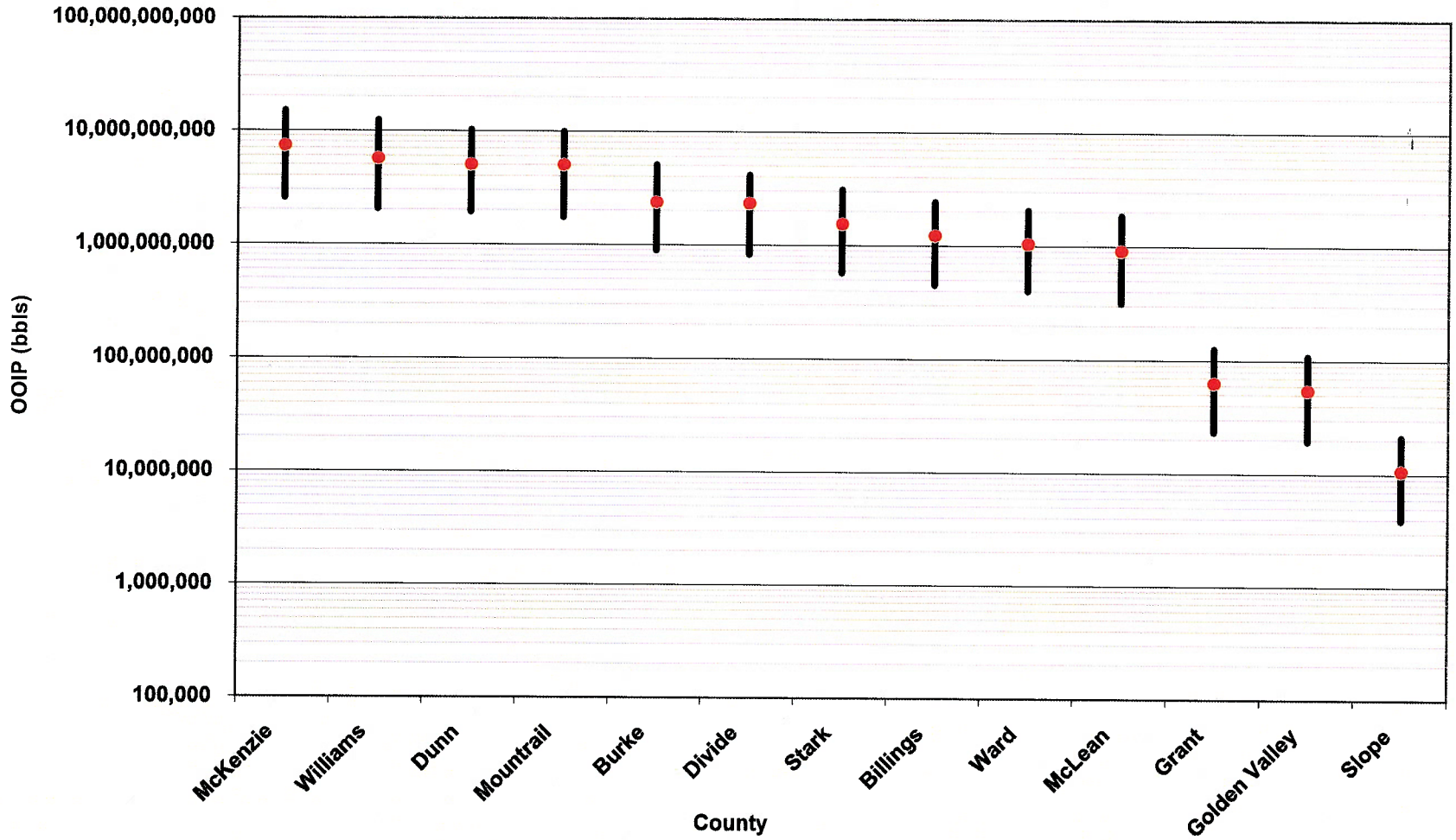


Figure 6 - Thermally