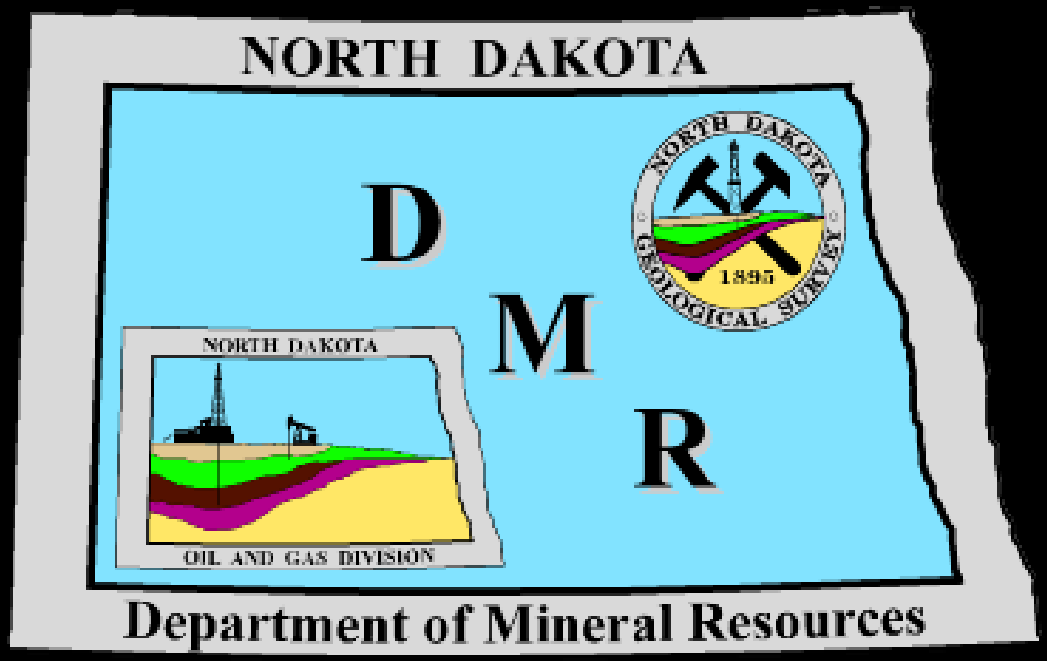
North Dakota Department of Mineral Resources



http://www.oilgas.nd.gov

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Bismarck, ND 58505-0840
(701) 328-8020 (701) 328-8000

Topics for Today

- Geology of Resource Plays
- Development History
- Activity
- Hydraulic Fracturing
- Future Prospects

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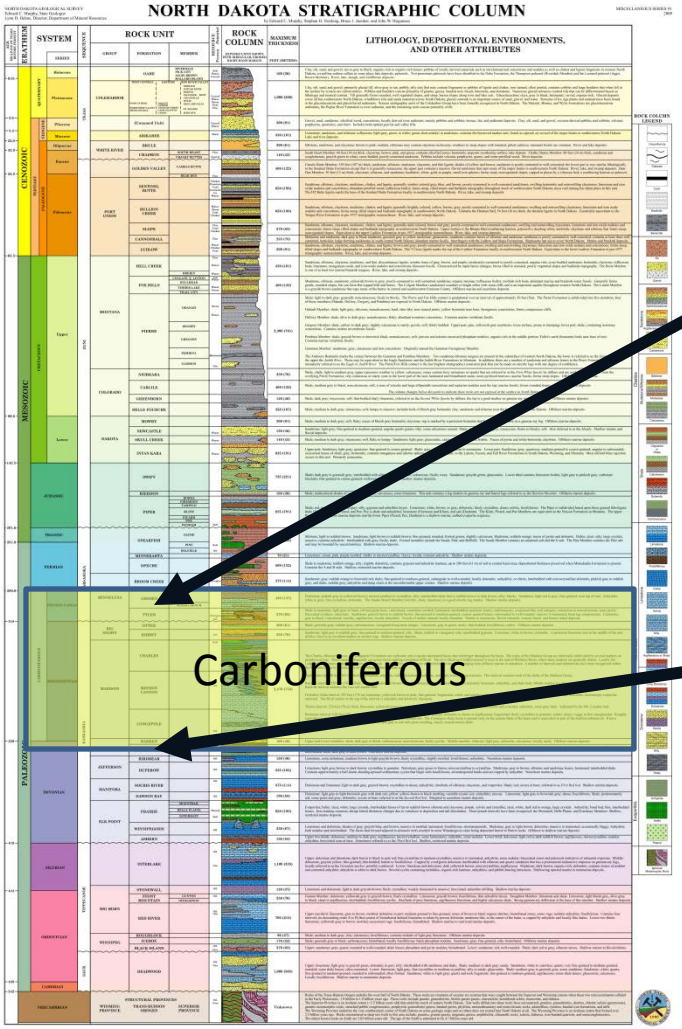
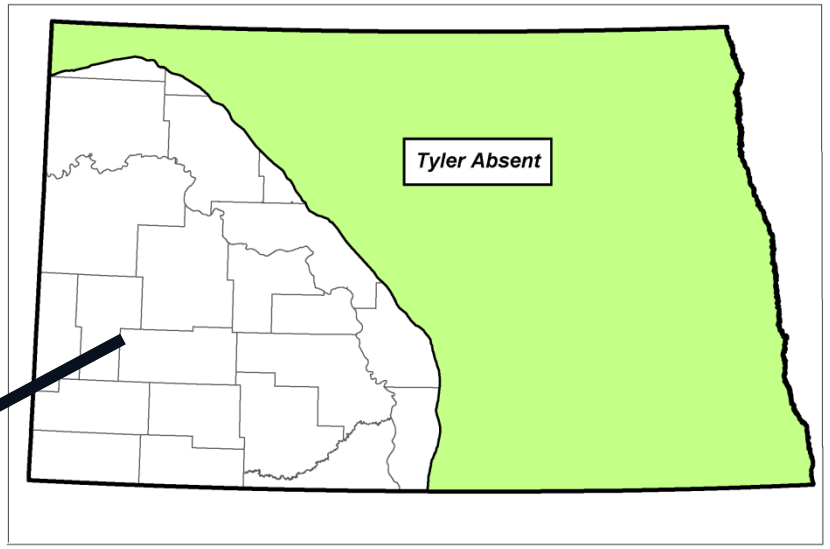
Source: U.S. Energy Information Administration based on data from various published studies. Canada and Mexico plays from ARI.
Updated: May 9, 2011

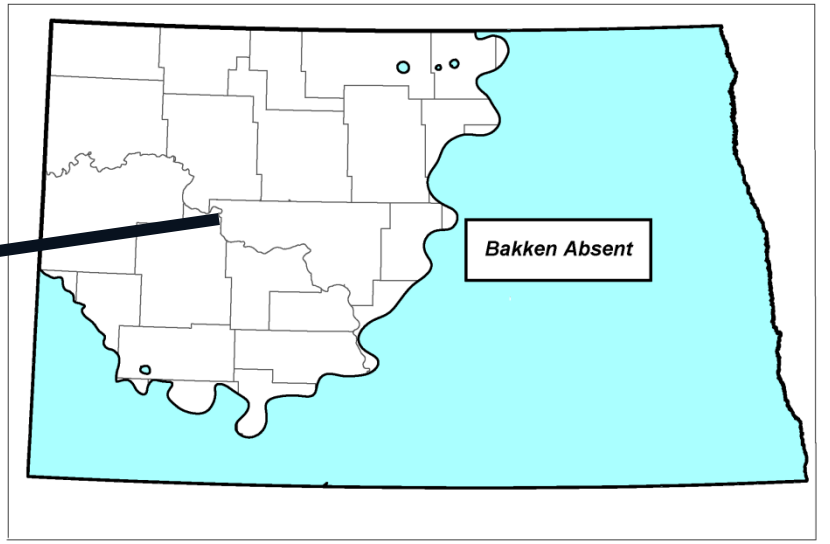
Resource Plays

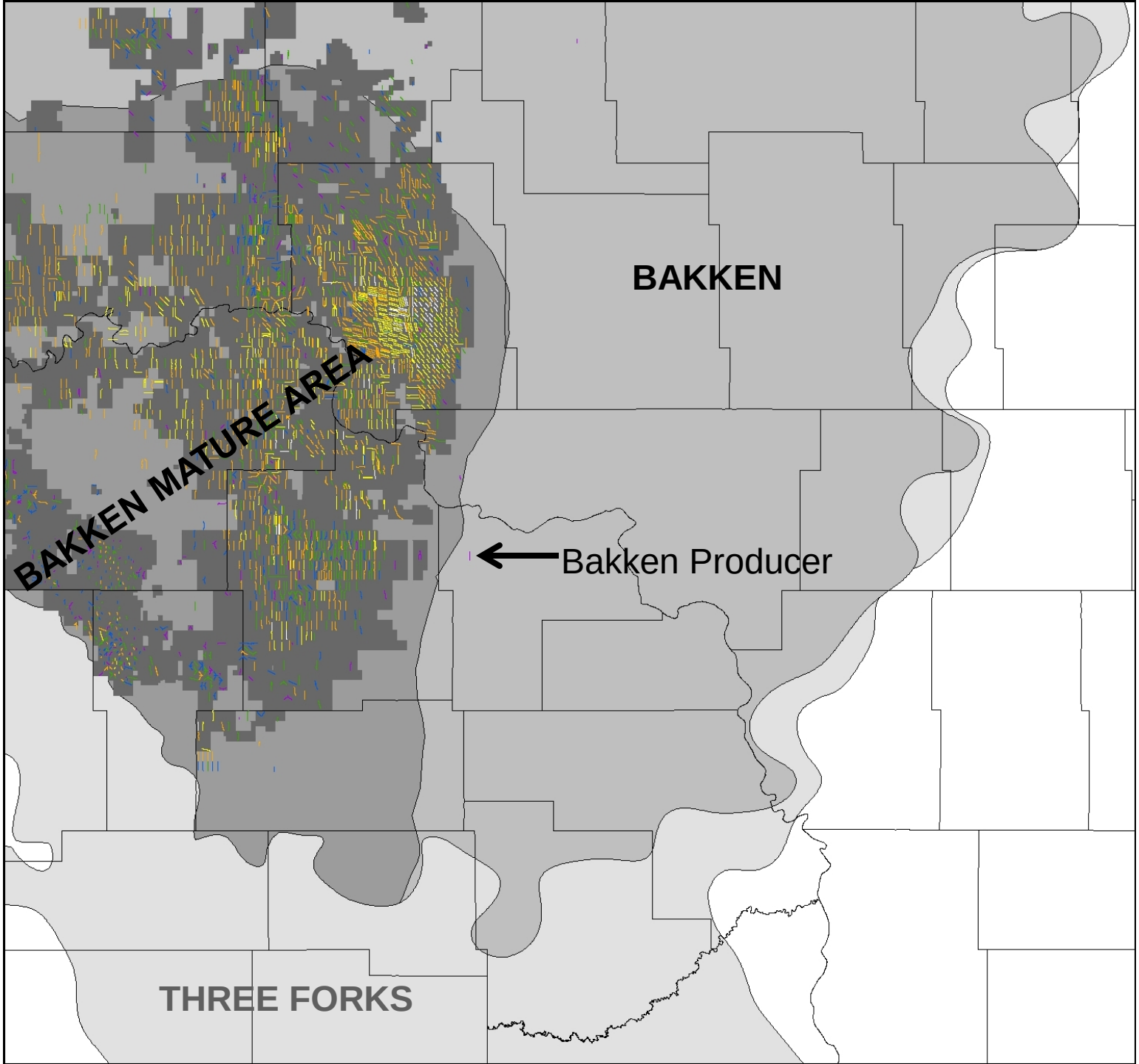
- 1) **Large area** of organic-rich source rock.
- 2) **Heat, pressure, and time to mature** source rock.
- 3) **Expulsion** of hydrocarbons from source rocks into adjacent rocks.
- 4) **Trapping** of hydrocarbons in overlying and underlying reservoirs that are porous, but low permeability.
- 5) **Technology to extract** hydrocarbons using natural or artificial fractures to get economic amounts of petroleum production.

1) Regional Extent Tyler and Bakken





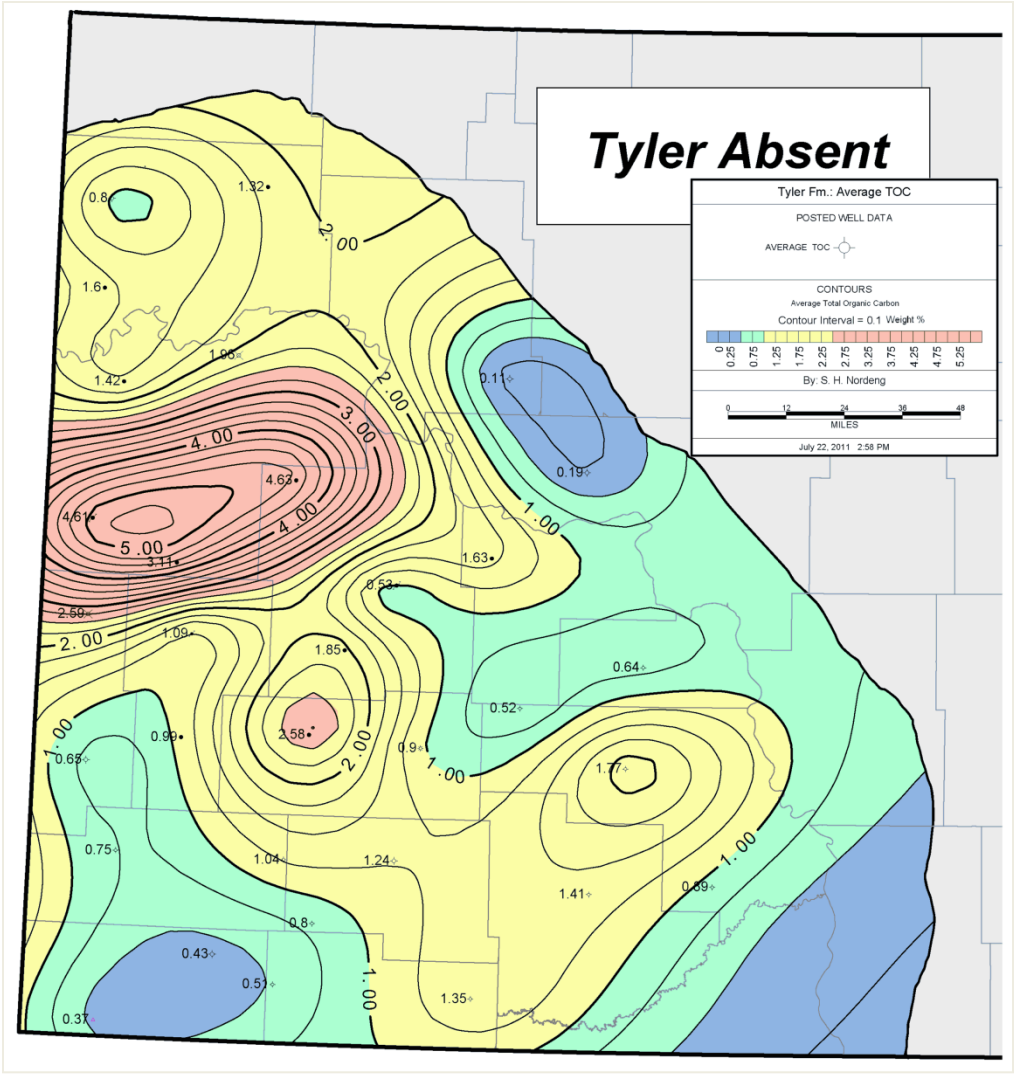



BAKKEN
BAKKEN MATURE AREA
Bakken Producer
THREE FORKS

1) Organic Richness: Bakken

- Average Total Organic Carbon:
  - 11.5 weight %
  - 30-40 % by volume

1) Tyler Formation: TOC content

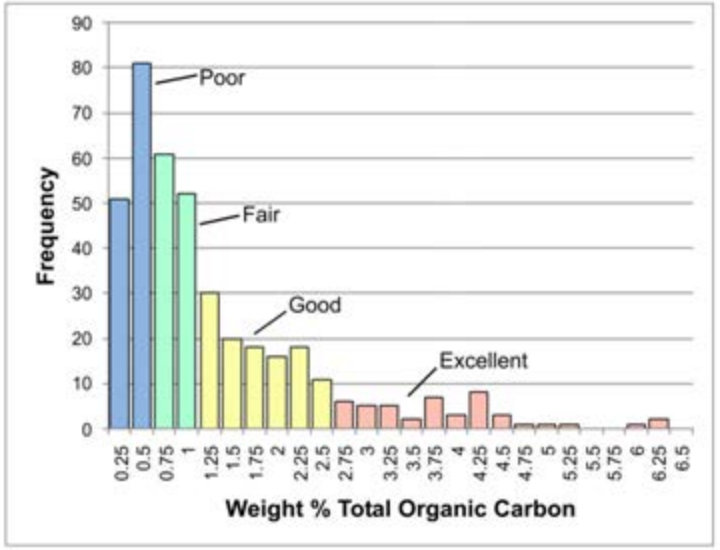


Average TOC = 1.39% by weight
(1/8 Bakken)

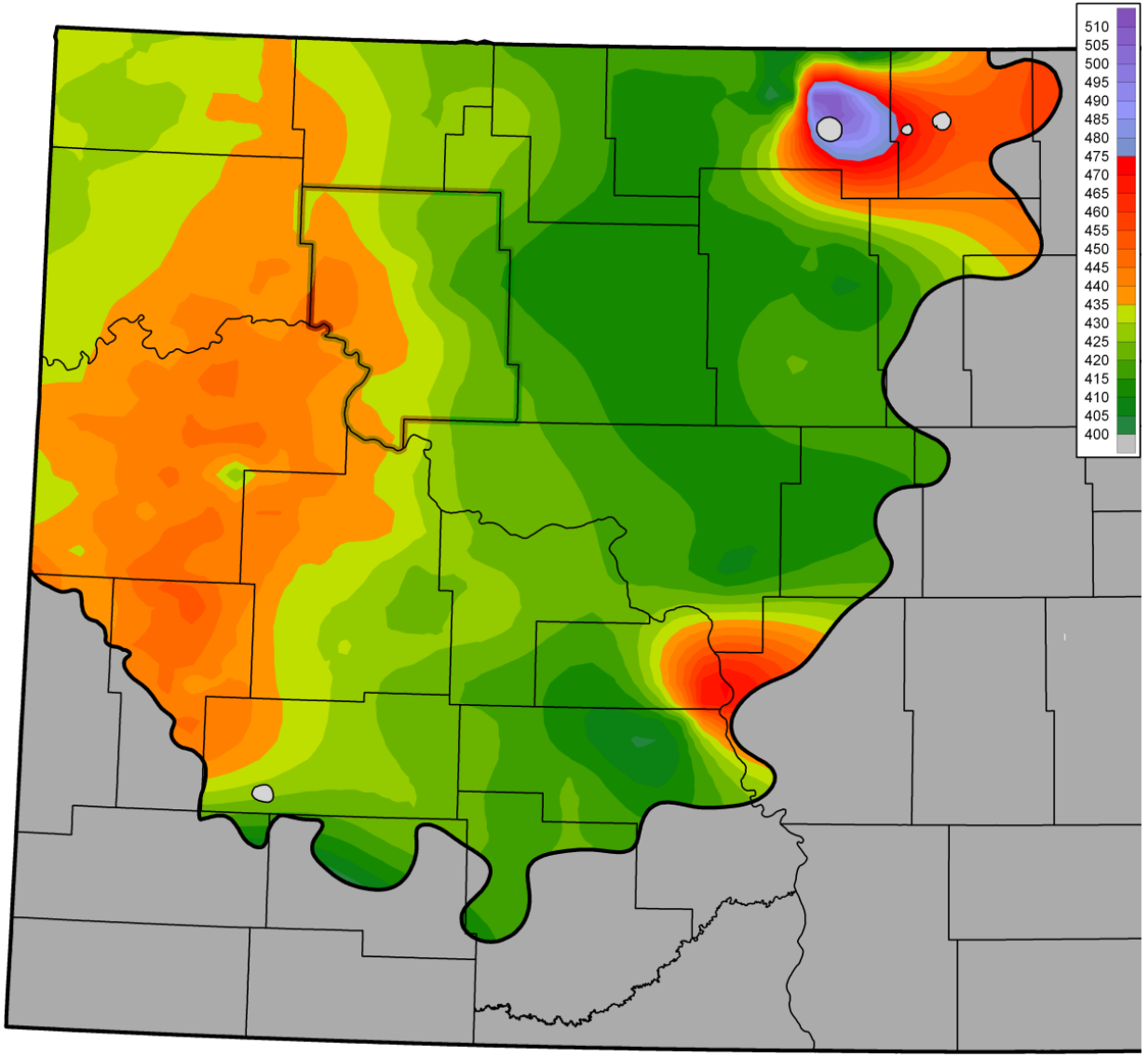
Area containing:

Excellent TOC = 2.02 million acres

Good TOC = 8.87 million acres
(1/80 Bakken)



