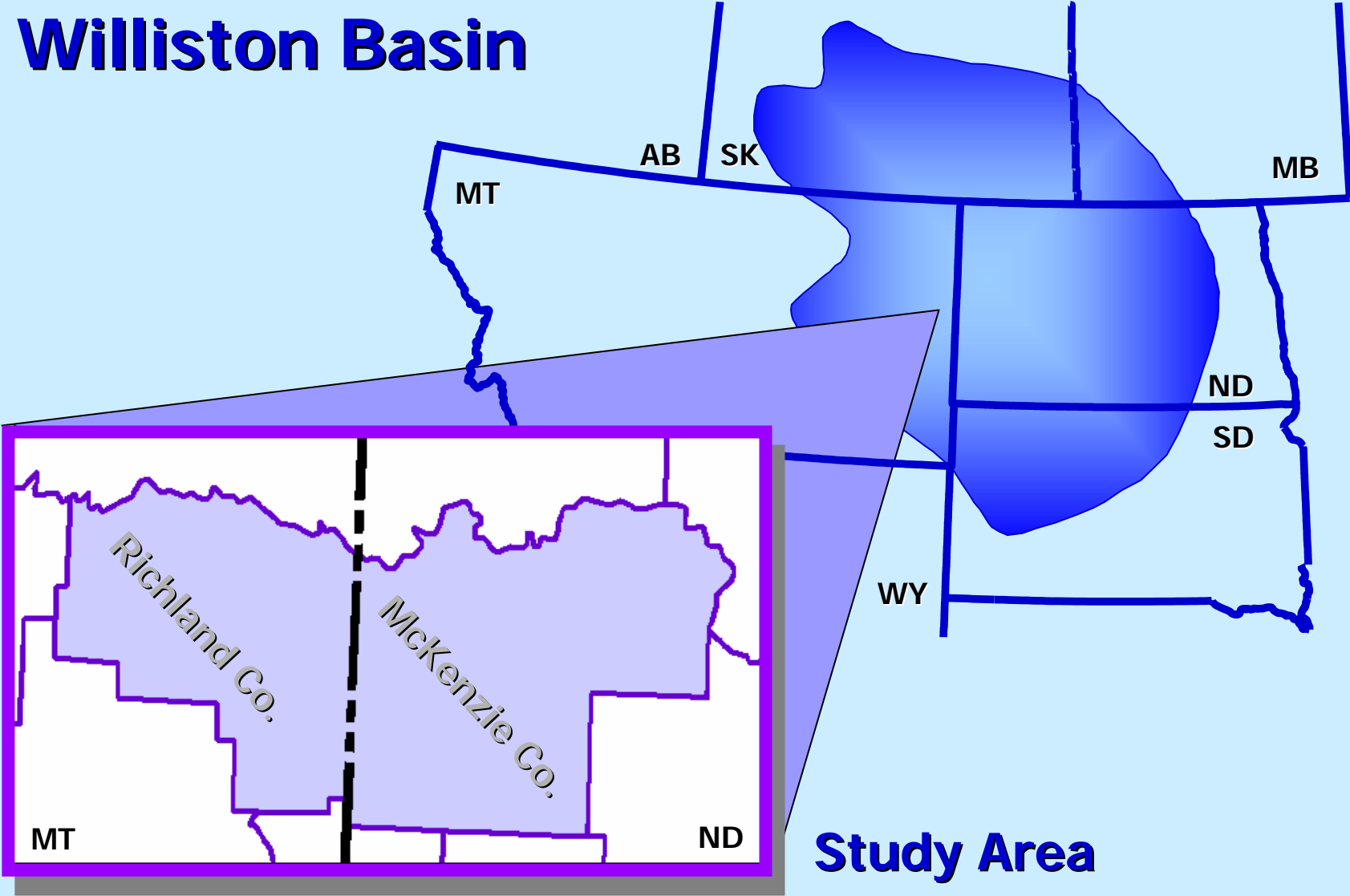


**Montana – North Dakota?  
Middle Member Bakken Play**

**Julie A. LeFever  
North Dakota Geological Survey**

# Williston Basin



# Bakken Formation

- **Geology**
  - Stratigraphy
  - Lithology
  - Depositional Environments/History
  - Age
  - Source Rock Potential