Mature Bakken Formation - middle member

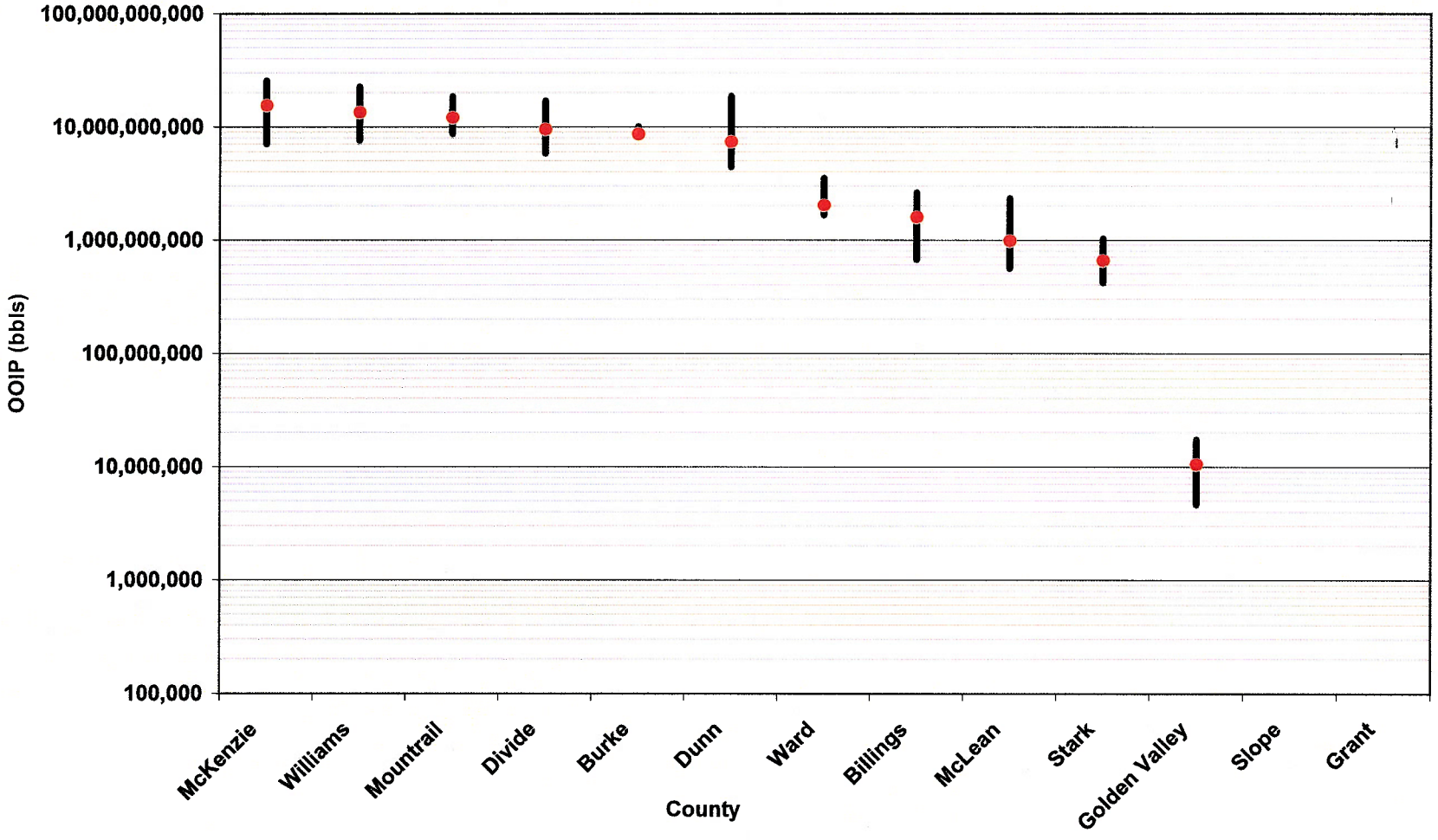