2) Bakken T_{max}: Maturation Index



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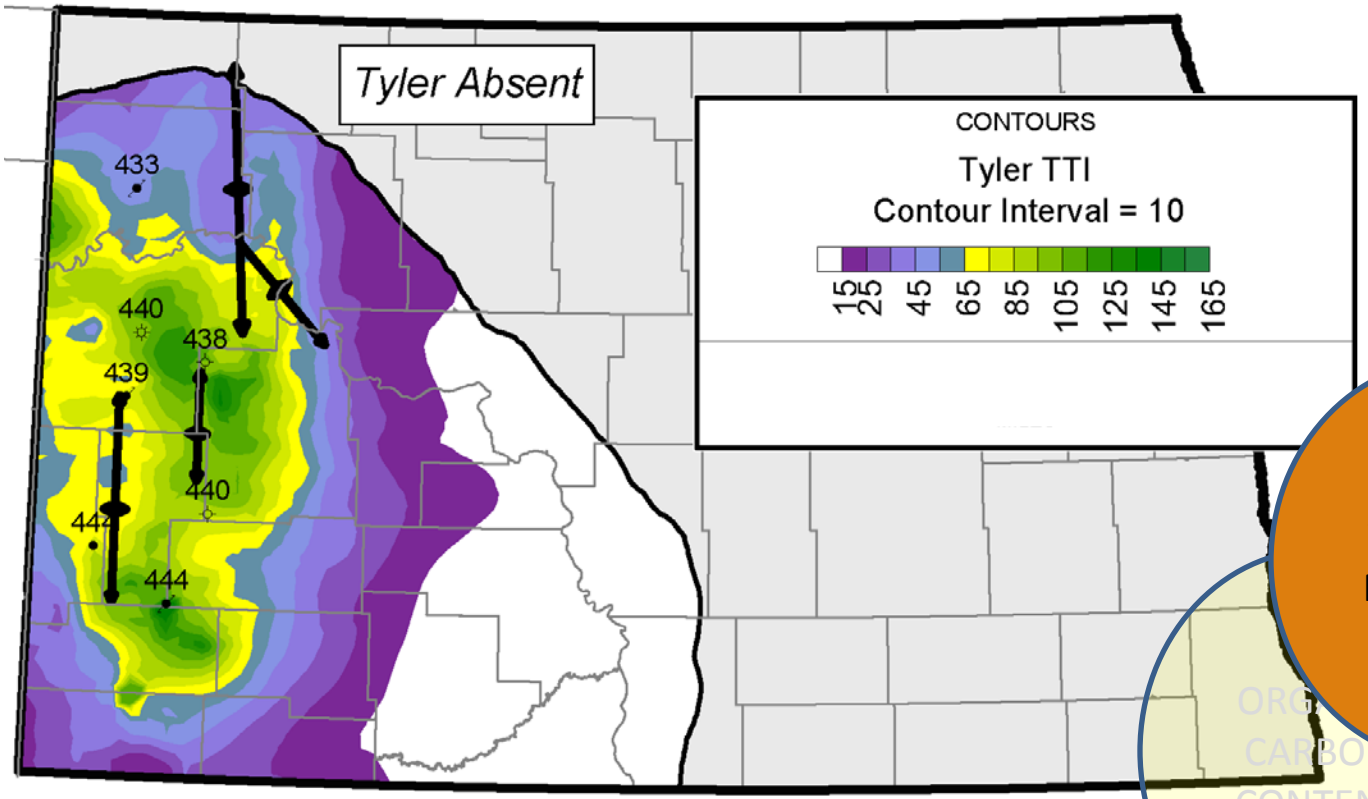
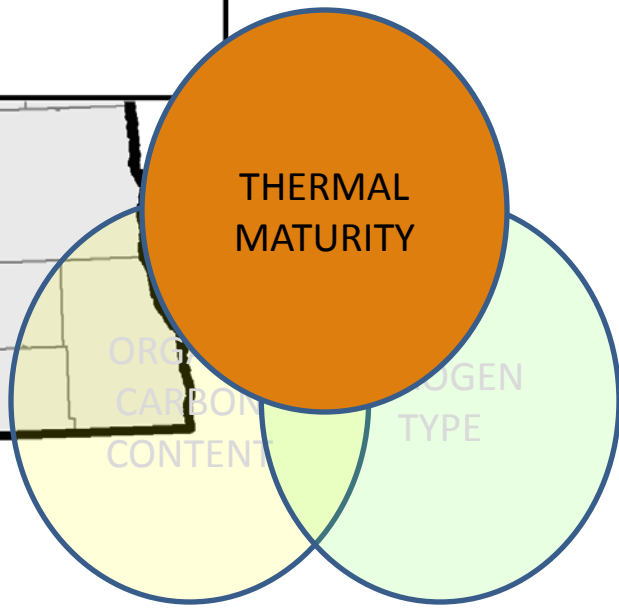
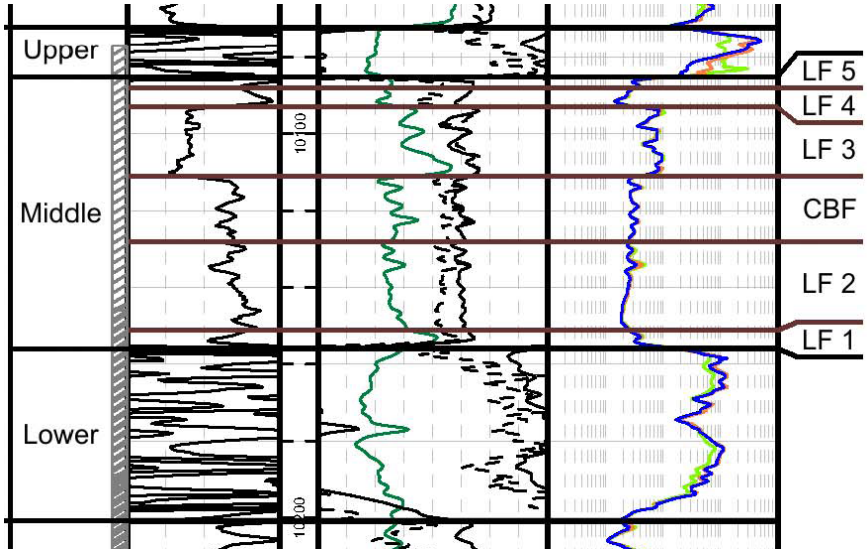
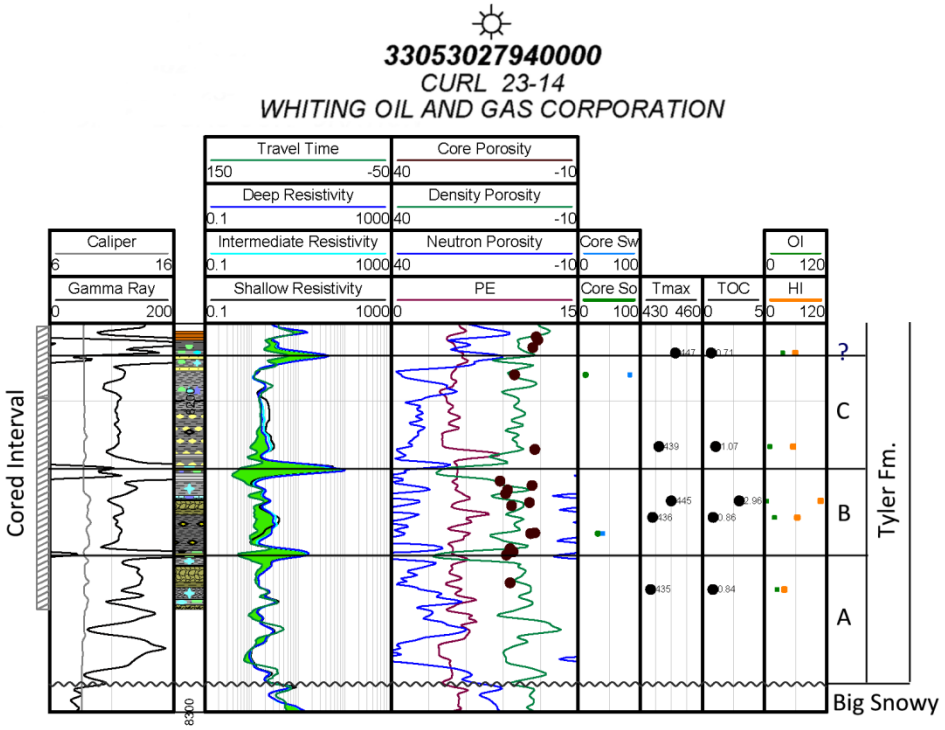


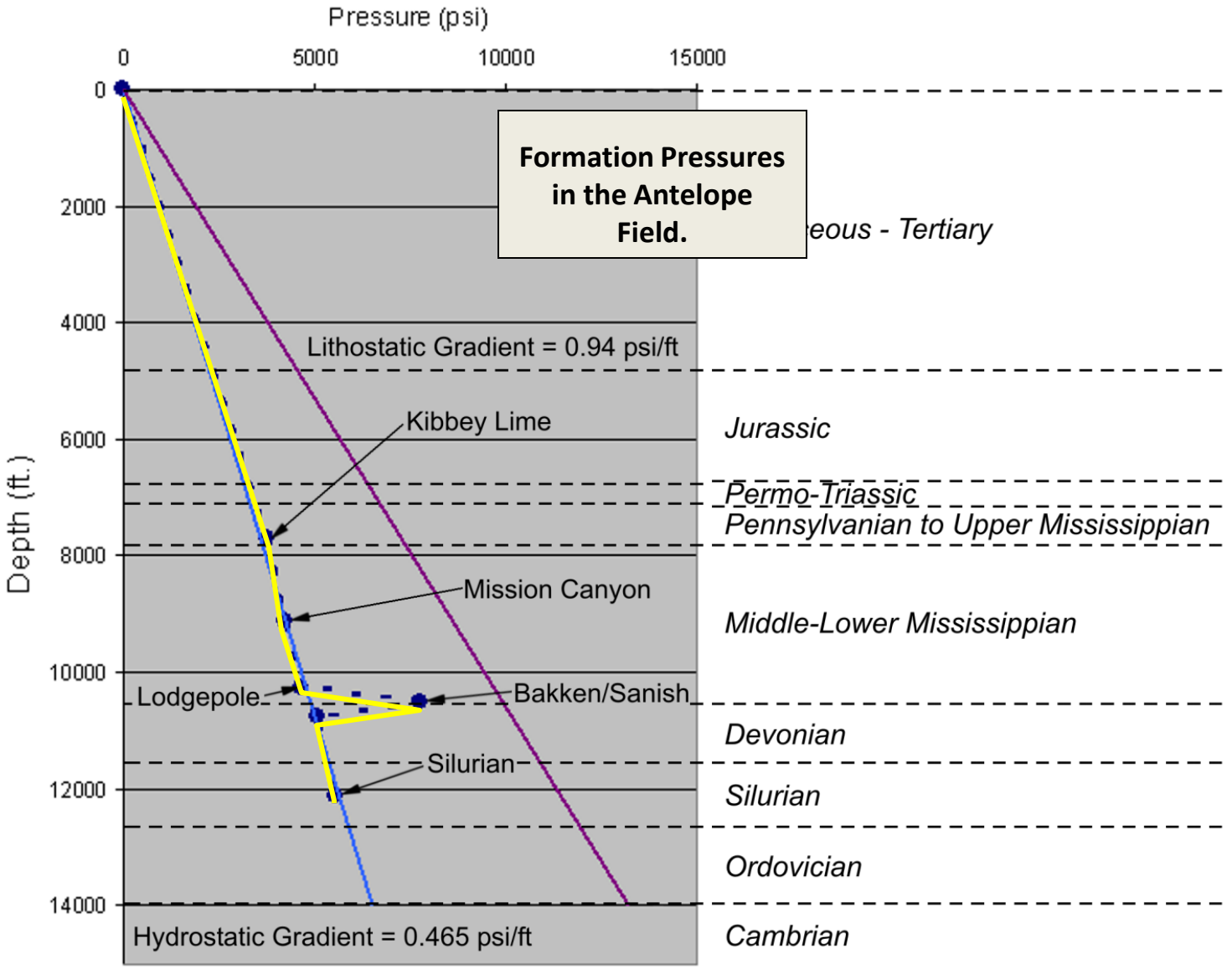


3) Expulsion of Petroleum from Source Beds into Low Perm Bounding Beds



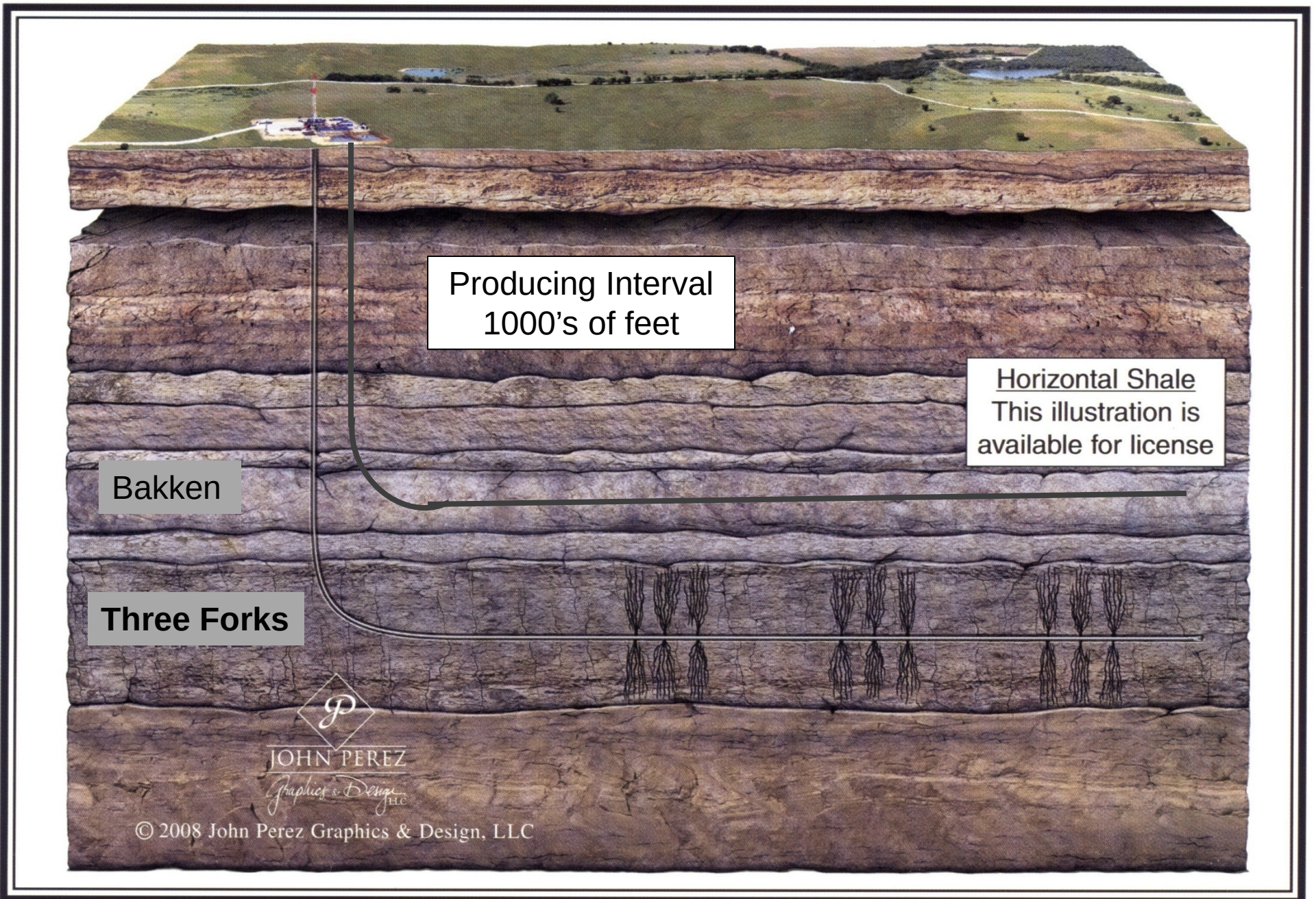


4) Trapping → abnormally High Formation Pressure



Modified from Meissner (1978)

5) Technology = horizontal well / multi stage hydraulic fractured



Drilling Voyager Oil Gas.flv

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- Development History
  - 2001 through 2003 MT Elm Coulee Activity
  - 2004 through 2006 operators tried many spacing-drilling-fracing combinations (vertical frac length and pool defined)
  - 2006 through 2009 operators focused on 640 & 1,280 acre spaced wells with single stage fracturing
  - Q4 of 2009 stage fracturing of +20 - ceramic proppant - 1,280 acre - 10,000 foot lateral combination identified
  - Q1 of 2010 Industrial Commission organized 15,000 square miles into North-South 1,280 acre spacing and drilling units

https://www.dmr.nd.gov/ - Oil and Gas Subscription: ArcIMS Viewer - Windows Internet Explorer

Oil and Gas Subscription: ArcIMS Viewer

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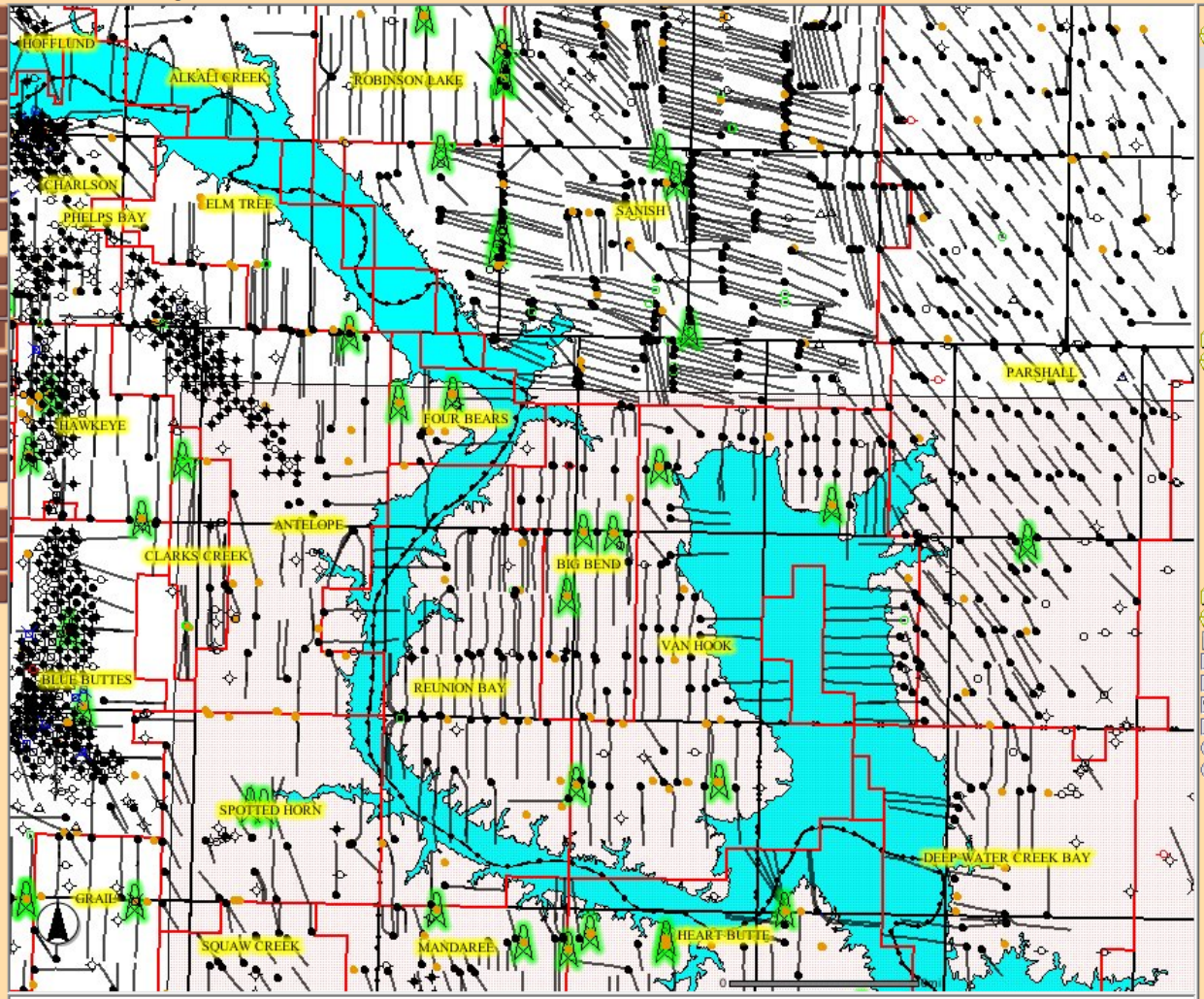
Find Well
Find Field/Unit
Find Section



ND OIL & GAS LAYERS

- Oil and Gas
  - Wells
  - Rig Location
  - Directional Surveys
  - Directional Legs
  - Horizontal Surveys
  - Horizontal Legs
  - Cases Docketed
  - Oil Fields
  - Unit Boundaries
  - Inspector Areas
  - Drilling / Spacing
  - Seismic
  - Gas Plants
- Other
- Imagery
  - Topo/DRG 250k
  - Topo/DRG 100k
  - NAIP 2009

Refresh Map

Auto Refresh

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- An inactive layer, click to make active.
- The active layer.