# Stratigraphy

## Three Forks Formation (Devonian)

- Conformable & Unconformable
- 250 ft thick
- Shales, dolostones, siltstones, and sandstones
- "Sanish Sand"
- Sublittoral to supralittoral



**SESW Sec. 13, T.23N.,R.56E.**

**AHEL #1 H8 Nevins**

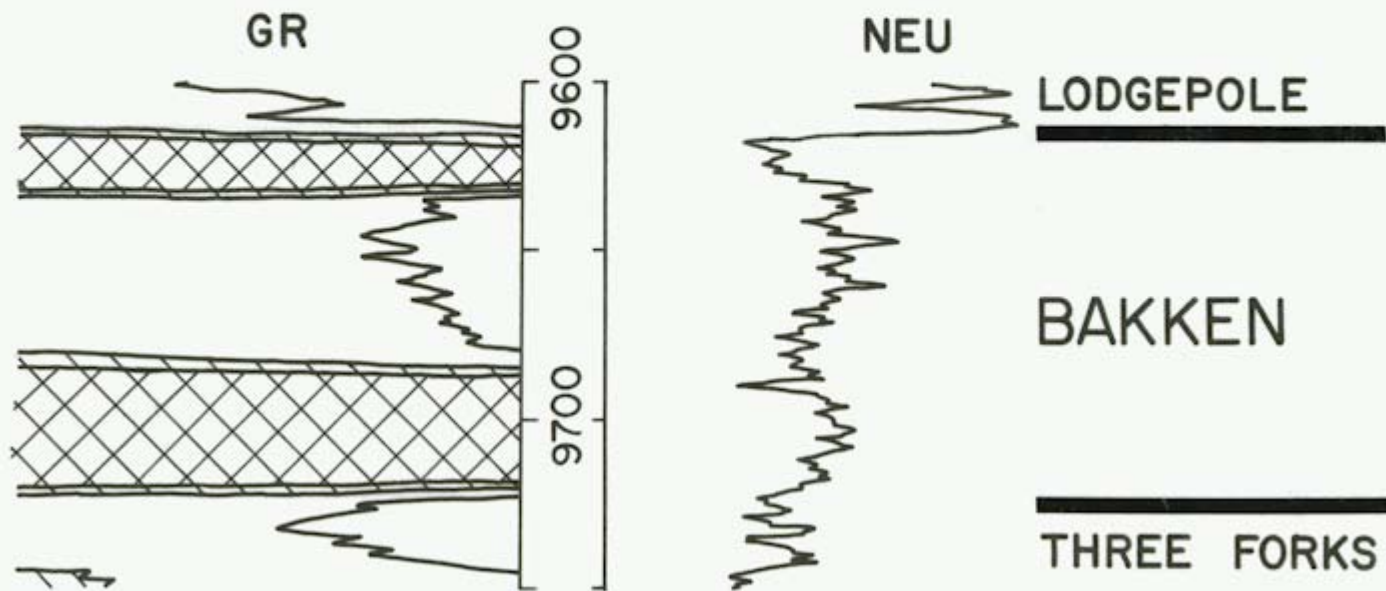