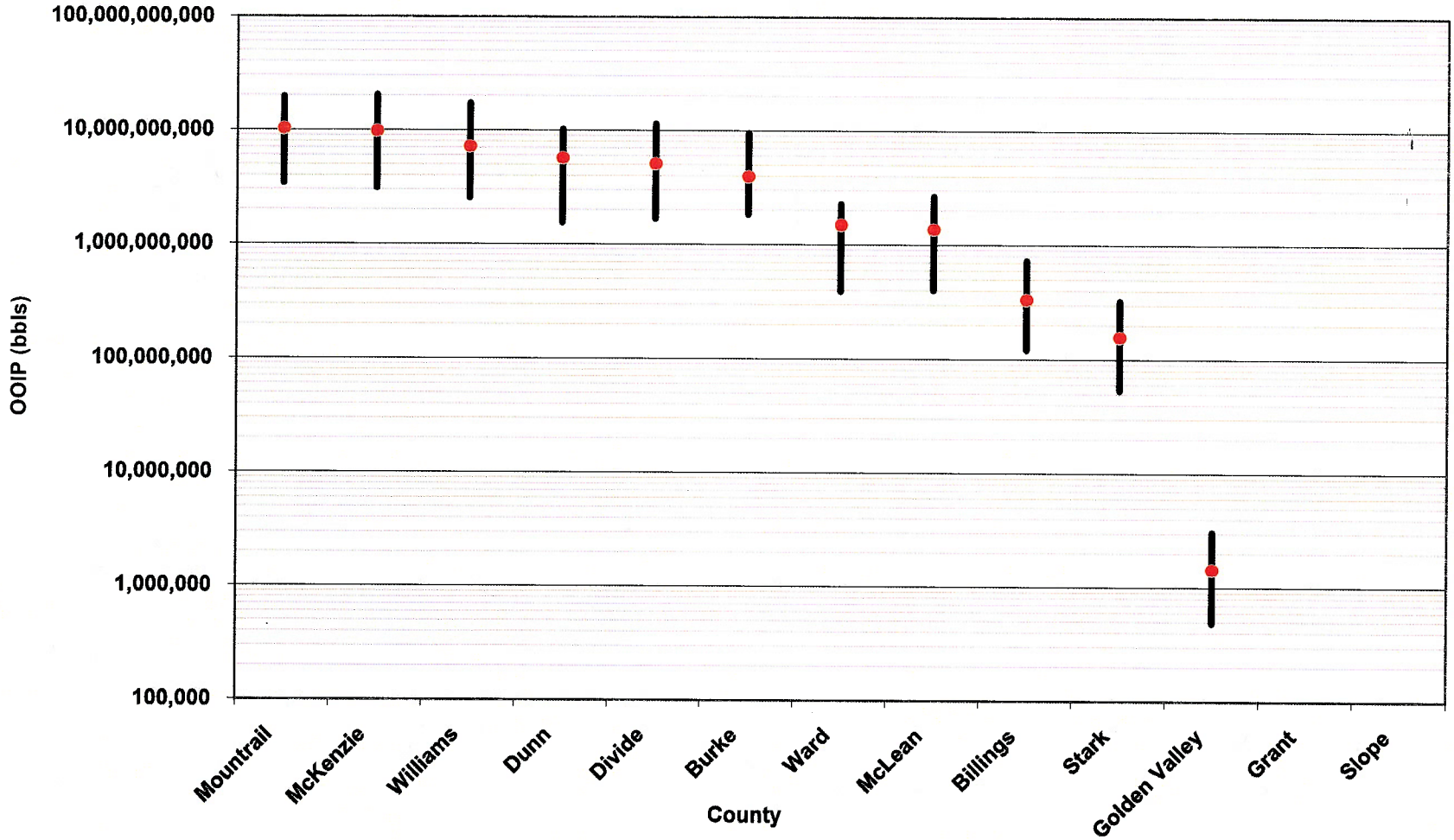