Pan

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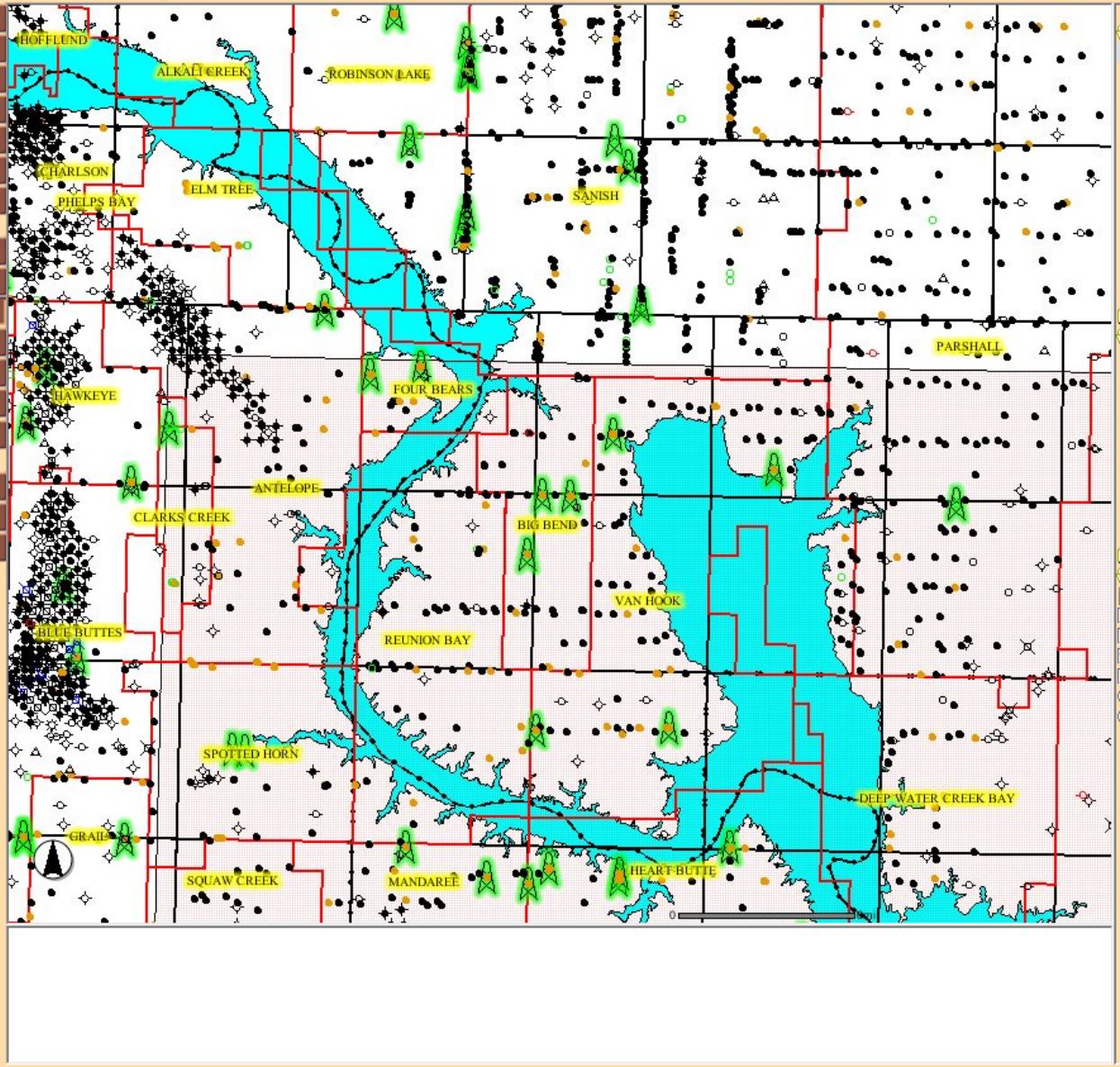
Find Field/Unit
Find Section



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Click to show

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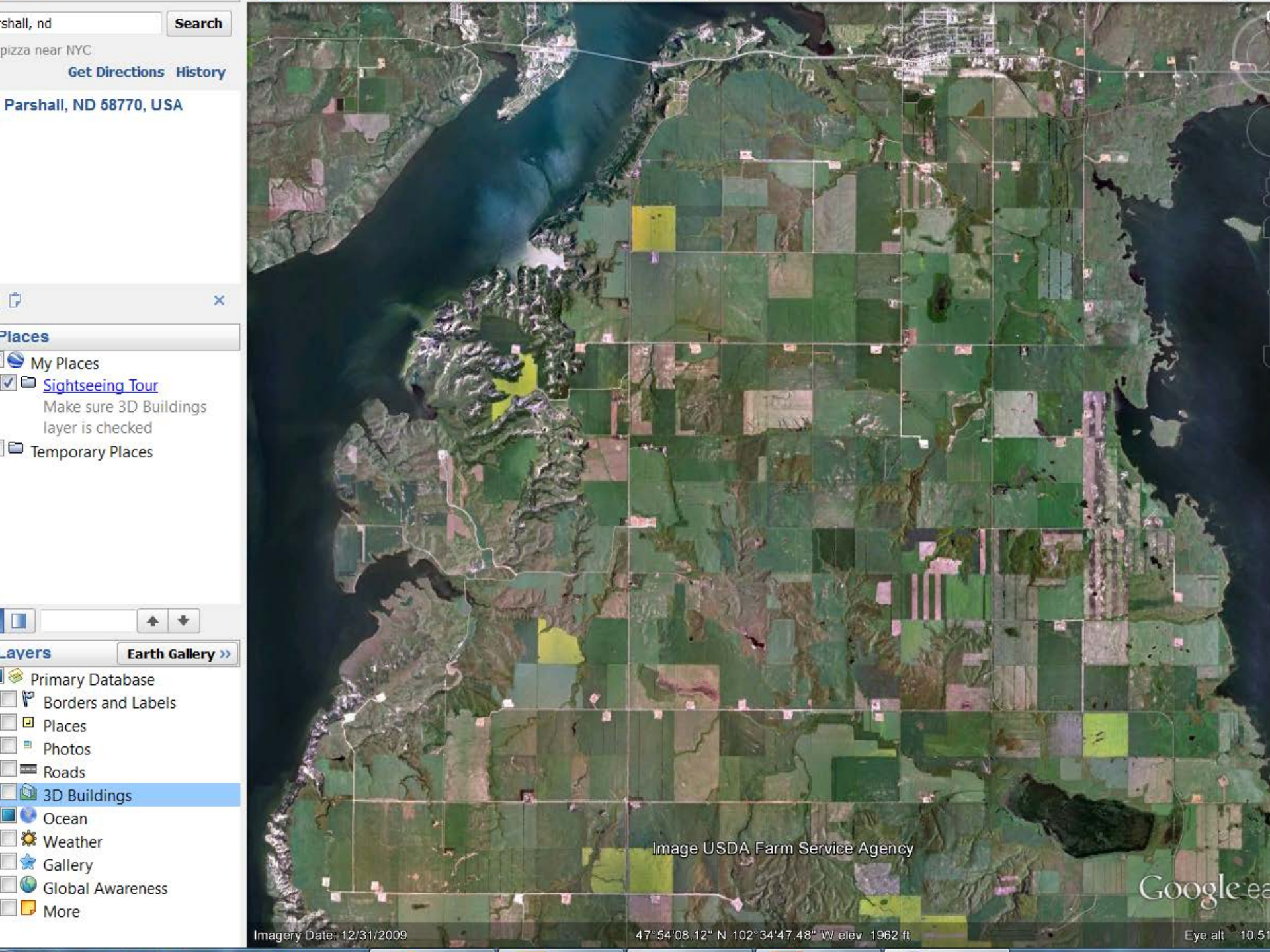
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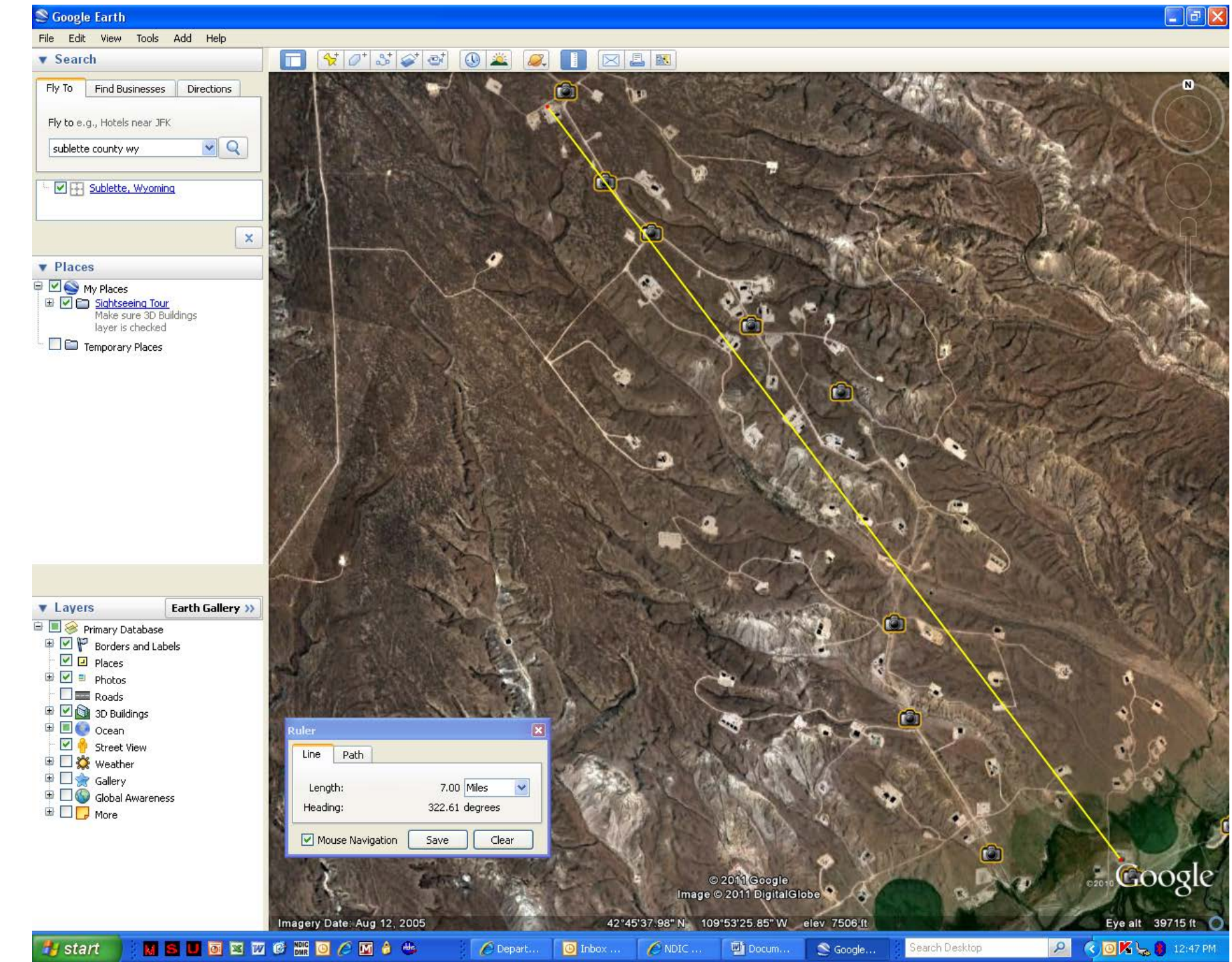
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Directions
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More
Ruler
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Path
Length: 7.00 Miles
Heading: 322.61 degrees
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42°45'37.98" N 109°53'25.85" W elev 7506 ft
Eye alt 39715 ft
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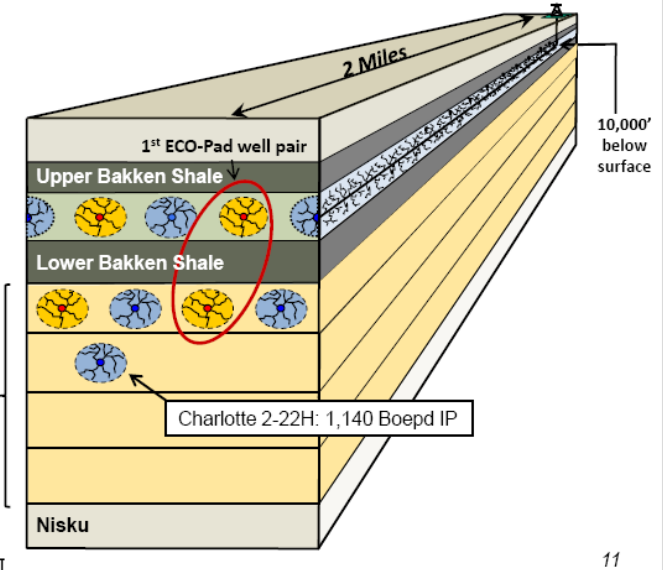
Vern Whitten Photography

Bakken Development Plan

- Original dual-zone development plan
  - 8 wells per 1,280 acres – 4 MB, 4TF
  - 603,000 Boe EUR per well (avg. 24.5 stages/completion)
  - ECO-Pad® design: 2 wells south, 2 wells north
- Additional Three Forks potential



Most Likely						
	Bakken		Three Forks		Total	
County	OOIP per County	EUR per County	OOIP per County	EUR per County	OOIP per County	EUR per County
Billings	3,141,271,156	115,858,434	1,717,909,400	154,611,846	4,859,180,556	270,470,280
Bottineau			1,642,257,140	147,803,143	1,642,257,140	147,803,143
Burke	14,891,719,317	187,975,278	2,084,609,970	187,614,897	16,976,329,287	375,590,175
Divide	16,836,857,774	123,315,660	855,513,980	76,996,258	17,692,371,754	200,311,919
Dunn	18,059,716,691	294,169,921	2,008,459,540	180,761,359	20,068,176,231	474,931,279
Golden Valley	66,147,411		25,519,700	2,296,773	91,667,111	2,296,773
Grant	62,508,094				62,508,094	
McHenry			539,104,280	48,519,385	539,104,280	48,519,385
McKenzie	32,438,937,580	382,654,320	3,941,684,770	354,751,629	36,380,622,350	737,405,950
McLean	3,253,719,118		351,841,190	31,665,707	3,605,560,308	31,665,707
Mercer			118,427,220	10,658,450	118,427,220	10,658,450
Morton			84,144,950	84,144,950	84,144,950	84,144,950
Mountrail	27,242,795,837	424,826,873	1,676,048,980	150,844,408	28,918,844,817	575,671,281
Oliver			9,002,880	810,259	9,002,880	810,259
Renville			183,377,880	16,504,009	183,377,880	16,504,009
Slope	10,586,089				10,586,089	
Stark	2,349,351,546	86,371,150	1,604,239,450	144,381,551	3,953,590,996	230,752,701
Ward	4,540,670,907		446,420,030	40,177,803	4,987,090,937	40,177,803
Williams	26,263,485,095	474,392,108	2,666,823,630	240,014,127	28,930,308,725	714,406,235
Total	**149,157,766,614**	**2,089,563,745**	**19,955,384,990**	**1,872,556,554**	**169,113,151,604**	**3,962,120,299**

Six Wells on a Single Pad

Vern Whitten Photography

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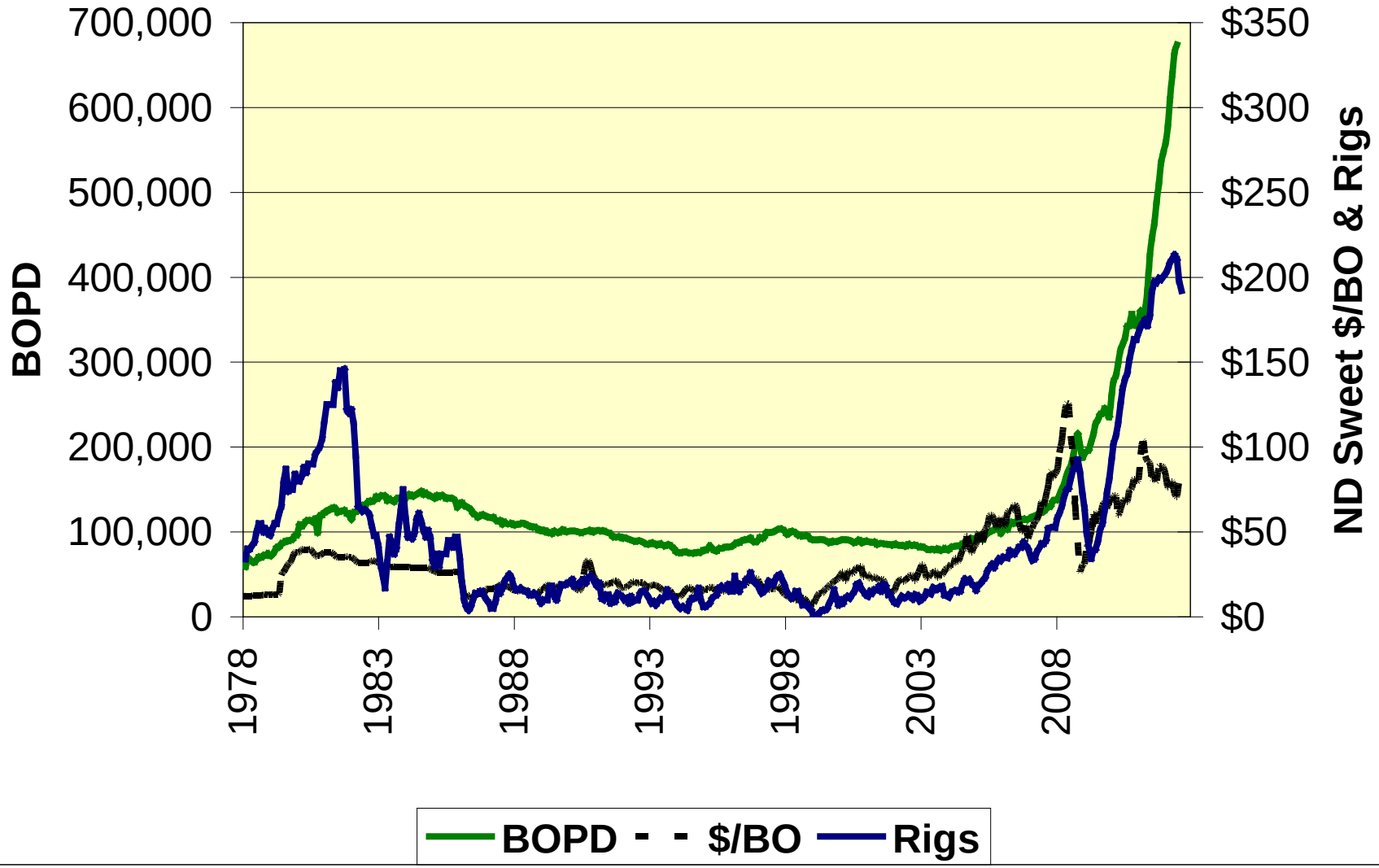
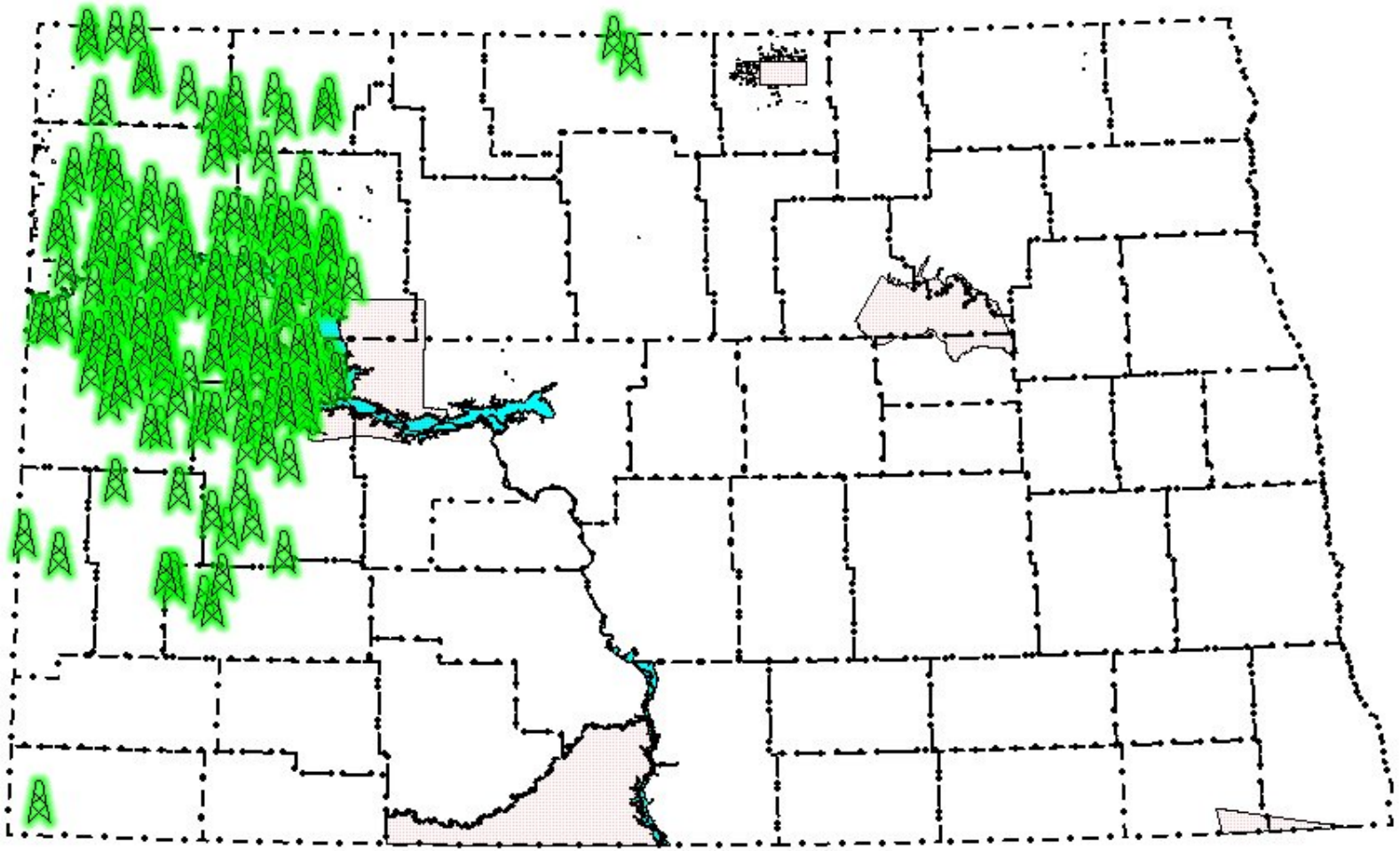
North Dakota Daily Oil Produced and Price