**Three Forks Fm.**

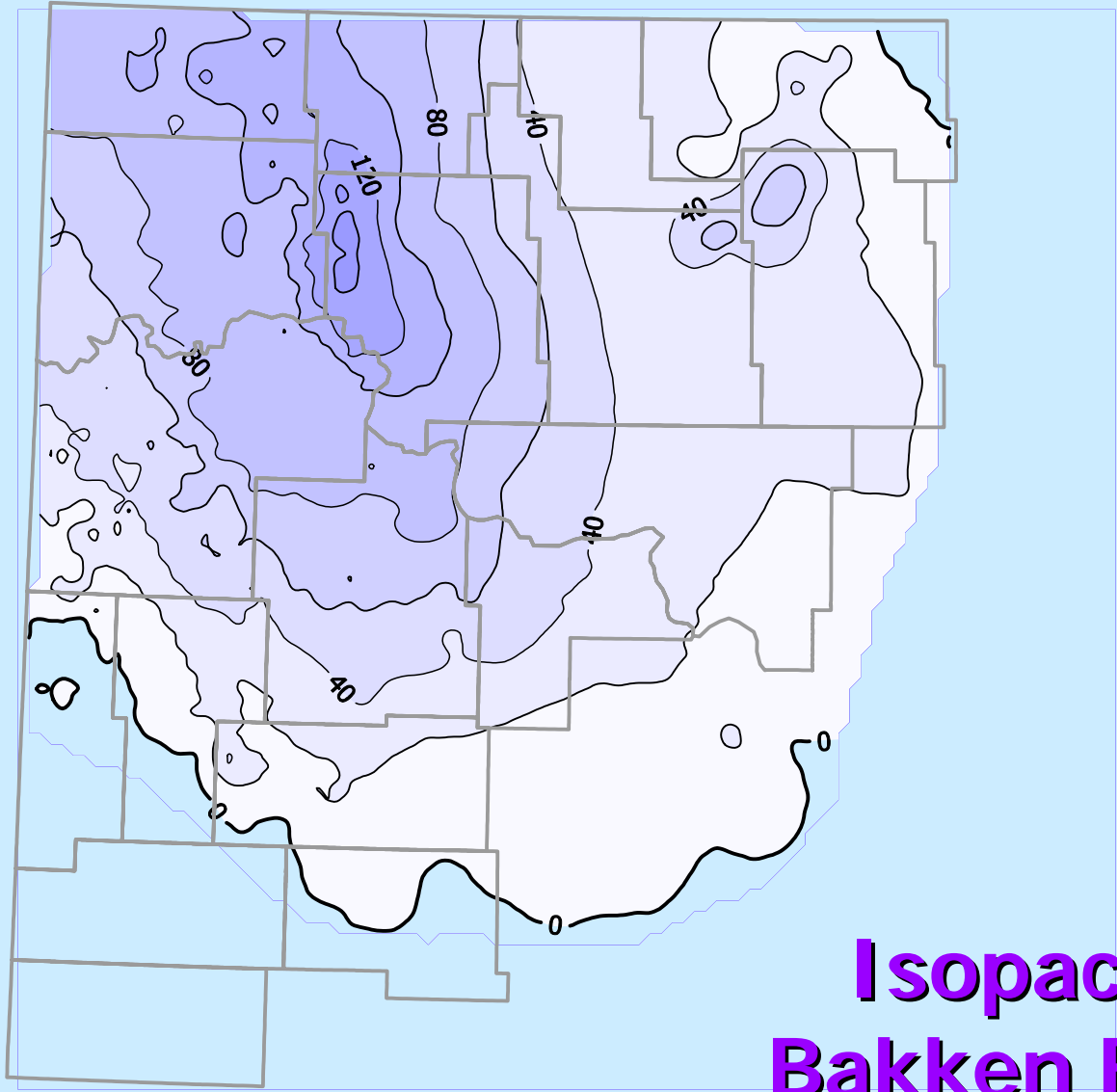
# Stratigraphy

## Bakken Formation

- **Nomenclature**
  - Defined in 1953
  - Amerada Petroleum - #1 H.O. Bakken
  - Restricted to the Subsurface
  - 105 ft thick
  - upper and lower shale
  - middle limestone member