Figure 7 - Thermally Mature Bakken Formation - lower shale member



Bakken Formation Reserves Estimates - April 7, 2008

Bakken Recoverable Reserves

County	Max	Min	Mean
McKenzie	61,092,805,333	12,768,723,210	32,438,937,580
Mountrail	48,071,238,924	14,057,191,895	27,242,795,837
Williams	52,407,038,986	12,218,256,790	26,263,485,095
Dunn	39,194,906,967	7,735,183,028	18,059,716,691
Divide	33,541,035,300	8,372,403,011	16,836,857,774
Burke	23,700,992,275	12,437,334,722	14,891,719,317
Ward	7,892,628,307	2,467,484,199	4,540,670,907
McLean	6,871,671,997	1,277,048,035	3,253,719,118
Billings	5,796,035,234	1,242,100,878	3,141,271,156
Stark	4,479,035,609	1,046,331,232	2,349,351,546
Golden Valley	130,056,732	24,538,677	66,147,411
Grant	126,677,986	23,265,040	62,508,094
Slope	21,249,293	3,922,551	10,586,089

Upper Bakken Reserves

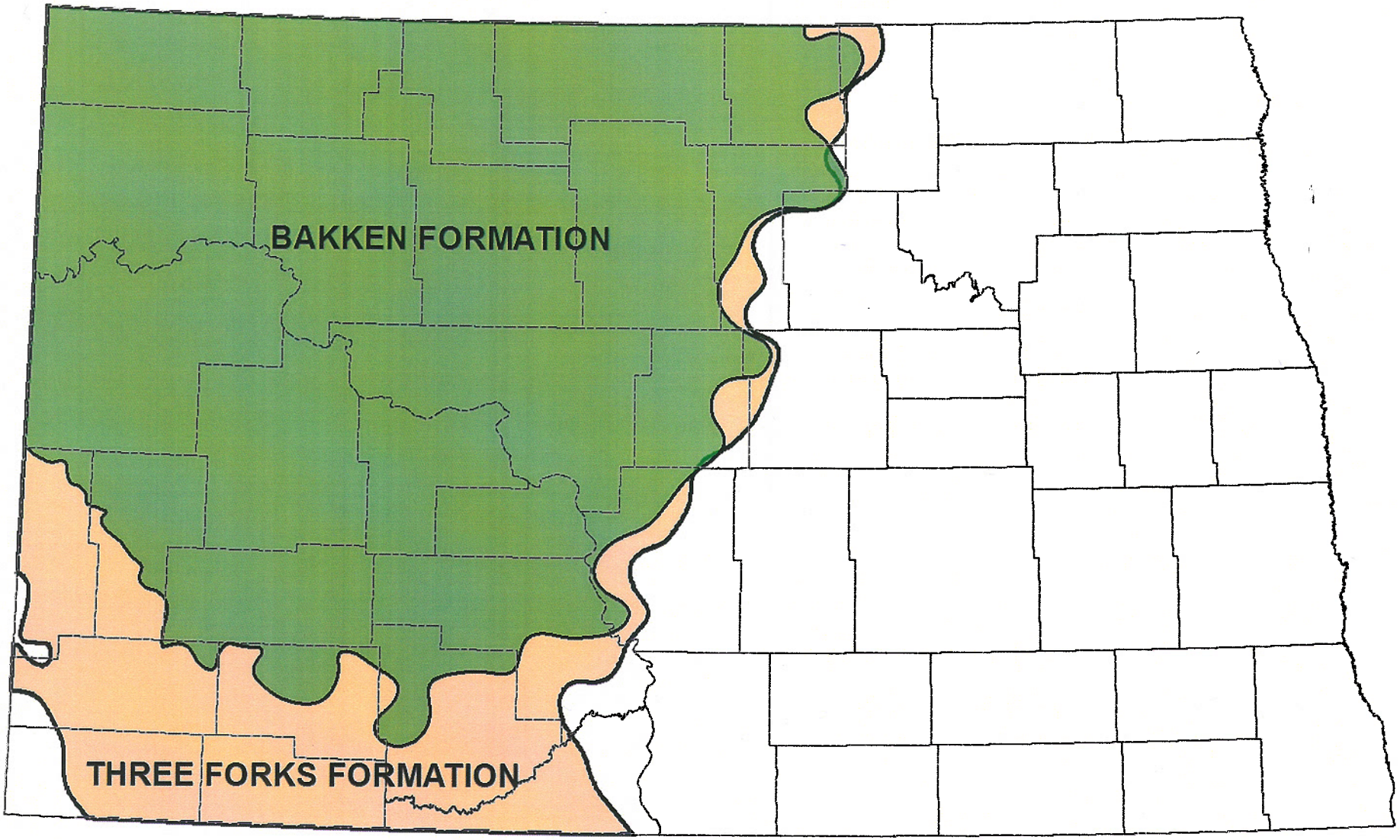
County	Max	Min	Mean
McKenzie	15,038,708,708	2,549,476,943	7,339,167,061
Williams	12,437,089,556	2,057,005,427	5,664,893,694
Dunn	10,278,088,597	1,935,190,345	5,015,896,693
Mountrail	9,957,931,770	1,742,420,204	4,996,332,036
Burke	5,085,214,500	898,362,087	2,357,132,090
Divide	4,140,005,371	830,924,783	2,316,233,185
Stark	3,120,187,177	573,037,832	1,539,627,844
Billings	2,433,811,594	451,893,441	1,225,813,668
Ward	2,068,736,273	402,031,120	1,037,975,913
McLean	1,866,271,205	316,384,571	910,774,749
Grant	126,677,986	23,265,040	62,508,094
Golden Valley	109,571,000	19,400,884	54,297,863
Slope	21,249,293	3,922,551	10,586,089