Oil and Gas : ArcIMS Viewer

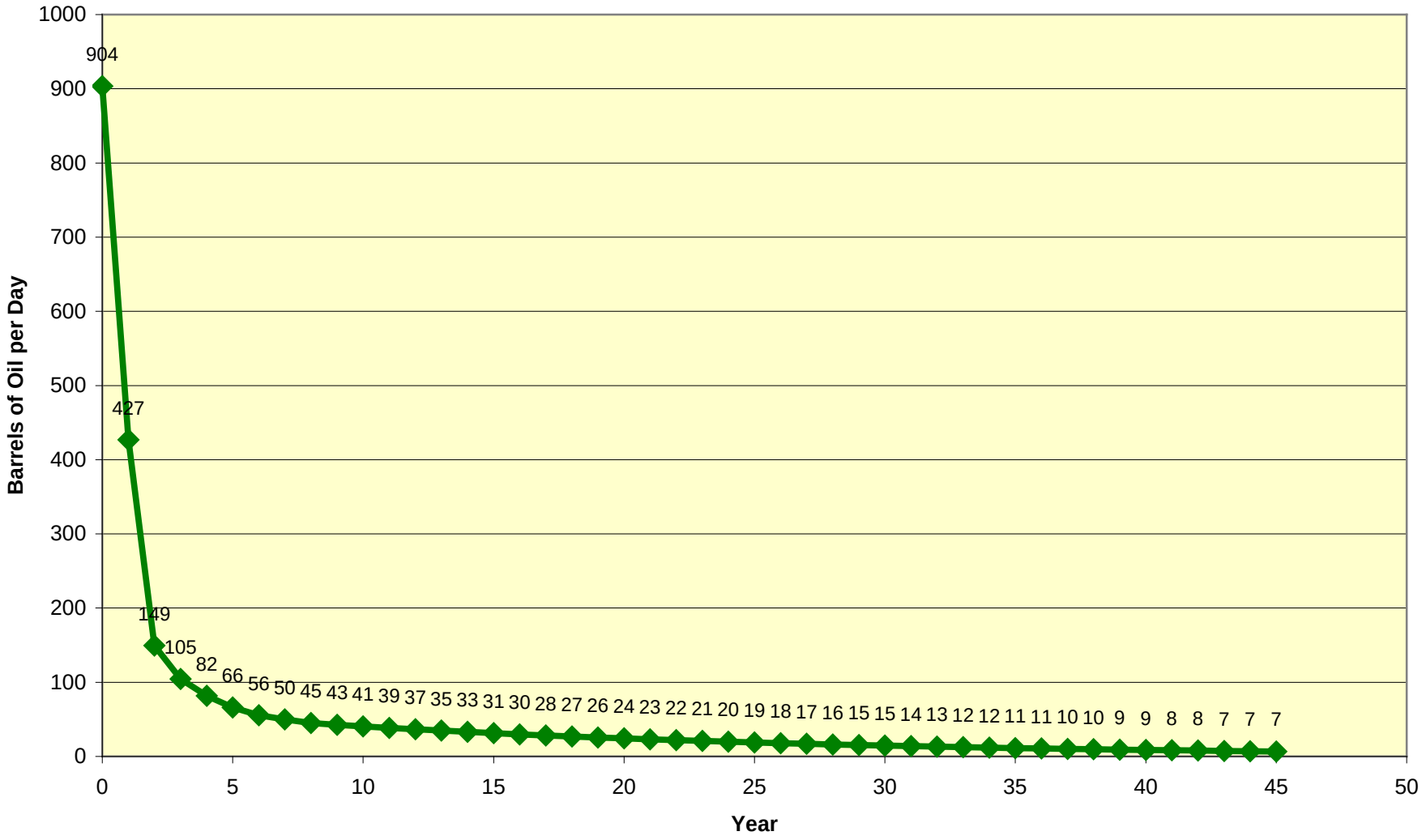
190 Rigs



Western North Dakota

- 1,800 to 3,000 wells/year = 2,000 expected
  - 150-250 rigs = 12,000 – 30,000 jobs
  - Another 10,000-15,000 jobs building infrastructure
  - 200 rigs can drill the wells needed to secure leases in 1 year
  - 200 rigs can drill the wells needed to develop spacing units in 18 years
  - 35,000-40,000 more new wells

Typical Bakken Well Production



What Does Every New Bakken Well Mean to North Dakota

A typical 2012 North Dakota Bakken well will produce for 45 years

If economic, enhanced oil recovery efforts can extend the life of the well

In those 45 years the average Bakken well:

Produces approximately 615,000 barrels of oil

Generates about $20 million net profit

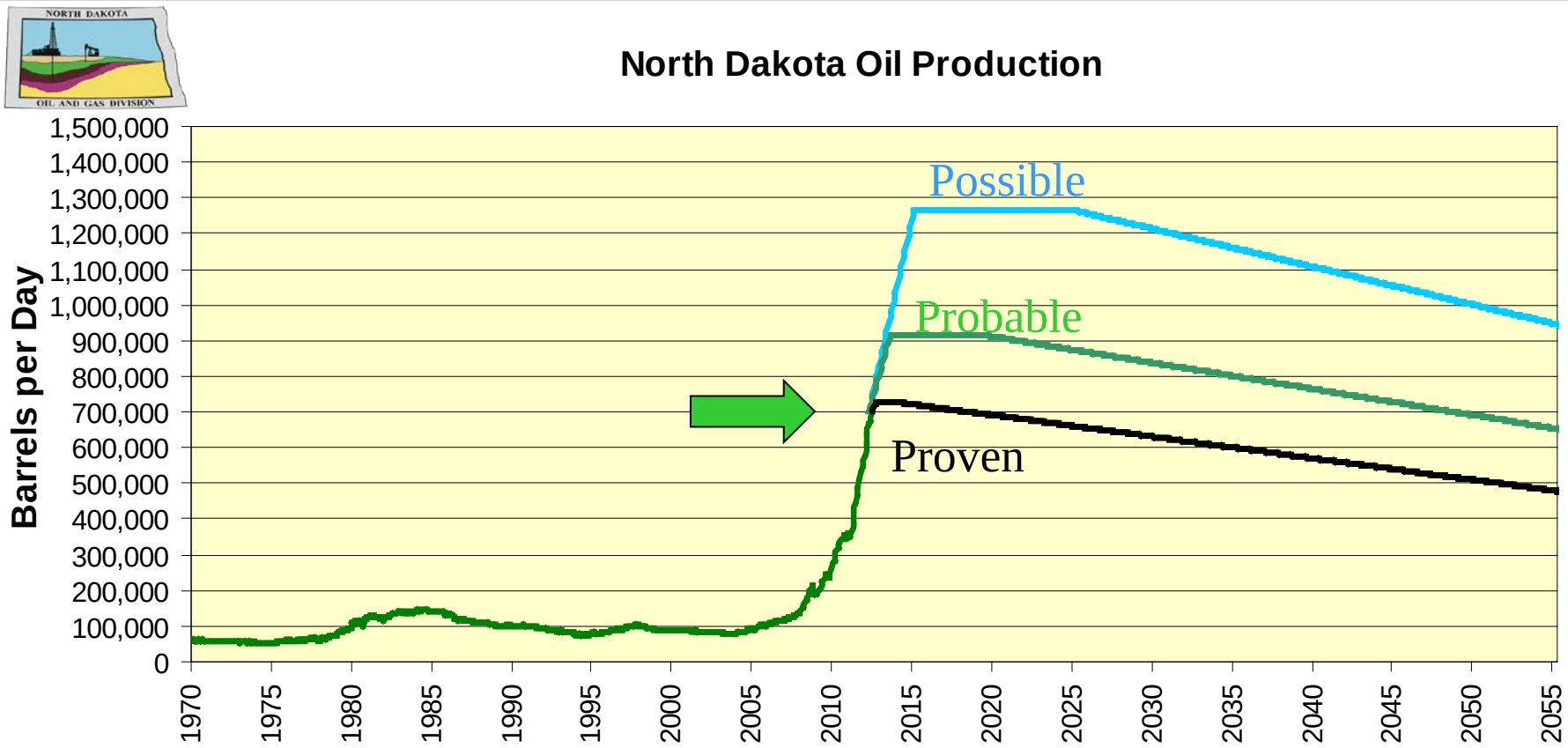
Pays approximately $4,325,000 in taxes
- $2,100,000 gross production taxes
- $1,800,000 extraction tax
- $425,000 sales tax

Pays royalties of $7,300,000 to mineral owners

Pays salaries and wages of $2,125,000

Pays operating expenses of $2,300,000

Cost $9,000,000 to drill and complete

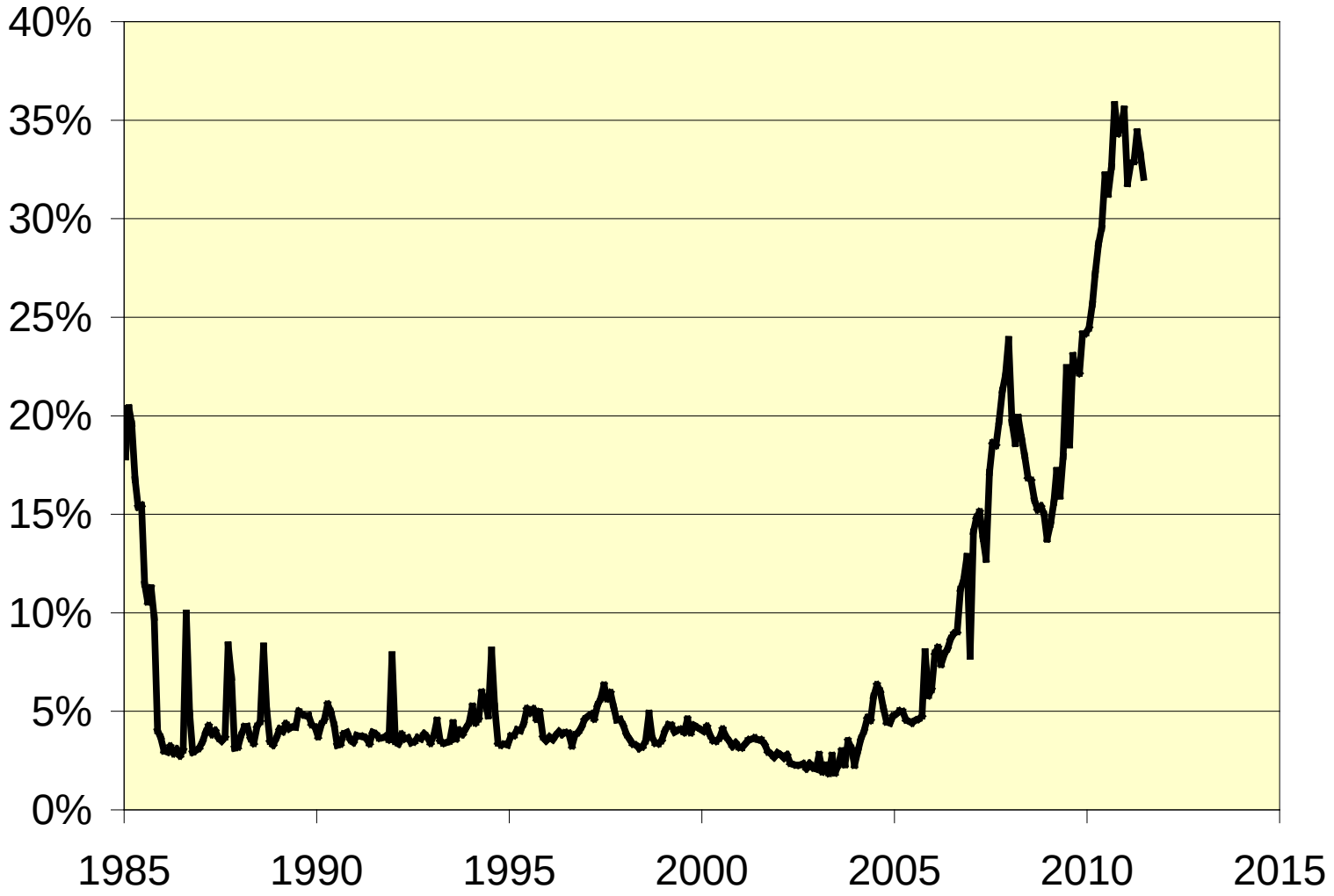


4,224 Bakken and Three Forks wells drilled and completed

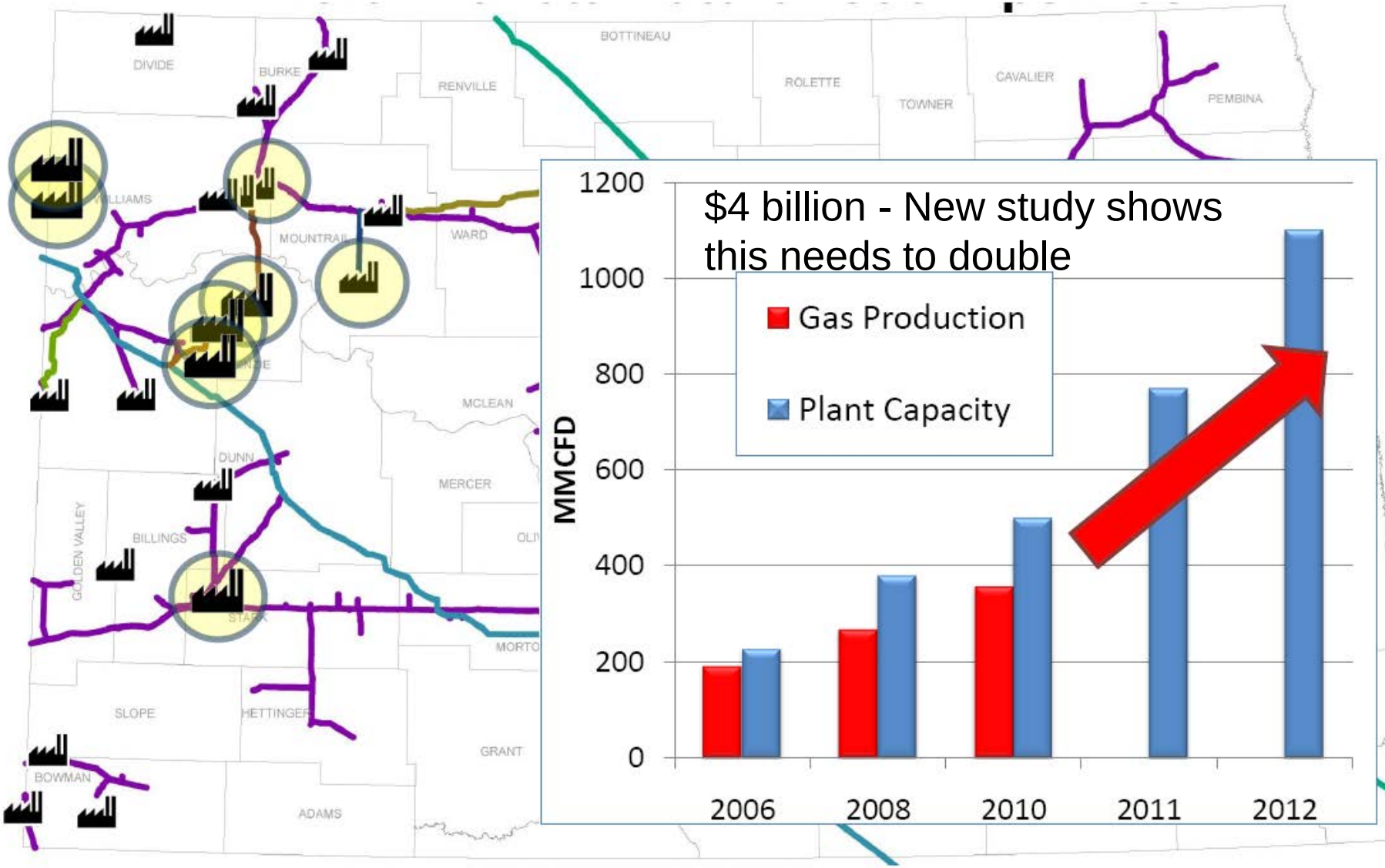
35,000-40,000 more new wells possible in thermal mature area

Proven=7.5 BBO Probable=11 BBO Possible=15.5 BBO (billion barrels of oil)