SW NW Sec. 12, T.157N., R.95W.  
AMERADA PETROLEUM CORP.  
H.O. BAKKEN NO. 1

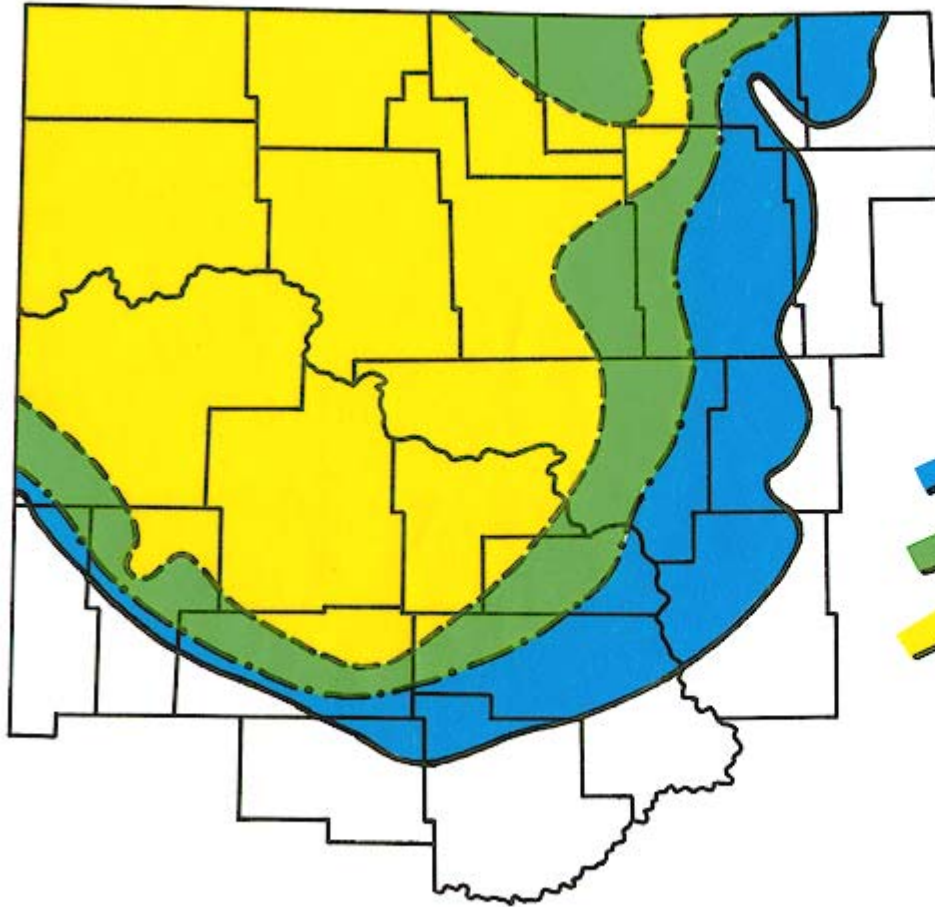




**Isopach of the Bakken Formation**



## Distribution of the Bakken Shale

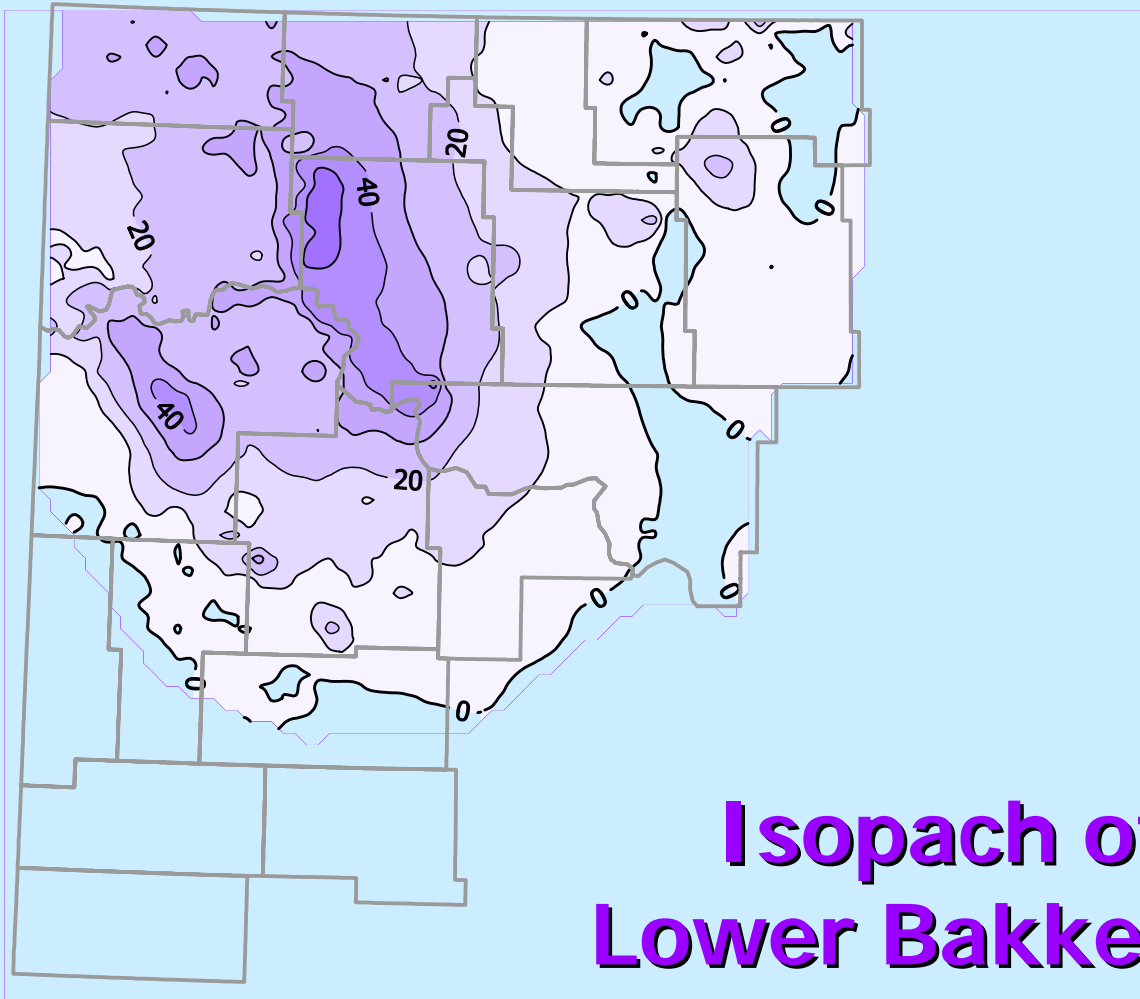


- upper shale