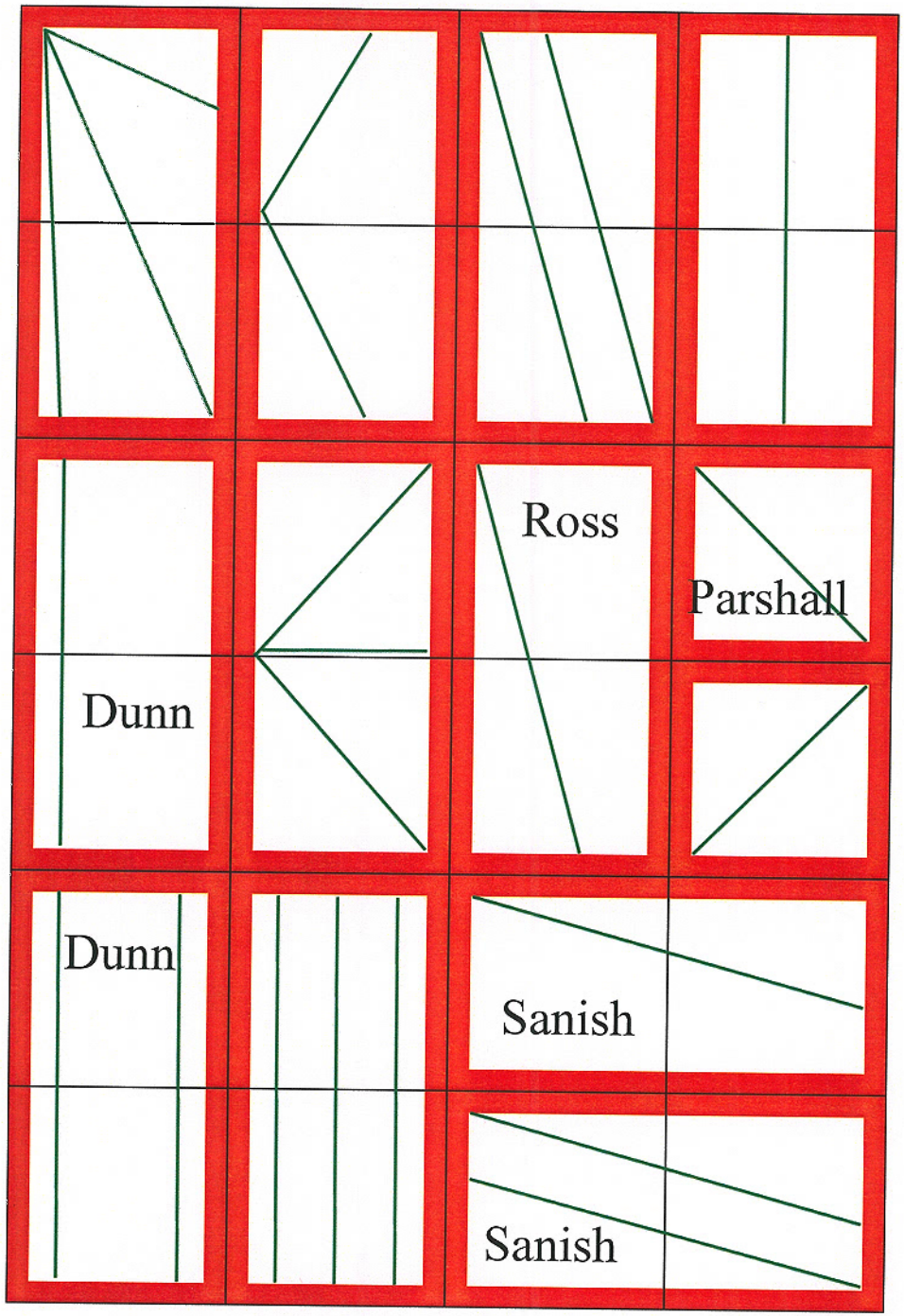
Middle Bakken Reserves

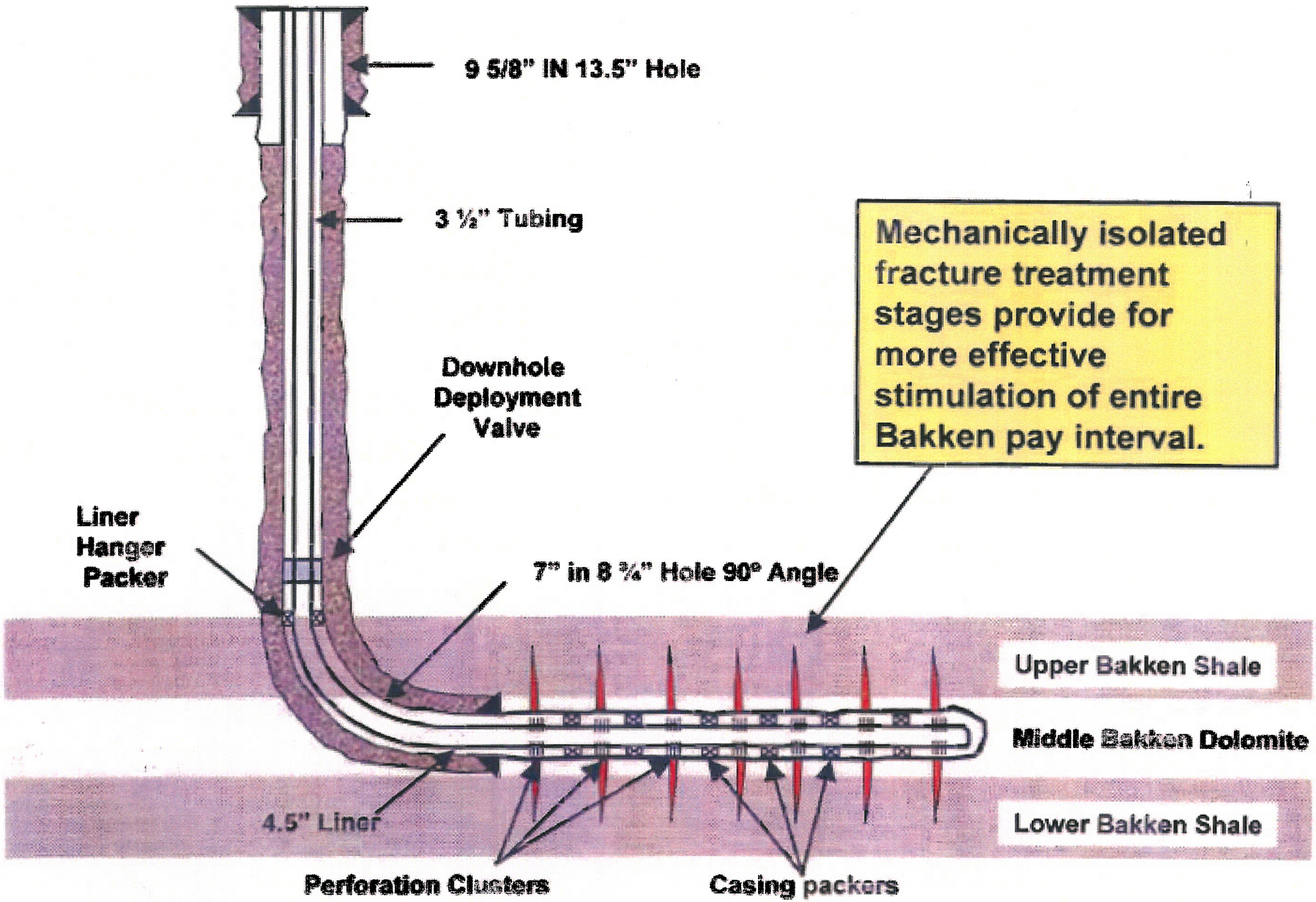
County	Max	Min	Mean
McKenzie	25,657,297,387	7,127,027,052	15,389,491,328
Williams	22,774,490,477	7,617,948,034	13,435,647,982
Mountrail	18,550,983,825	8,722,285,173	12,033,194,776
Divide	17,078,410,439	5,878,970,891	9,465,290,116
Burke	10,109,202,690	9,704,834,583	8,597,350,325
Dunn	18,730,395,473	4,448,468,925	7,386,142,503
Ward	3,553,845,683	1,670,944,021	2,021,237,904
Billings	2,634,058,978	669,301,843	1,583,245,050
McLean	2,349,666,026	558,045,681	981,377,177
Stark	1,033,499,393	419,859,129	653,114,200
Golden Valley	17,405,957	4,650,139	10,413,908
Slope	0	0	0
Grant	0	0	0