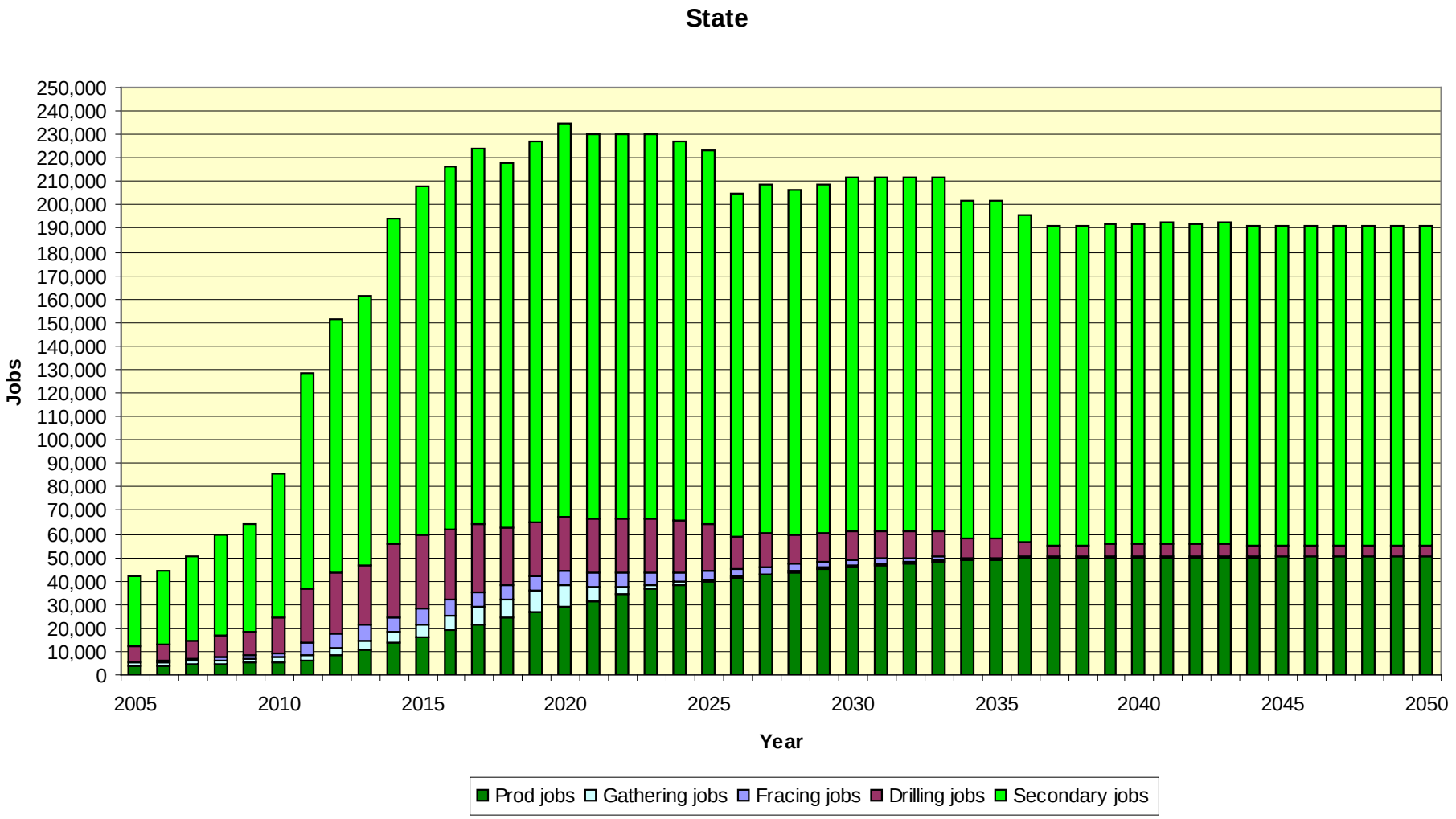
North Dakota Monthly Gas Flared



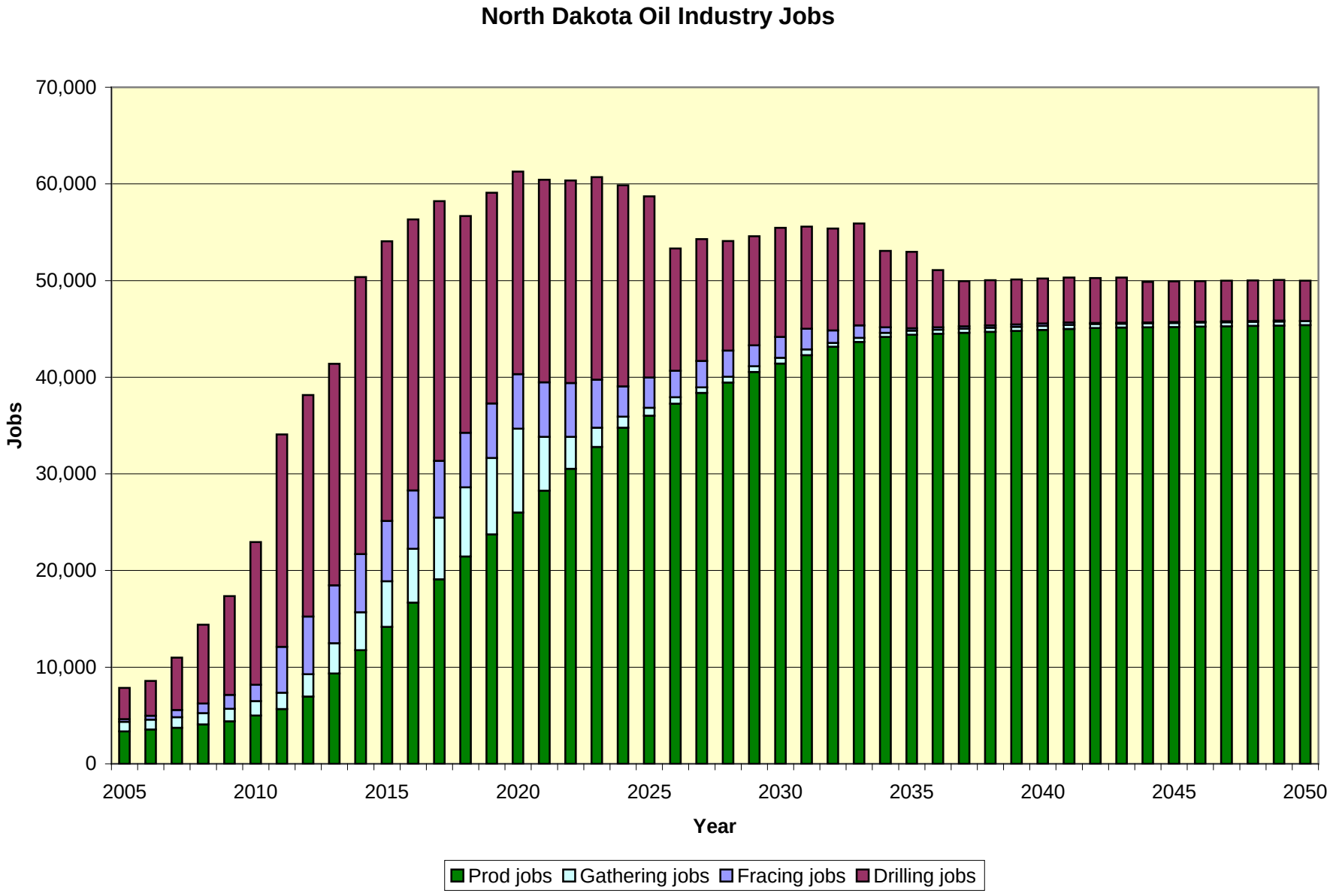
New or Expanding Gas Plants



Expected Case



Expected Case



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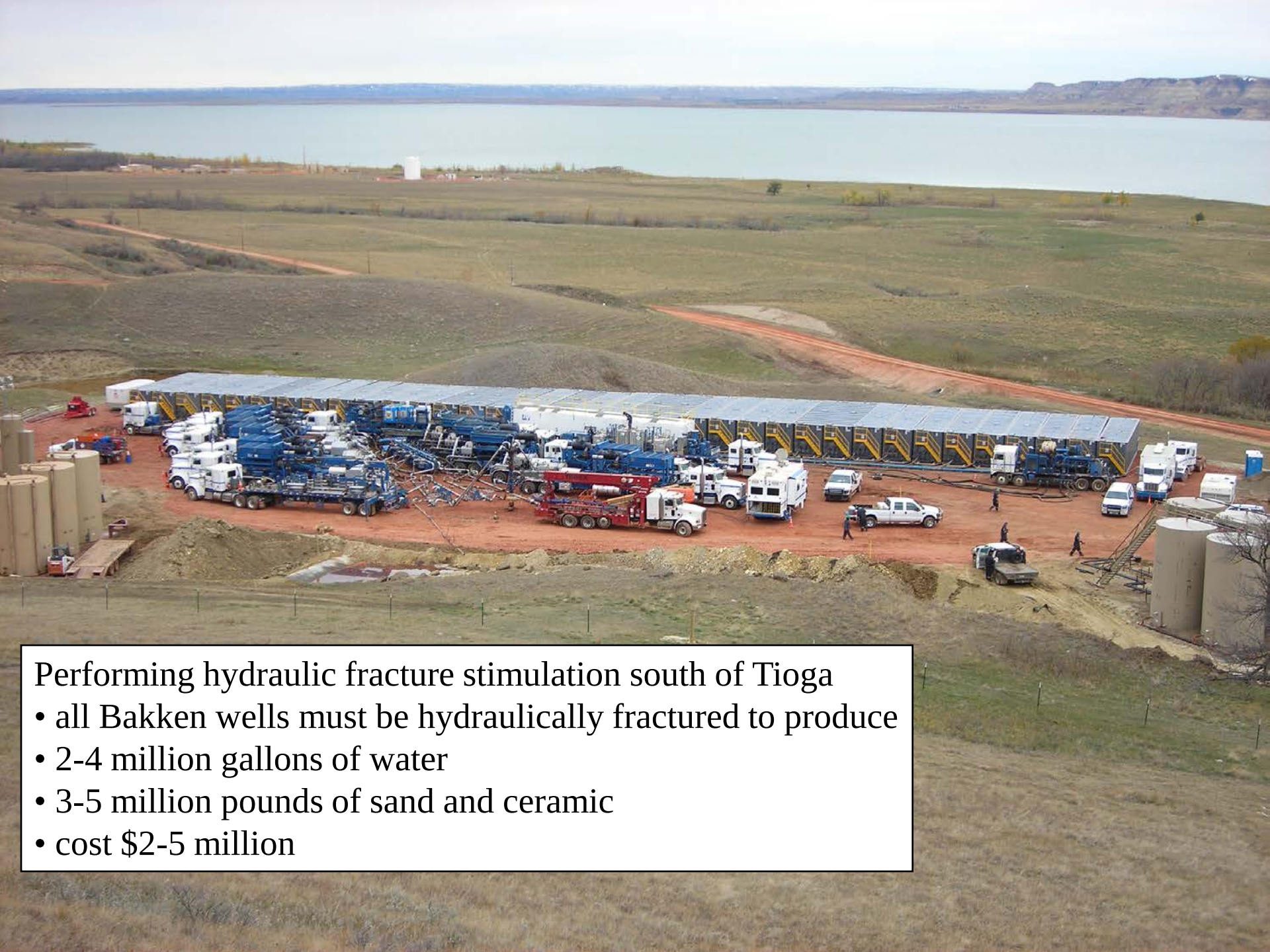
Hydraulic Fracturing
Lifeline to Domestic Energy

Hydraulic Fracturing

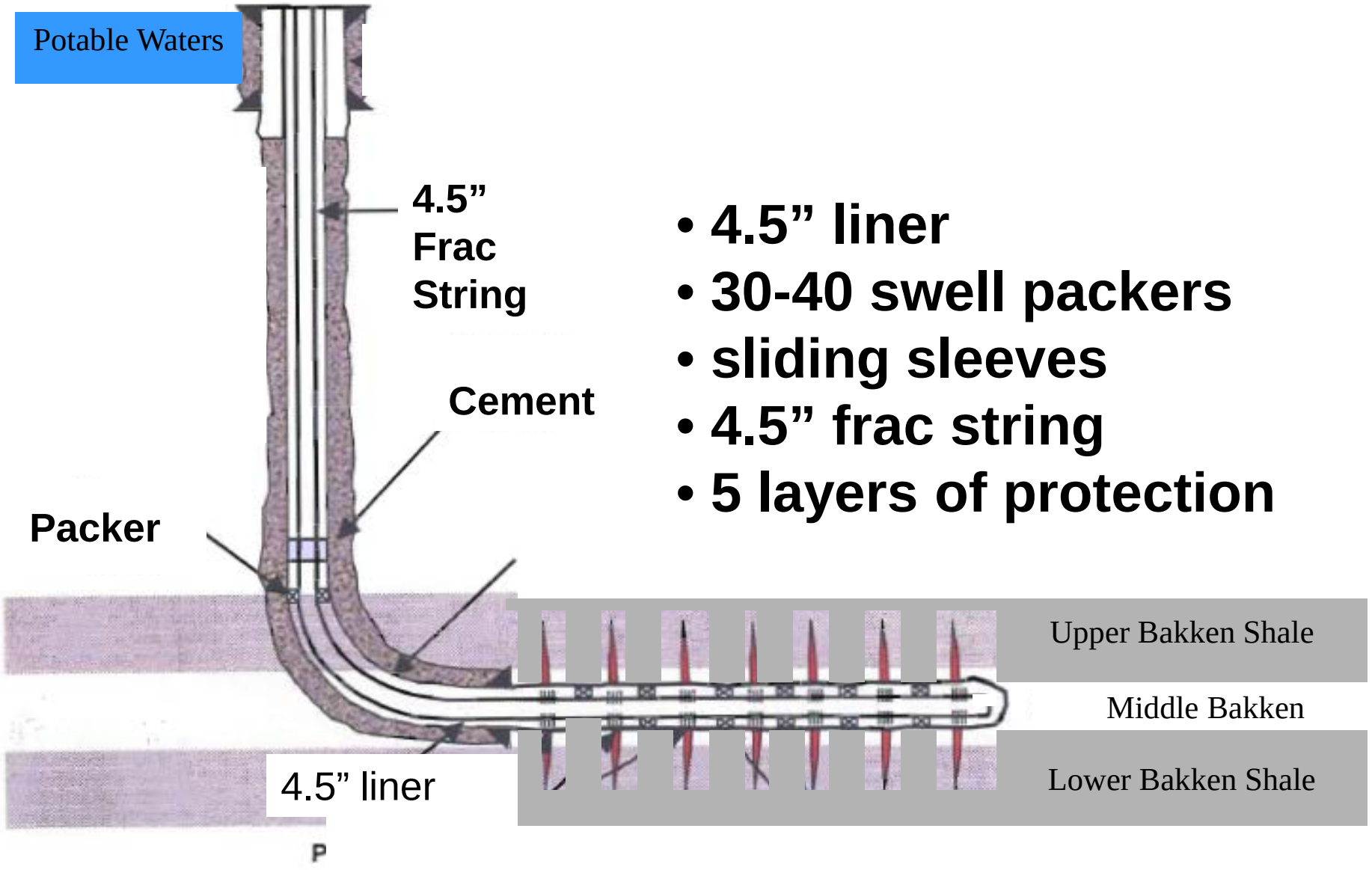
- **Why**
  - **Easy oil and gas that flow without fracturing are already developed**
  - **Unconventional Reserves**
    reservoirs are tight (look at sample)
    uneconomic to produce without fracing
    must create a path for oil to flow
- **How**
- **Regulations**



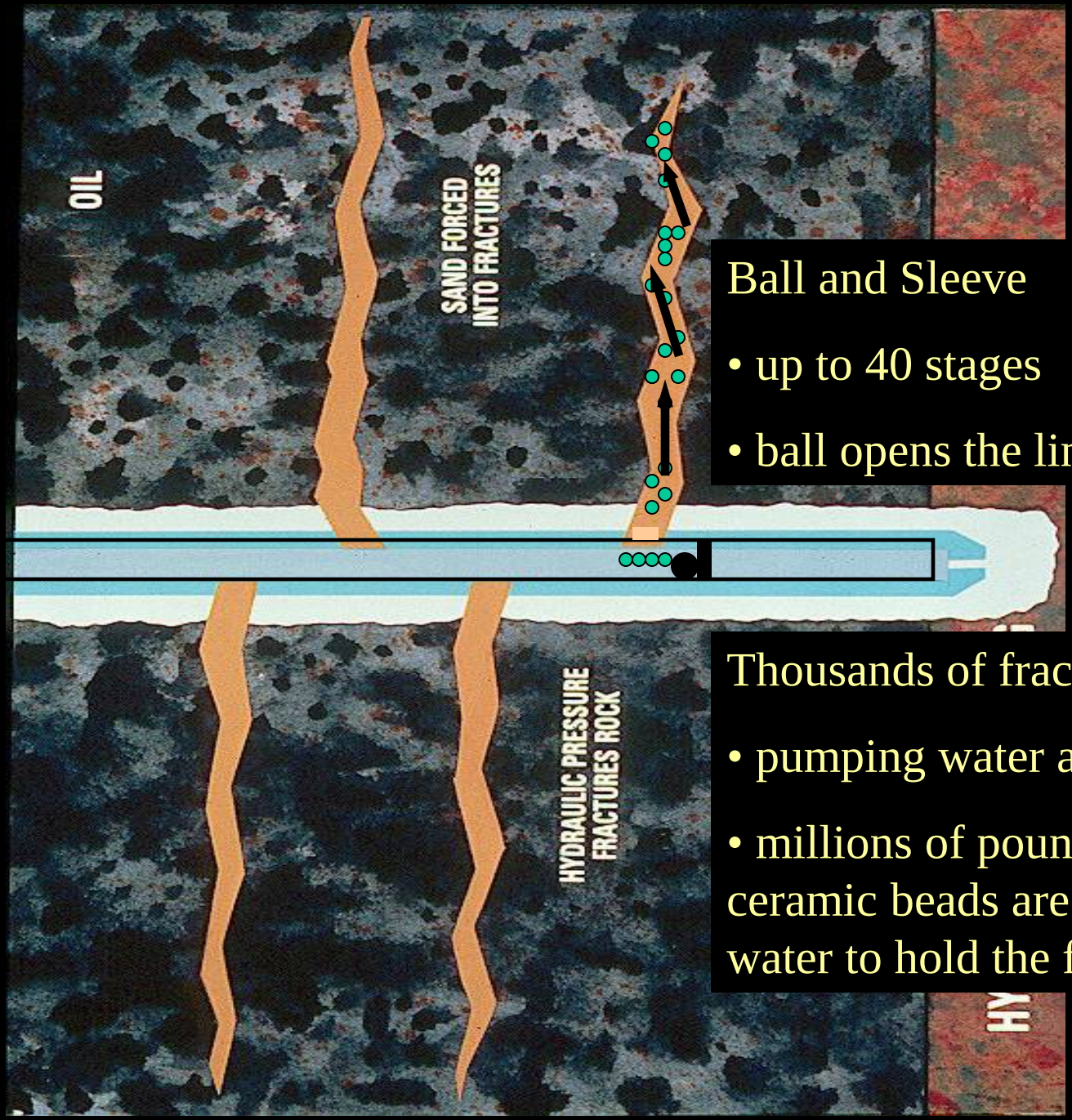
Performing hydraulic fracture stimulation south of Tioga

- all Bakken wells must be hydraulically fractured to produce
- 2-4 million gallons of water
- 3-5 million pounds of sand and ceramic
- cost $2-5 million

TYPICAL HORIZONTAL OIL WELL



- 4.5” liner
- 30-40 swell packers
- sliding sleeves
- 4.5” frac string
- 5 layers of protection

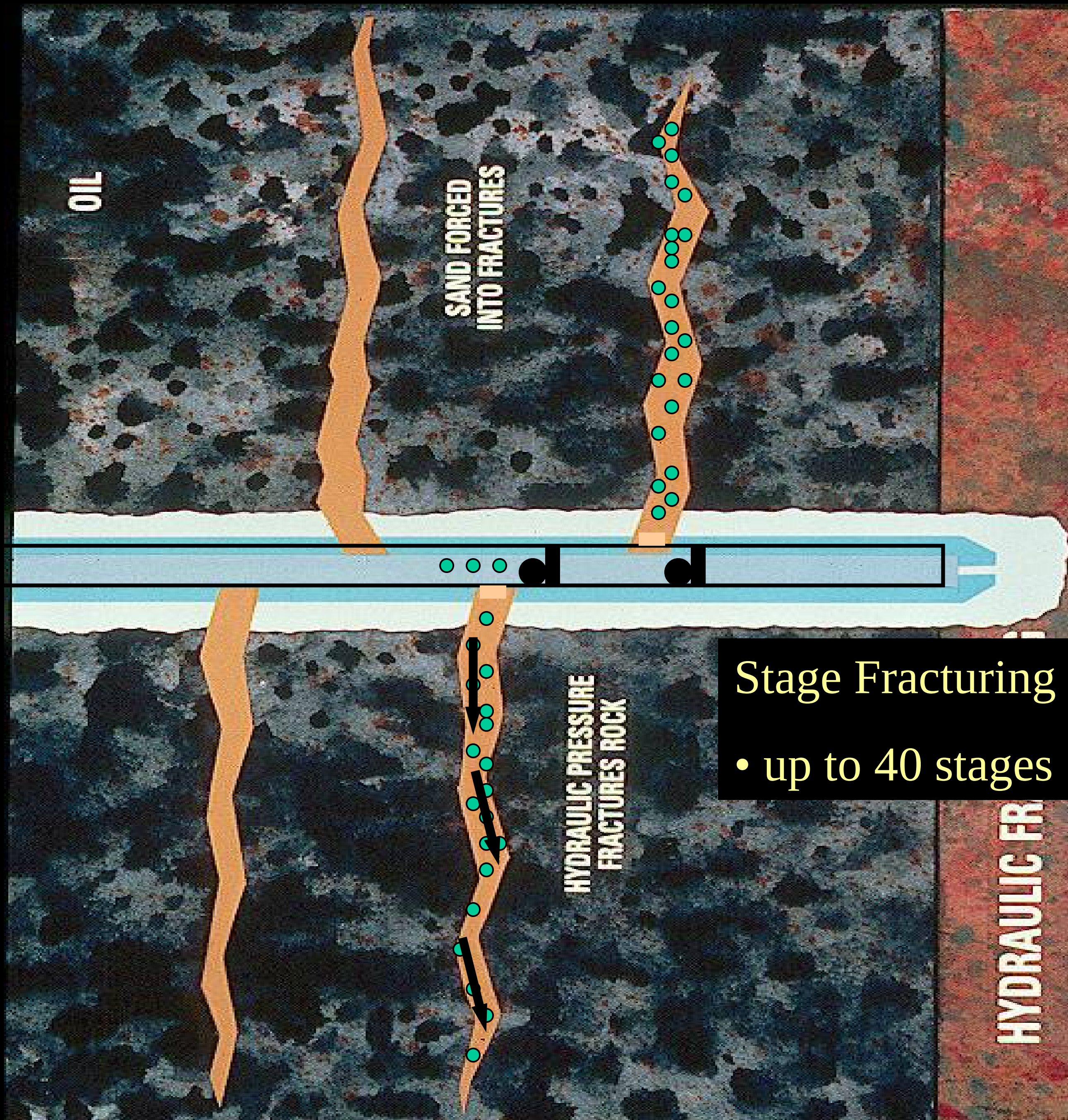


Ball and Sleeve

- up to 40 stages
- ball opens the liner sleeve

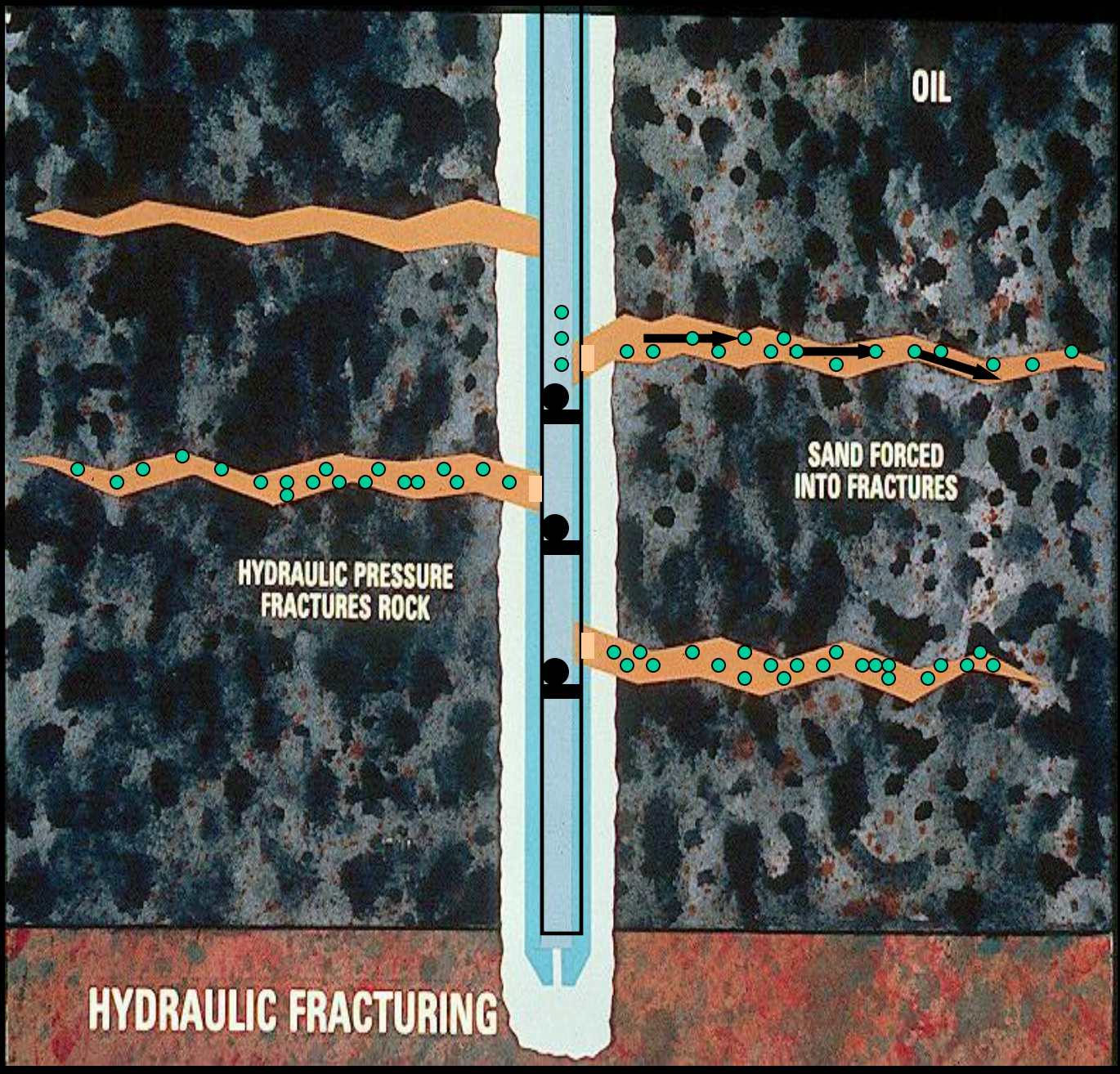
Thousands of fractures are created

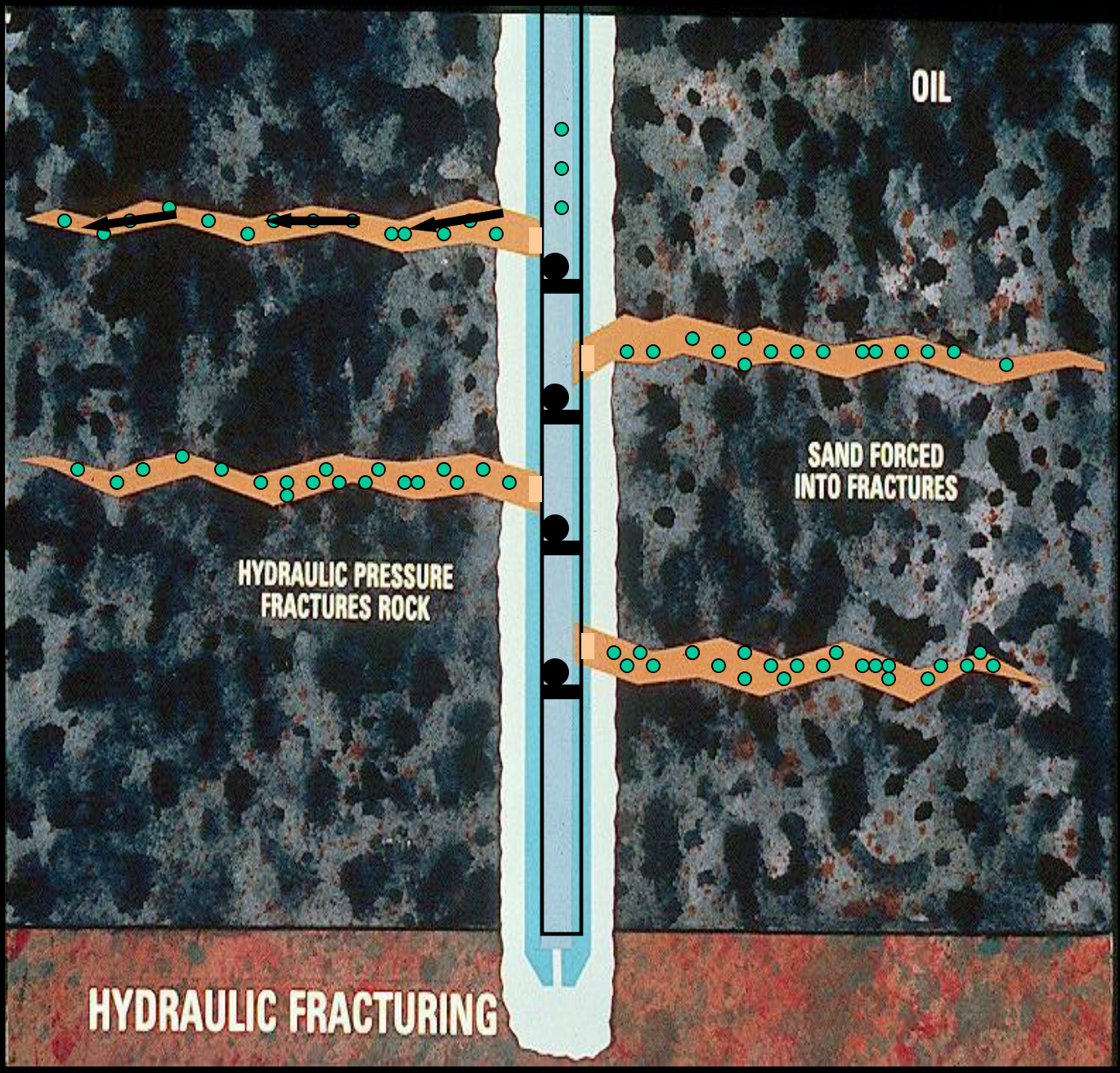
- pumping water at 6,000-9,000 psi
- millions of pounds of sand and ceramic beads are pumped with the water to hold the fractures open.