Lower Bakken Reserves

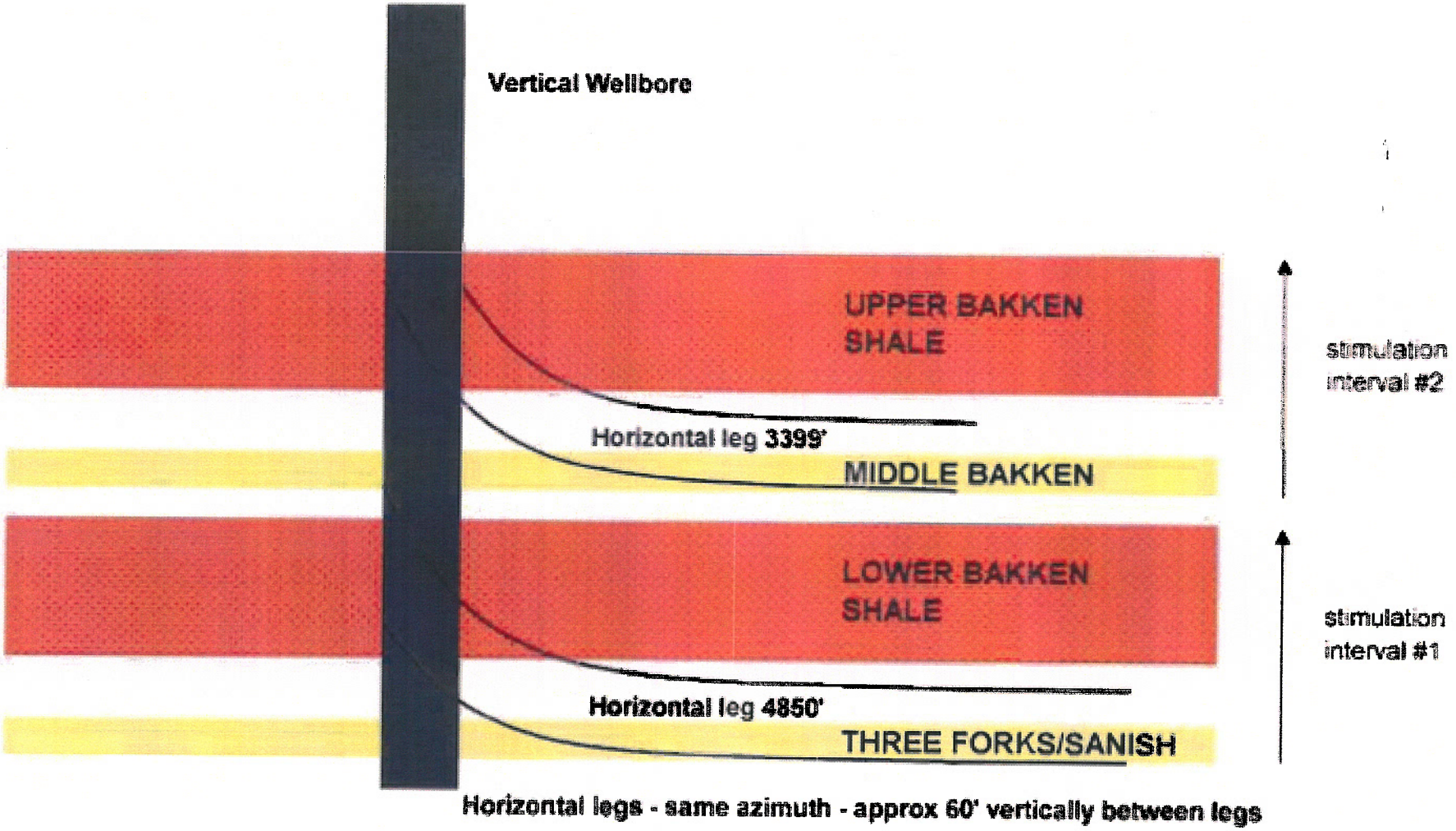
County	Max	Min	Mean
Mountrail	19,562,323,329	3,399,716,377	10,213,269,025
McKenzie	20,396,799,238	3,092,219,215	9,710,279,191
Williams	17,195,458,953	2,543,303,329	7,162,943,418
Dunn	10,186,422,897	1,544,293,899	5,657,677,494
Divide	11,377,410,361	1,662,507,337	5,055,334,474
Burke	9,451,784,214	1,834,138,052	3,937,236,901
Ward	2,270,046,350	394,509,058	1,481,457,090
McLean	2,655,734,766	402,617,782	1,361,567,191
Billings	728,164,662	120,905,594	332,212,438
Stark	325,349,039	53,434,271	156,609,501
Golden Valley	3,079,774	487,655	1,435,639
Grant	0	0	0
Slope	0	0	0


BAKKEN FORMATION
THREE FORKS FORMATION


Ross
Parshall
Dunn
Dunn
Sanish
Sanish


9 5/8" IN 13.5" Hole
3 ½" Tubing
Downhole Deployment Valve
Mechanically isolated fracture treatment stages provide for more effective stimulation of entire Bakken pay interval.
Liner Hanger Packer
7" in 8 ¾" Hole 90° Angle
Upper Bakken Shale
Middle Bakken Dolomite
Lower Bakken Shale
4.5" Liner
Perforation Clusters
Casing packers

WELLBORE CONFIGURATION



GeoSteering Tool