Stage Fracturing

- up to 40 stages


OIL
SAND FORCED
INTO FRACTURES
HYDRAULIC PRESSURE
FRACTURES ROCK
HYDRAULIC FRACTURING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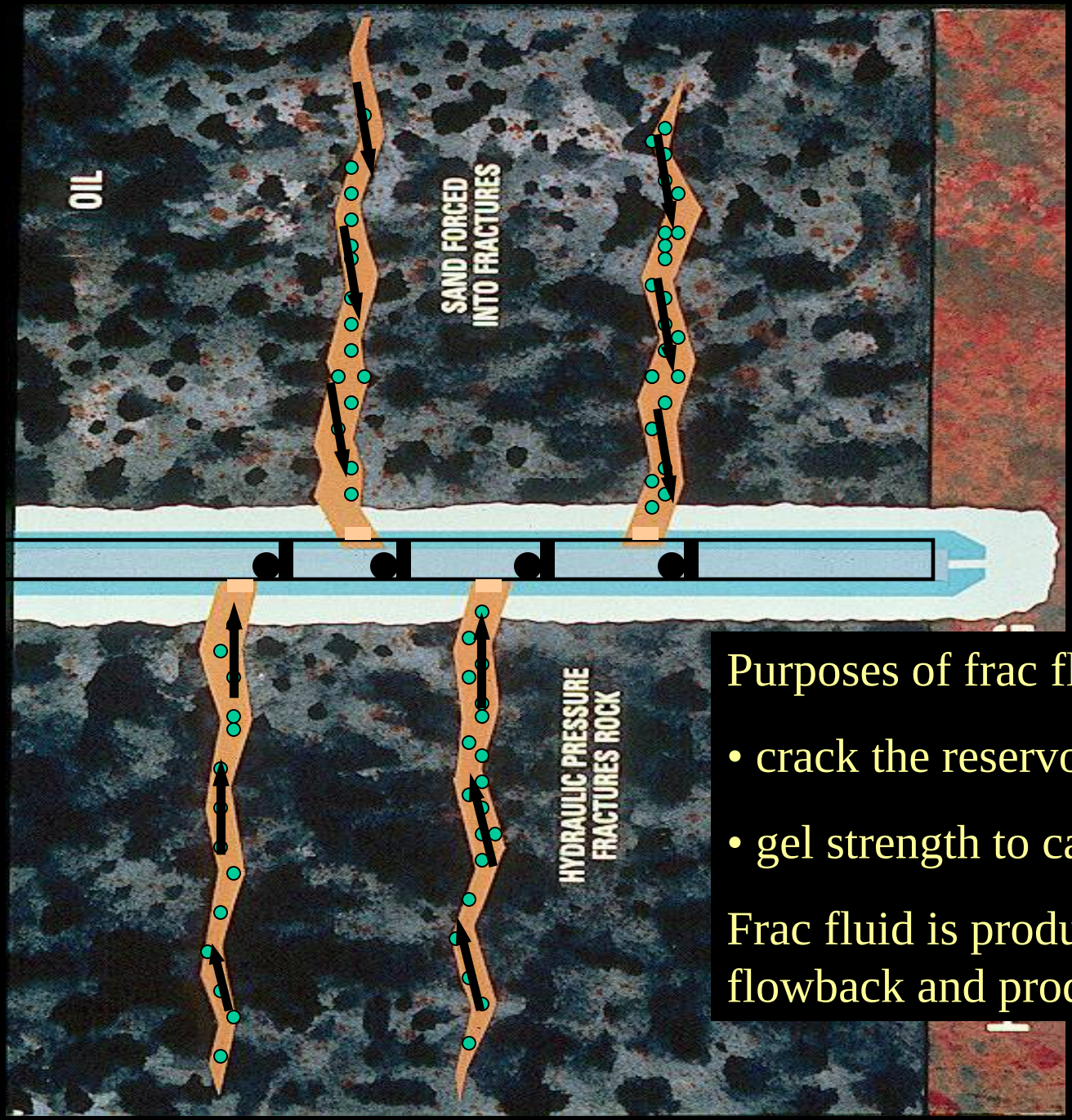
HYDRAULIC PRESSURE
FRACTURES ROCK
HYDRAULIC FRACTURING

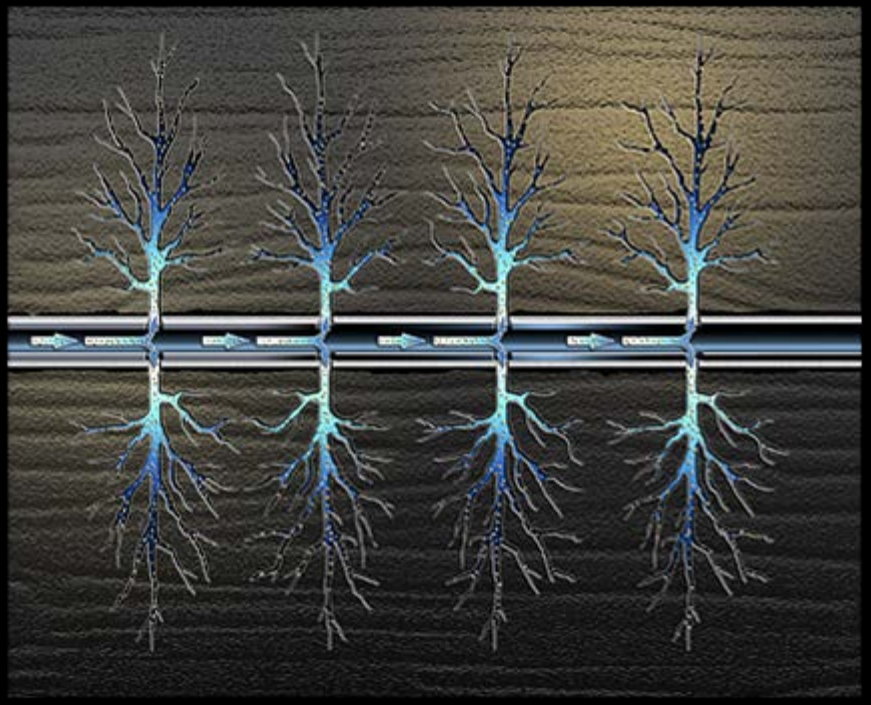


Purposes of frac fluid

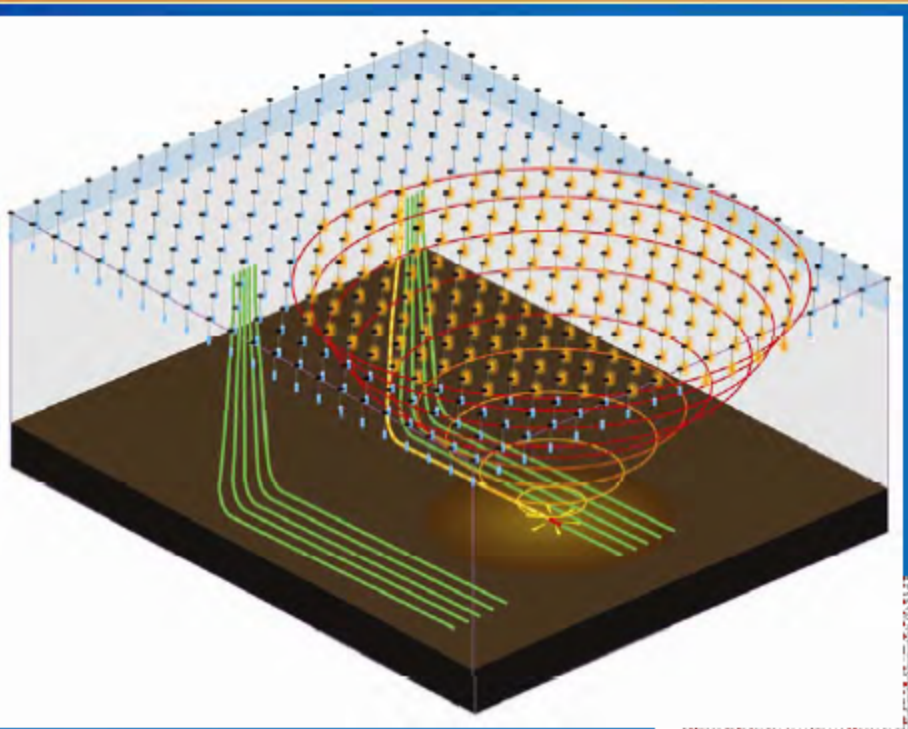
- crack the reservoir
- gel strength to carry sand

Frac fluid is produced back as flowback and produced water

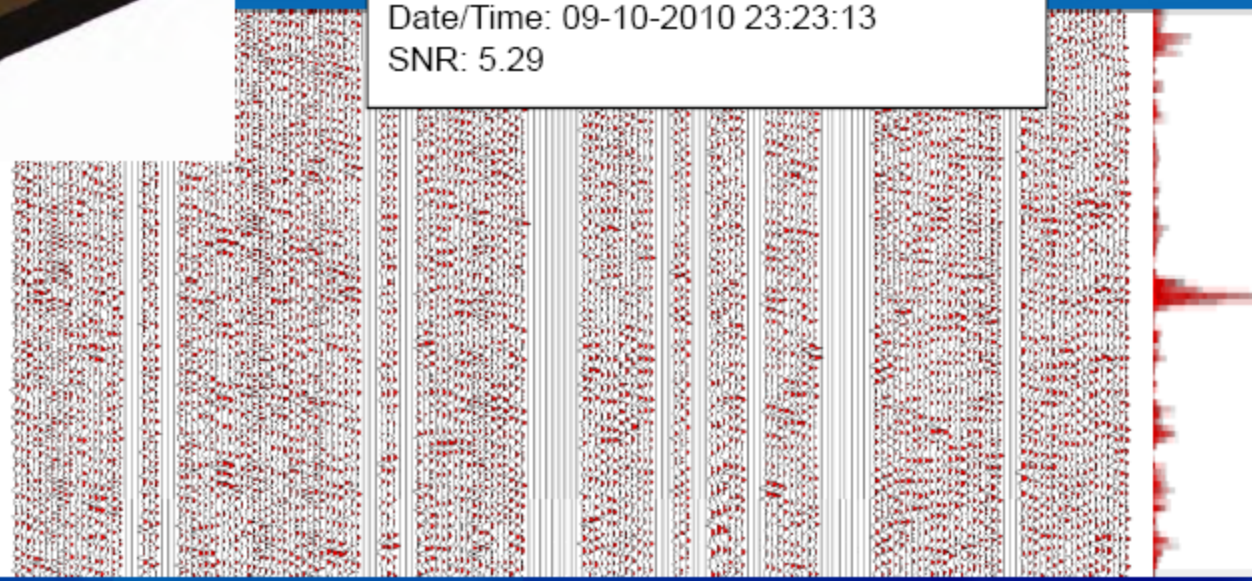
Each hydraulic fracturing stage creates hundreds of fractures extending several hundred feet from wellbore



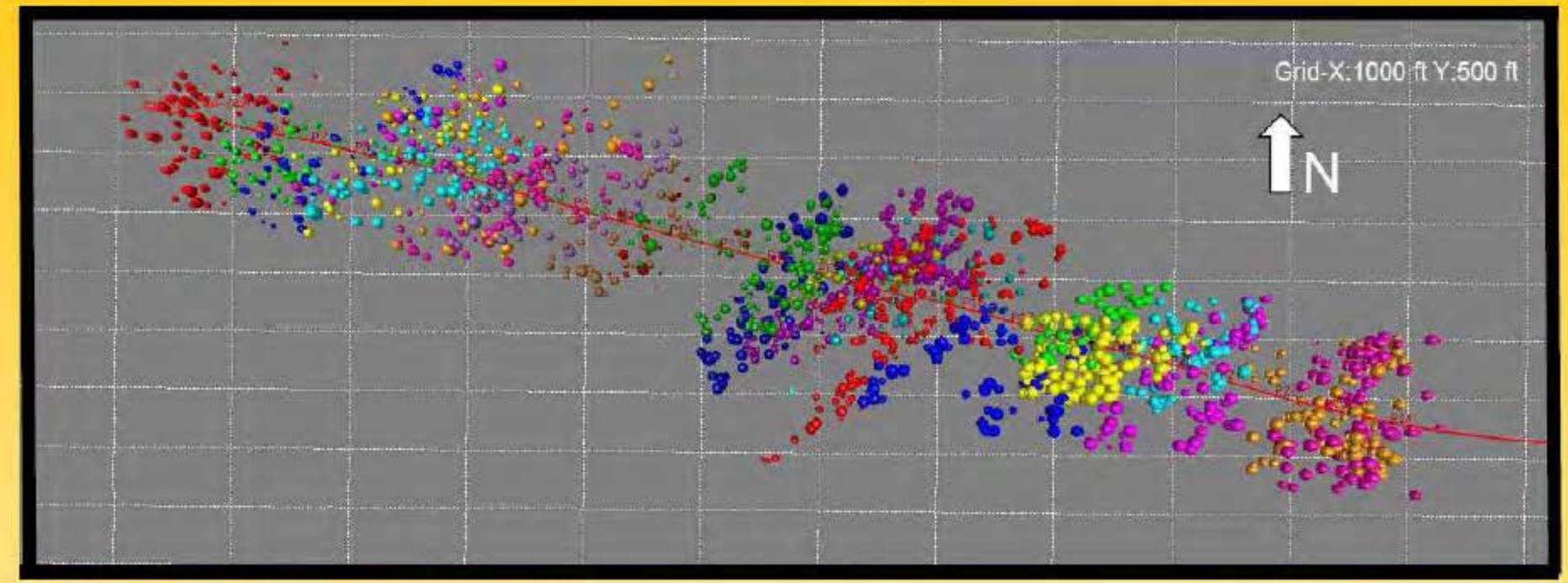
PSET Imaging



Microseismic events are imaged via PSET, a migration based imaging algorithm.



"Excellent 'frac saturation'…."



- **24-Stage Frac / IP: 2,558 BOE/D**
- **Excellent "frac saturation" evidenced by minimal gaps of unfraced rock along the wellbore with some stages impacting the same rock volume.**
- **Minimal gaps along NE trending natural fractures where the frac follows large regionally extensive fractures. These areas already have good naturally occurring fractures.**
- **Lateral frac wings that average 750' on either side of the wellbore. This is consistent with our other fracs and planned spacing pattern for full field development.**

States have been regulating the full life cycle of hydraulic fracturing for decades

- Geology of each sedimentary basin is different
- Water Appropriation Regulation
- Oil & Gas Regulation
- Health and Environmental Regulation

North Dakota has been regulating the full life cycle of hydraulic fracturing for decades

- Water Commission
  - water supply
- Industrial Commission
  - well construction
  - disposal of flow back water
- Health Department
  - spill cleanup

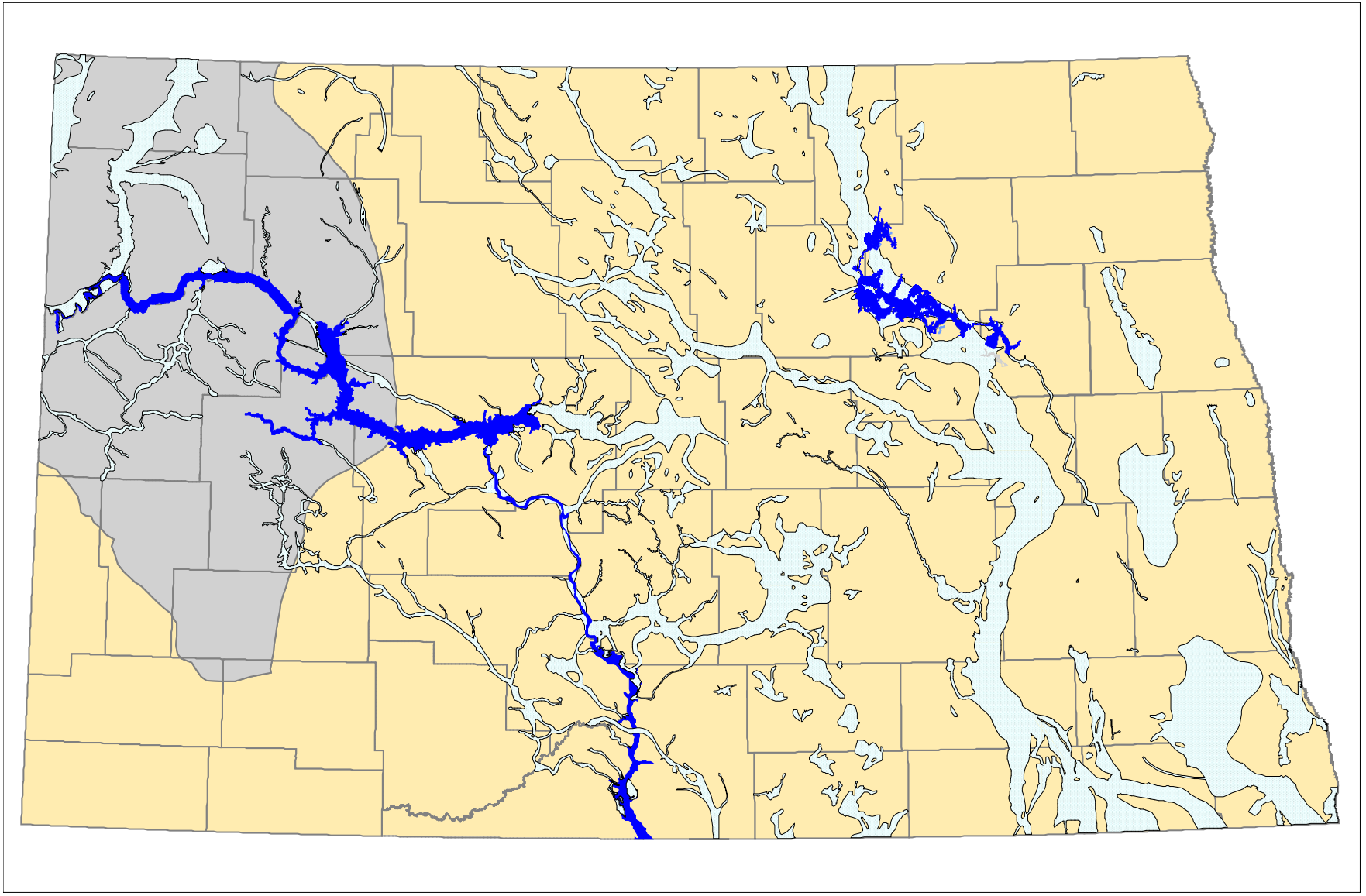
Water Commission Regulation

- Regulate water appropriations
- Guard against withdrawals exceeding recharge

Thirsty Horizontal Wells

- 2,000 - 3,000 wells / year
- 15 - 25 years duration
- 20 - 30 million gallons water / day

Glacial Drift Aquifers



FRAC WATER NEEDS

- Lake Sakakawea (Missouri River) is the best water resource
  - one inch contains 10 billion gal water
    - enough to fracture 2,500-5,000 wells
    - 30 million gallons flows through Bismarck every 3 minutes

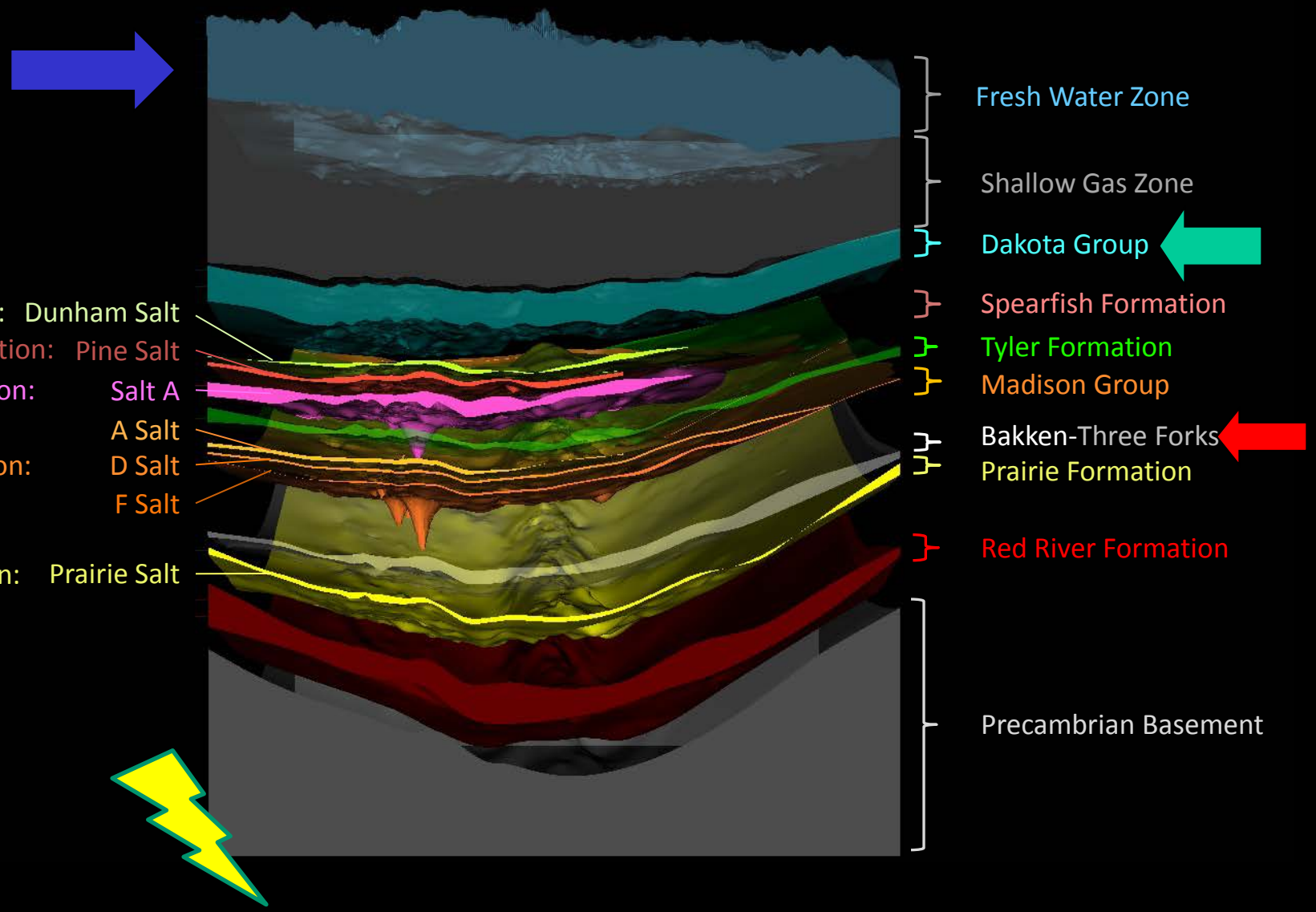
Industrial Commission Regulation

- Well construction for Hydraulic fracturing
  - Two casing strings required
  - Both strings must be cemented
  - Pressure tests required
  - Frac is > 1.5 mile below potable water

Industrial Commission Regulation

- Water flow back after frac
  - Storage in open pits prohibited
  - Disposal wells permitted through Underground Injection Program
  - Disposal zone is 1/2 mile below potable waters with impermeable shale between and >2 miles above earthquake zone with many layers including salt between

Significant Salt Intervals of Northwestern North Dakota



Health Department Regulation

- Cleanup of discharge to environment
- Coordinate with local Emergency Managers
- Emergency Planning and Community Right-to-know Act (EPCRA)
- Congress passed for storing and handling of chemicals
- Requires material safety data sheet (MSDS) for each chemical on location

- **Compound**
  - **Purpose**
    - **Common application**

- Fresh **Water** – 80.5%
- Proppant – 19.0%
  - Allows the fractures to remain open so the oil and gas can escape
    - Drinking water filtration, **play ground sand**
- Acids - 0.12%
  - Help dissolve minerals and initiate fractures in rock (pre-fracture)
    - **Swimming pool cleaner**
- Petroleum distillates – 0.088%
  - Dissolve polymers and minimize friction
    - **Make-up remover**, laxatives, and candy
- Isopropanol – 0.081%
  - Increases the viscosity of the fracture fluid
    - **Glass cleaner**, antiperspirant, and hair color
- Potassium chloride – 0.06%
  - Creates a brine carrier fluid
    - Low-sodium **table salt substitute**
- Guar gum – 0.056%
  - Thickens the water to suspend the sand
    - **Thickener used in cosmetics**, baked goods, ice cream, toothpaste, sauces, and salad dressing
- Ethylene glycol – 0.043%
  - Prevents scale deposits in the pipe
    - Automotive **antifreeze**, household cleansers, deicing, and caulk

- Sodium or potassium carbonate – 0.011%
  - Improves the effectiveness of other components, such as cross-linkers
    - Washing soda, detergents, **soap**, water softeners, glass and ceramics
- Sodium Chloride – 0.01%
  - Delays break down of the gel polymer chains
    - **Table Salt**
- Polyacrylamide – 0.009%
  - Minimizes friction between fluid and pipe
    - **Water treatment**, soil conditioner
- Ammonium bisulfite – 0.008%
  - Removes oxygen from the water to protect the pipe from corrosion
    - Cosmetics, **food and beverage processing**, water treatment
- Borate salts – 0.007%
  - Maintain fluid viscosity as temperature increases
    - Used in laundry **detergents**, hand soaps and cosmetics
- Citric Acid – 0.004%
  - Prevents precipitation of metal oxides
    - **Food additive**; food and beverages; lemon juice
- N, n-Dimethyl formamide – 0.002%
  - Prevents the corrosion of the pipe
    - Used in **pharmaceuticals**, acrylic fibers and plastics
- Glutaraldehyde – 0.001%
  - Eliminates bacteria in the water
    - **Disinfectant**; Sterilizer for medical and dental equipment

Hydraulic Fracturing Stimulation is Safe

- IOGCC survey—no contamination
- EPA survey – no contamination
- GWPC study verifies State's regs
- GWPC National Registry f/chemicals
    - FracFocus

Find a Well

Back To Search

Next Page

Page 1 of 5 Go

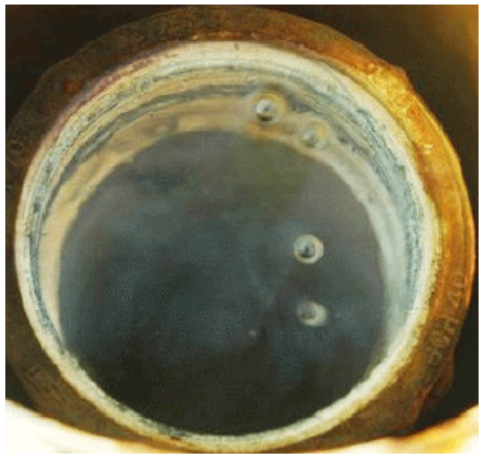
	API No.	Job Date	State	County	Operator	WellName	Well Type	Latitude	Longitude	Datum
	33-025-01132	4/13/2011	North Dakota	Dunn	XTO Energy/ExxonMobil	Alwin Federal 12X-19	Oil	47.627564	-102.967017	NAD83
	33-105-01913	4/18/2011	North Dakota	Williams	XTO Energy/ExxonMobil	Lonnie 31X-3	Oil	48.196639	-102.880264	NAD83
	33-105-01824	5/14/2011	North Dakota	Williams	XTO Energy/ExxonMobil	Allen 21X-17	Oil	48.254792	-103.058819	NAD83
	33-105-01825	4/28/2011	North Dakota	Williams	XTO Energy/ExxonMobil	Woodrow 34X-32	Oil	48.198603	-103.053617	NAD83
	33-053-03113	3/22/2011	North Dakota	Mc Kenzie	XTO Energy/ExxonMobil	101 Federal 21X-24	Oil	47.546178	-104.000694	NAD83
	33-105-01948	2/26/2011	North Dakota	Williams	XTO Energy/ExxonMobil	Normark 24X-31	Oil	48.460233	-103.008811	NAD83
	33-105-01899	2/17/2011	North Dakota	Williams	XTO Energy/ExxonMobil	Michael State 31X-16	Oil	48.167464	-103.031950	NAD83
	33-025-01165	5/9/2011	North Dakota	Dunn	Marathon Oil	Lucky Fleckenstien #34-20H	Oil	47.264306	-102.330608	NAD83
	33-025-01173	5/3/2011	North Dakota	Dunn	Marathon Oil	Wardner #24-35H	Oil	47.245872	-102.445641	NAD83

SHALLOW GAS PROJECT

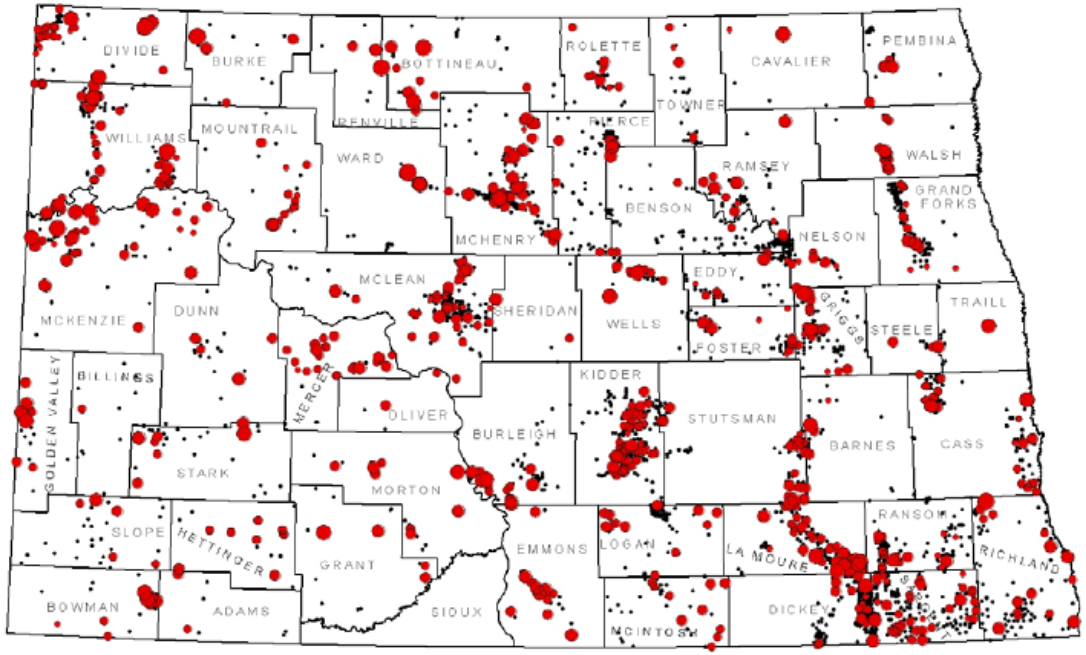
The Geological Survey tested 4,325 NDSWC monitoring wells for methane in 52 of the 53 counties in North Dakota from 2006-2010.

The Geological Survey recently completed phase I of a study of shallow natural gas in North Dakota. We investigated 9,400 ND State Water Commission monitoring well sites, tested 4,325 wells, and detected methane in 905 wells. Approximately 20% of the wells contained detectable gas.

During the second phase of the project, thirty groundwater samples, primarily from eastern North Dakota, will be analyzed for dissolved gas composition, isotopes, and general chemistry. This will enable us to determine the source of the gas and identify chemical groundwater signatures that might assist the oil and gas industry in natural gas exploration.

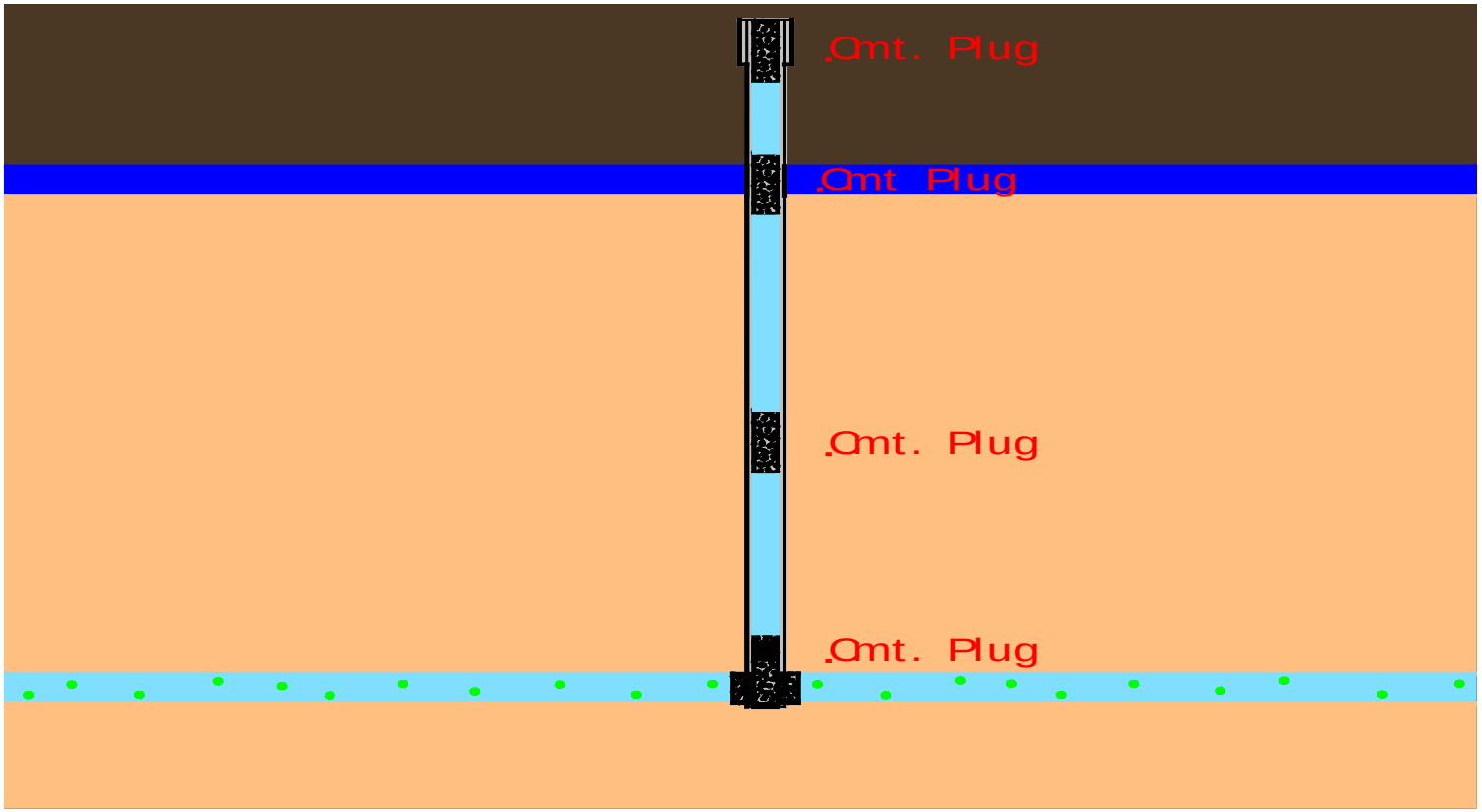


Methane bubbling to the surface in a two-inch NDSWC monitoring well.



Monitoring wells that contained methane are indicated with red dots, black dots are wells that contained no detectable methane. The red dots are sized to reflect the concentration of methane -- the higher the concentration, the larger the dot.

PLUG AND ABANDON



BTA Oil Producers. JV-P#1. Near Rider Field
NDIC File No. 14857. SE SE 15-140-103.
Panoramic Reclamation photo taken looking 070
towards middle of location. May 1, 2001. dwn.

Well was plugged in 07/1998

Reclamation work in 09/1998

Seeded in Spring of 1999

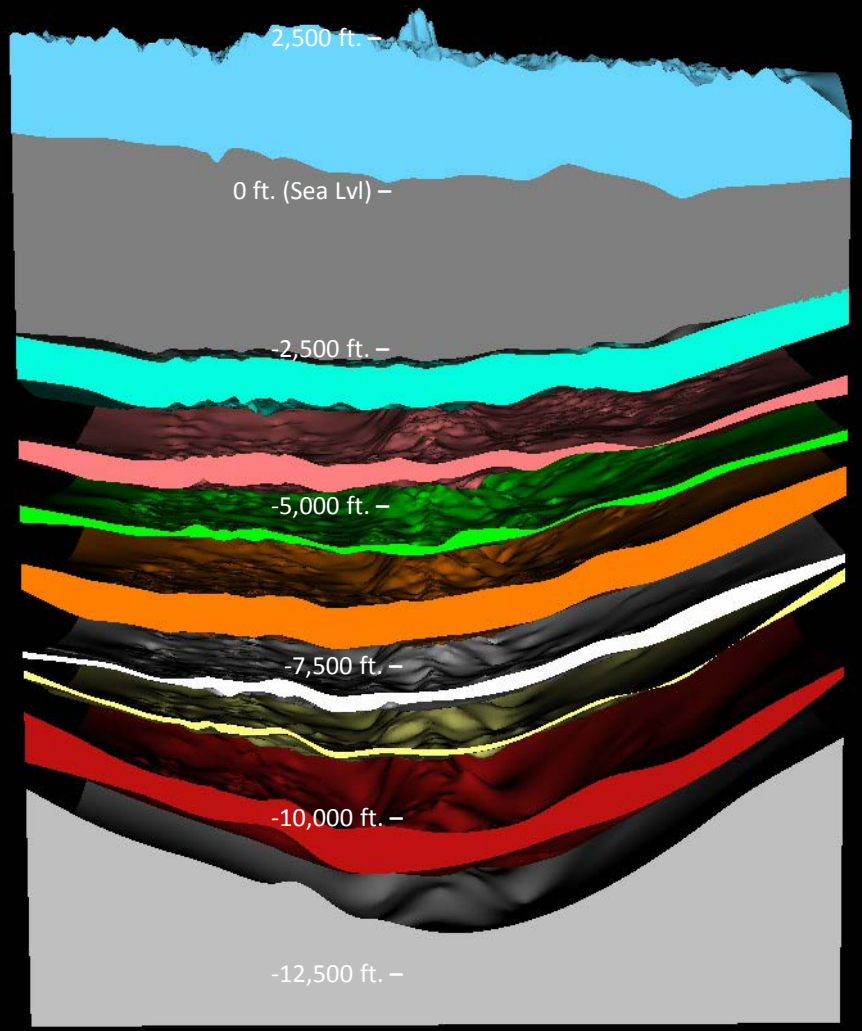
BTA Oil Producers - JV-P#1 - Rider Field.
NDIC File No. 14857. SE SE 15-140-103.
Panoramic photo looking east. Photo taken from butte to west on 7/2/2002.

BTA Oil Producers. JV-P#1. Near Rider and Knutson Fields.
NDIC File No. 14857. SE SE 15-140-103.
Panoramic photo looking east from butte west of location.
Photo taken on May 7th, 2003. dwn.

Topics for Today

- Geology of Resource Plays
- Development History
- Activity
- Hydraulic Fracturing
- Future Prospects

Three-Dimensional Geologic Model of Northwestern North Dakota



Uranium/Coal
Shallow Gas
Frac Propant
Geothermal

Salt-Water Disposal

Oil & Gas

Oil & Gas

Oil & Gas

Oil & Gas
Potash

Deep Oil & Gas

Fresh Water Zone

Shallow Gas Zone

Dakota Group

Spearfish Formation

Tyler Formation

Madison Group

Bakken-Three Forks

Prairie Formation

Red River Formation

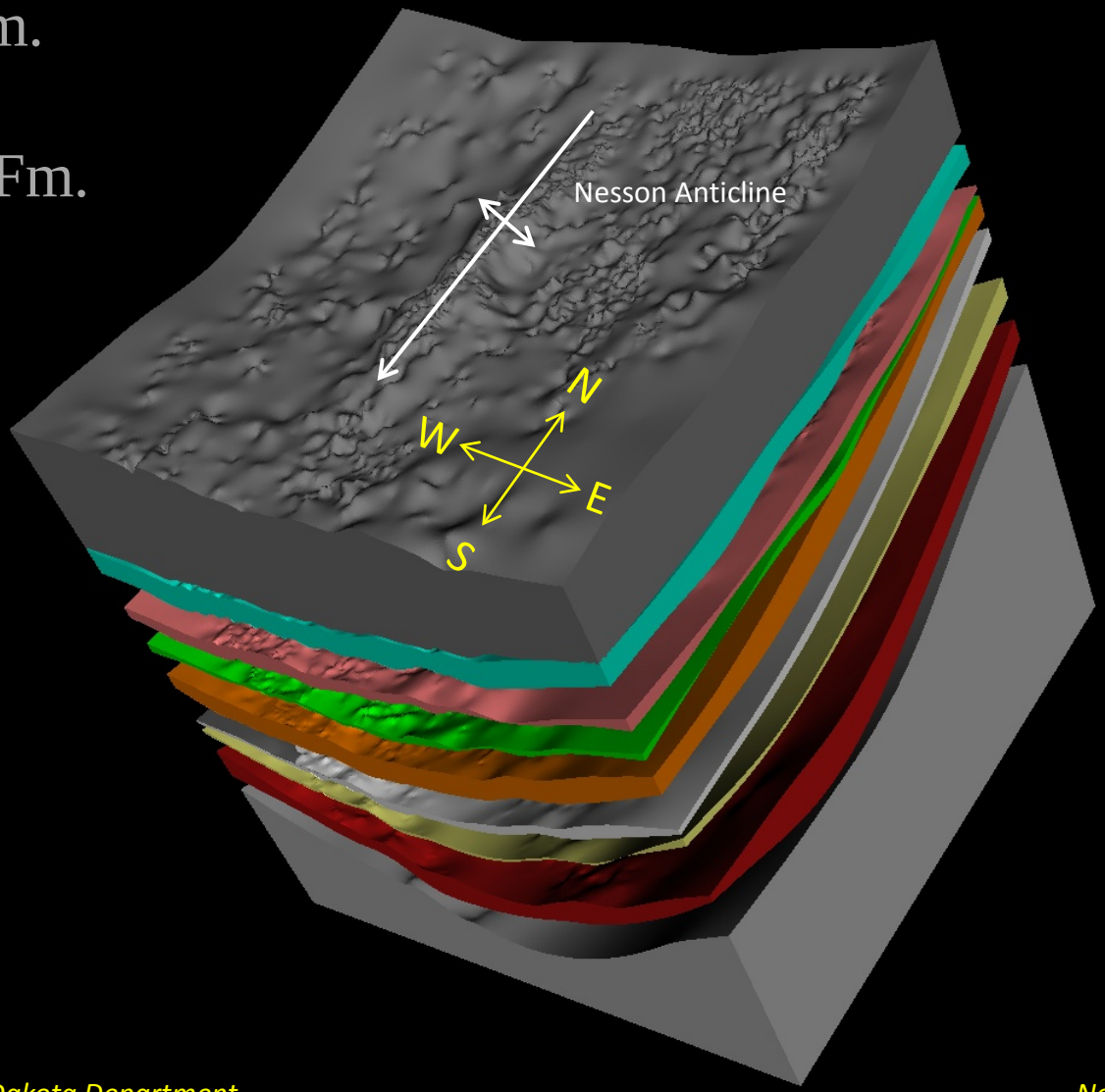
Precambrian Basement

North Dakota Department of Mineral Resources

North Dakota Geological Survey

Shallow Gas Prospects

-Pierre Fm.
-Niobrara Fm.
-Carlile Fm.
-Greenhorn Fm.



North Dakota Shallow Gas FID Field Screening Summary*								
County	Year	Wells Investigated Summary				Range of FID Instrument Response		
		Wells Investigated	Wells Field Screened	Wells with a positive FID response (>0.0)	Wells with no FID response (0.0)	Low (ppm as CH4)	High (ppm as CH4)	Average (ppm as CH4)
Grand Forks	2010	341	162	16	146	0.3	555.6	57
Walsh	2010	146	29	17	12	0.4	41.9	5
Pembina	2010	160	70	18	52	0.3	879.3	57
Dickey	2010	708	257	17	240	0.4	3,051	188
2010-Total		1355	518	68	450			
Traill	2009	39	11	1	10	1,075	1,075	1,075
Griggs	2009	110	94	20	74	0.2	2,063	165
Ransom	2009	362	179	30	149	0.2	186	17
Richland	2009	317	147	28	119	0.5	28,123	1,066
Oliver	2009	35	7	3	4	1.8	28	17
Mercer	2009	115	38	24	14	0.3	103	11
Dunn	2009	271	27	5	22	1.9	124.6	55
Billings	2009	121	14	1	13	2	2	2
Golden Valley	2009	75	29	16	13	0.6	4,291	307
Stark	2009	168	35	7	28	3.7	5,596	890
Slope	2009	63	31	5	26	3.4	172.6	42
Bowman	2009	104	47	13	34	0.7	24,250	2,124
Mountrail	2009	111	35	19	16	0.1	515.5	51
McLean	2009	433	212	44	168	0.1	839.1	42
Grant	2009	58	18	4	14	8.1	4,238.0	1,171
Adams	2009	41	8	2	6	5.6	68.0	36.8
Hettinger	2009	43	15	8	7	2.0	36.7	11
McIntosh	2009	114	48	11	37	1.5	79.7	16
McKenzie	2009	378	68	29	39	0.3	13,487	1,152
Williams	2009	334	167	66	101	0.1	14,290	364
Burke	2009	65	20	5	14	0.4	31,347	6,344
Divide	2009	195	88	38	50	0.1	16,155	751
Cass	2009	187	102	20	82	0.4	5,620	321
Sargent	2009	561	289	40	249	0.2	933.0	51
Wells	2009	113	77	22	55	0.1	4,567	316
Eddy	2009	173	64	7	57	0.1	211	33
Foster	2009	121	69	10	59	0.1	186	39
Nelson	2009	117	32	9	23	0.2	60	12
Ramsey	2009	260	68	14	54	0.2	294	82
Cavalier	2009	64	5	2	3	0.1	6,087	3,044
2009-Total		5,148	2,044	503	1,344			
Sheridan	2008	71	7	2	5	1	538.3	297
Benson	2008	341	127	9	118	0.5	223.7	44
Logan	2008	127	75	12	63	3.4	41.5	16
2008-Total		539	209	23	186			
Ward	2007	151	79	27	52	0.2	50,000	2,353
Barnes	2007	51	28	5	23	0.3	2,897	520
Morton	2007	48	29	12	17	1.1	2,347	271
LaMoure	2007	287	195	49	146	0.4	3,712	252
Burleigh	2007	143	64	18	46	1.1	1,208	211
McHenry	2007	433	350	55	295	0.2	2,329	131
Steele	2007	21	9	3	6	2	146.3	79
Pierce	2007	148	105	8	97	1.7	71.7	18
2007-Total		1282	859	177	682			
Renville	2006	34	8	3	5	20.6	28,000	9,420
Bottineau	2006	110	33	11	22	2.4	30,362	3,102
Emmons	2006	109	50	12	38	1.6	775	196
Kidder	2006	451	377	63	314	0.2	840.5	41.1
Stutsman	2006	170	107	21	86	0.4	182	27
Towner	2006	78	31	6	25	0.2	32.8	8
Rolette	2006	114	52	10	42	0.6	15.2	5
2006-Total		1066	658	126	532			
Project Totals		9,390	4,288	897	3,194	*Preliminary Data Subject to Revision		

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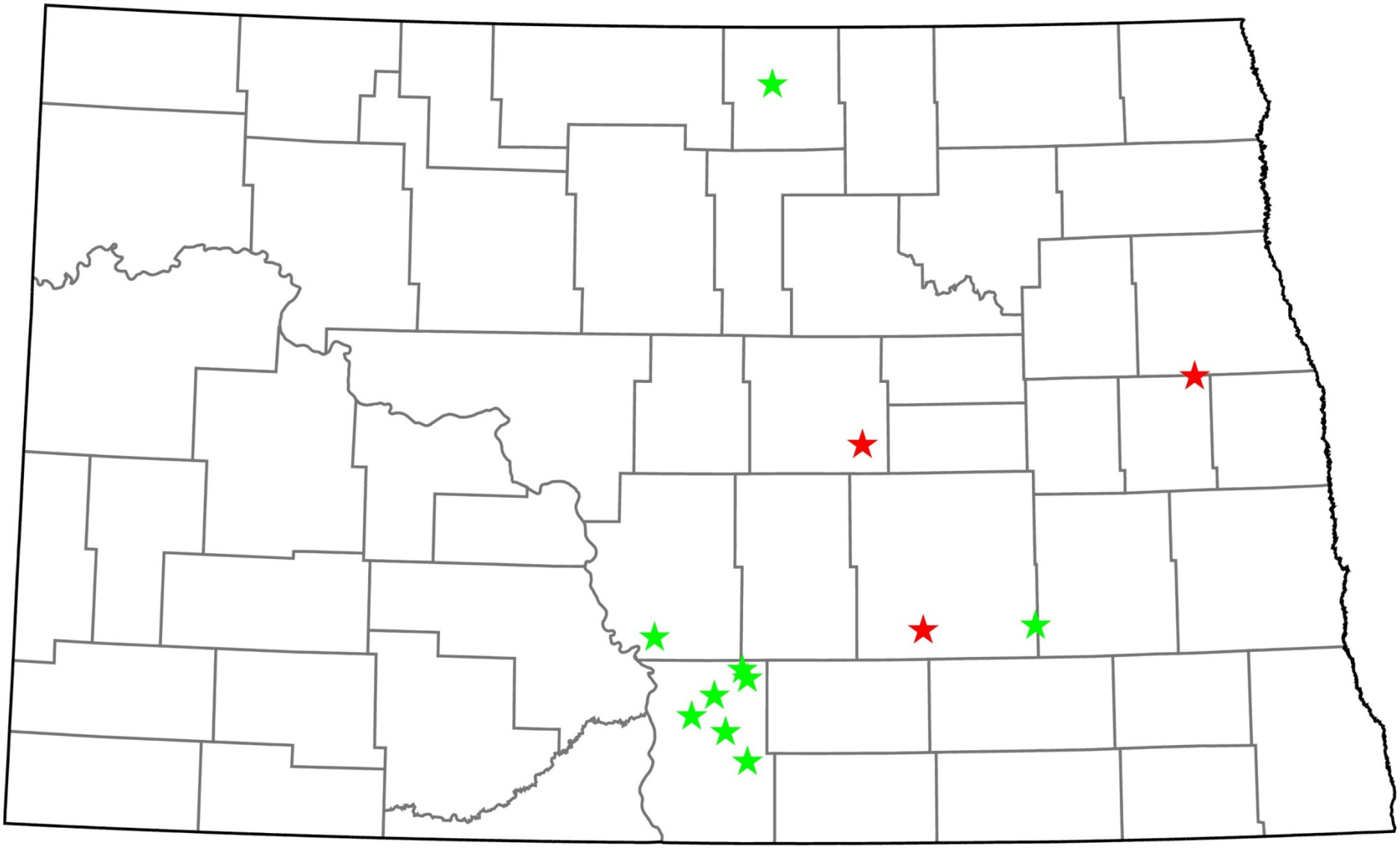
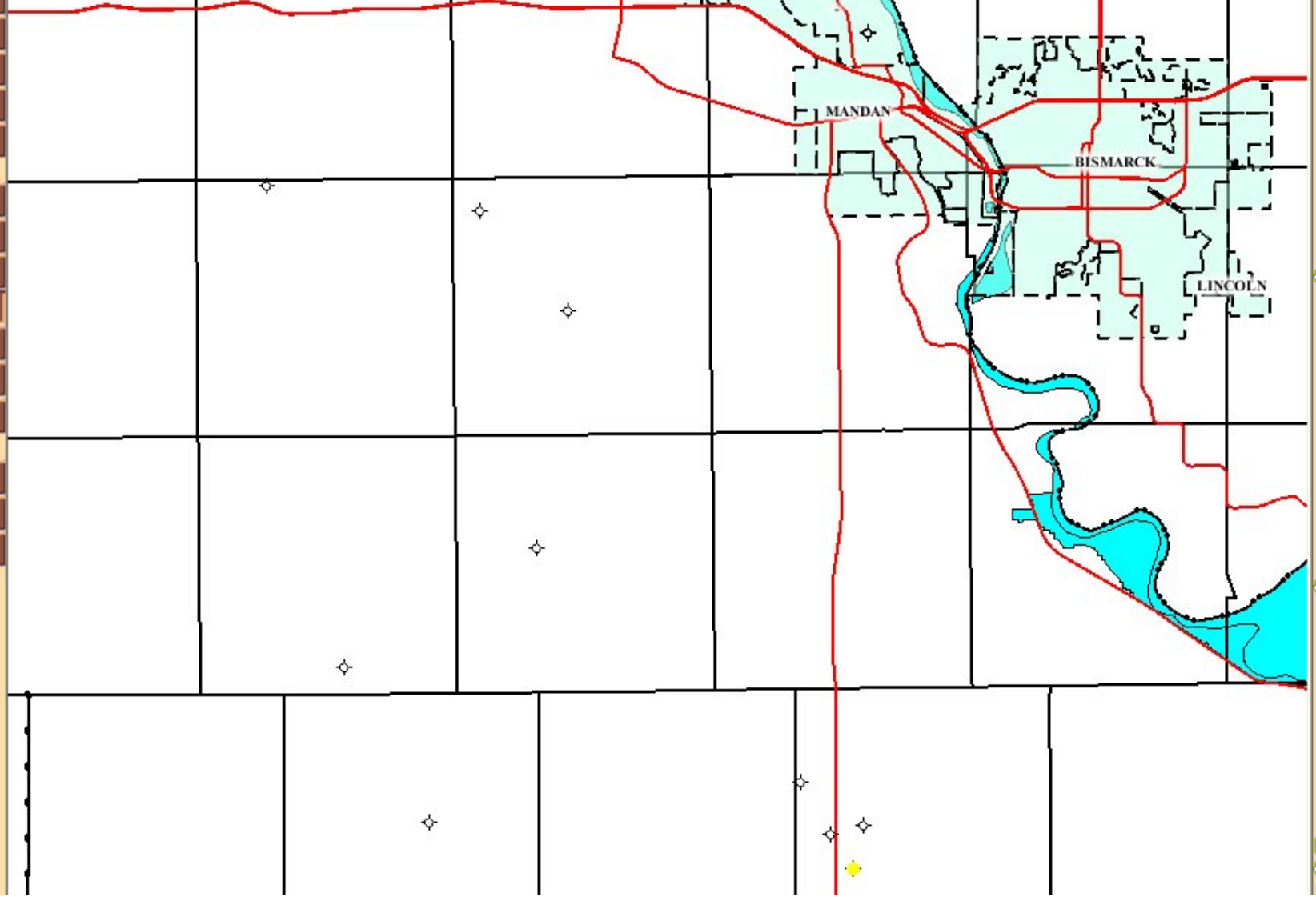
SHALLOW GAS WELLS DRILLED IN NORTH DAKOTA EAST OF THE MISSOURI RIVER



Wells drilled prior to July 2003

Wells drilled after July 2003



4-10-51 DST #1 6912-22: Open 2 hours, shut in 15 minutes. Rec. 25' drilling fluid, 720 black sulfur water and 1/2 pt. 30° brown oil in test tool. Initial hydrostatic mud pressure 2631 psi, initial flow pressure 295 psi, final flow pressure 468 psi, shut in pressure 1965 psi, final hydrostatic mud pressure 2602 psi

Estimate 20-50 billion tons of ND Mineable Reserves

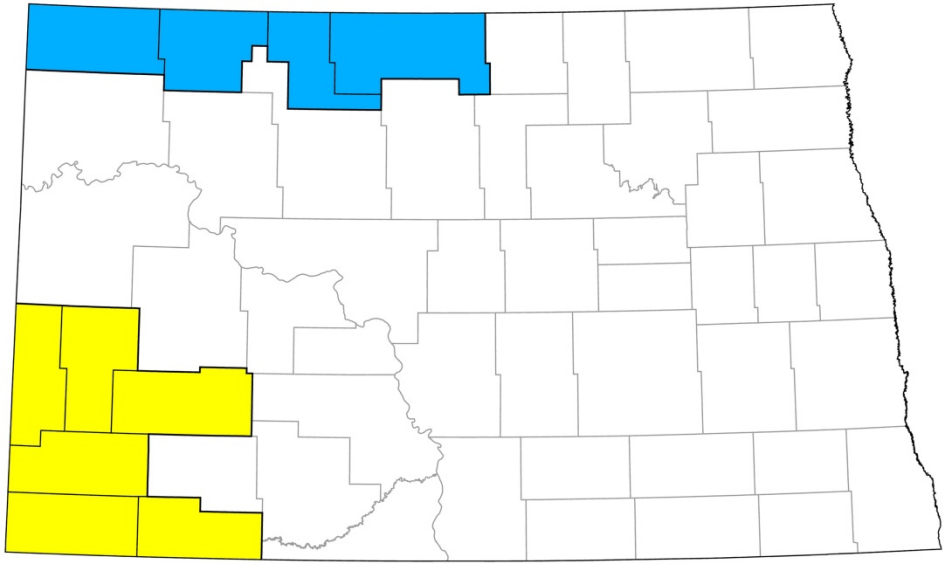
$6 trillion -15 trillion

Potash core from a depth of 9,000 feet in Burke County.

We have received a number of enquires from the mineral industry in the past 18 months as the price increased for a variety of elements and minerals. Chief among these enquiries has been uranium and potash. Uranium was mined in North Dakota in the 1960s. It was heavily explored for in the 1970s, but has been of little interest for the last 30 years until the price for uranium oxide reached an all time high in June of 2007. Companies have also expressed interest in associated elements molybdenum and germanium. We are aware of three companies that are contemplating mining uranium in southwestern North Dakota.

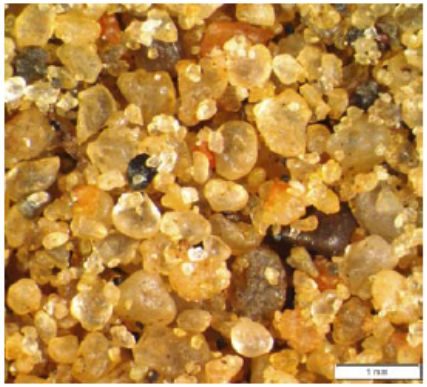
Potash or potassium salts are primarily used in the production of fertilizer. Potash exploration took place in northwest North Dakota in the 1970s. Since 2006, the price of potash rose from $190 to $1,050 per ton then fell to $300 per ton and is rising again. Based on increasing demand in rice growing regions. There are two companies that we know are actively pursuing potash exploitation.

Formation Resources drilling for uranium, molybedenum, and germanium under a subsurface mineral permit in Billings County during the fall of 2008.



Counties that contain uranium deposits are in yellow and those that contain the shallowest potash deposits are in blue.

PROPPANT PROJECT

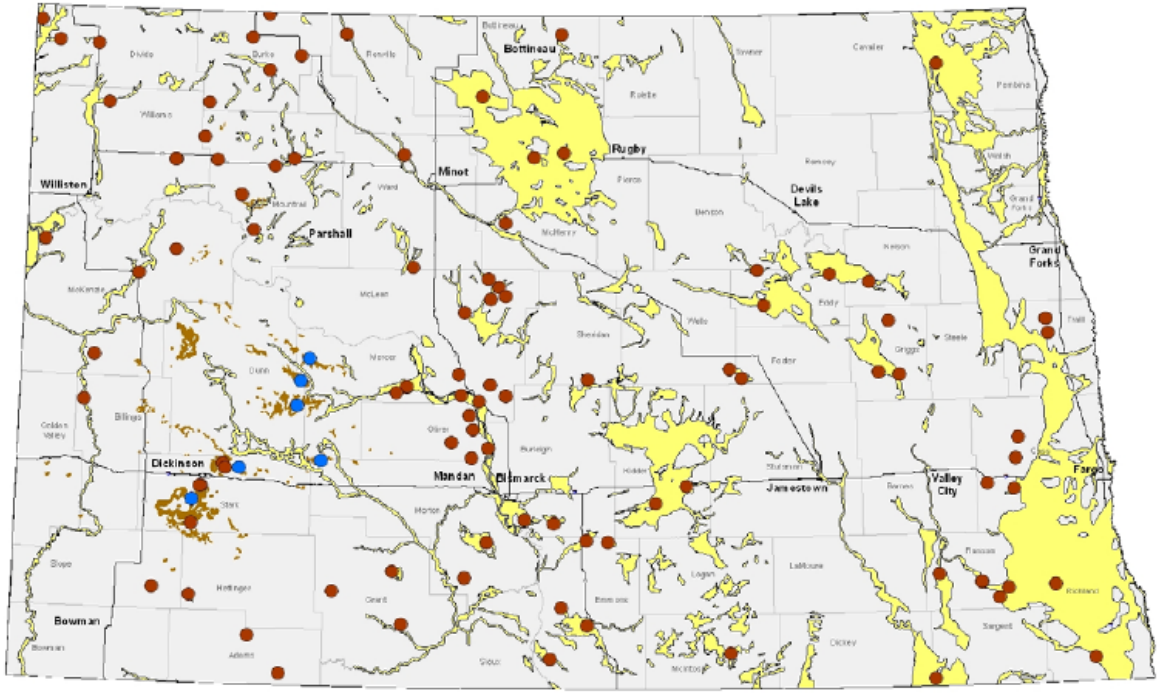


Photomicrograph of sand grains collected in McHenry County.

Photomicrograph of ceramic proppant from a batch that was used in a Bakken well in North Dakota. This proppant was manufactured in China.

Millions of tons of sand and ceramic proppants are used every year in the Williston Basin, part of a multi-billion dollar industry. The Geological Survey has collected 125 sand samples throughout the state in our search for deposits that could be utilized for oil and gas proppants in the well fracing process. We are in the process of performing preliminary analysis on those samples to determine if any would fit the proppant criteria. We have also collected clay samples and will be testing those samples for their kaolin content to determine their suitability in the manufacturing of ceramic proppants.

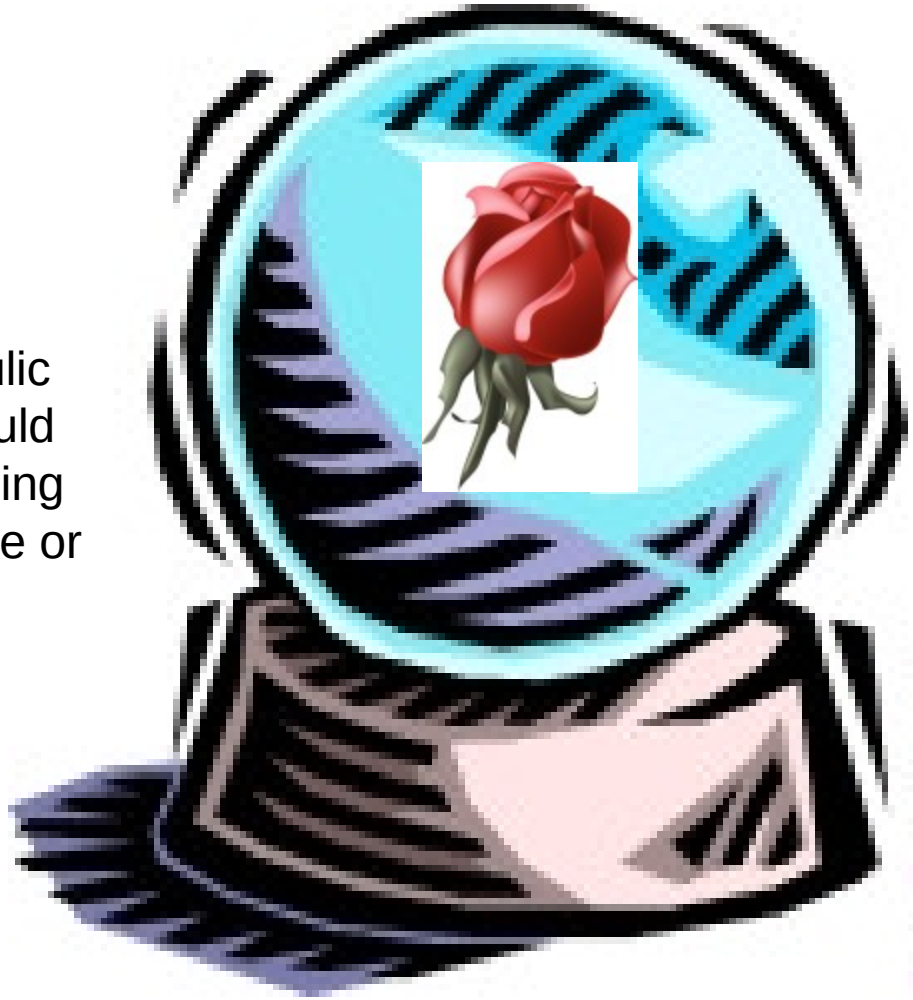
Under the second phase of this project, the ten most promising sand samples will undergo full ISO analysis (including bulk density, specific gravity, crush resistance, etc), mineralogy (XRD), and stack conductivity analysis to determine which are the most suitable proppant candidates and we will continue to evaluate the clay beds.



Locations of sand samples (red dots) and clay samples (blue dots) collected during this study. The areas in yellow are known sand deposits and the areas in brown are kaolinitic claystones within the Golden Valley Formation.

Draft BLM Hydraulic Fracturing rule could double federal drilling permit approval time or worse.

Current administration budget contains tax changes that could reduce drilling capital 35-50%



The future looks promising for sustained Bakken/Three Forks development

Draft EPA guidance on diesel fuel in hydraulic fracturing could triple drilling permit approval time or worse.

World and U.S. economies continue to struggle. If China joins the downward spiral oil price could fall enough to make some areas uneconomic