- middle member
- lower shale

# Stratigraphy

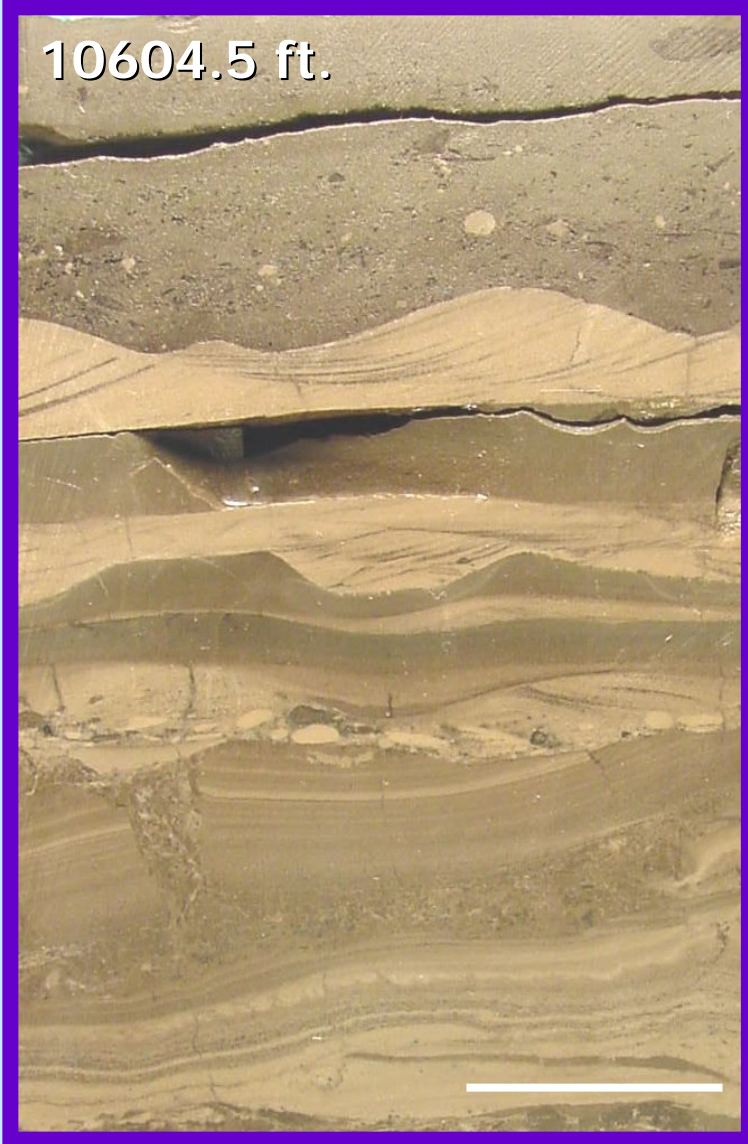
## Bakken Formation

- **Lithology**
  - **Lower Shale Member**
    - 50 ft thick
    - Dark brown to black, fissile, non-calcareous, organic-rich shale
    - Quartz, pyrite
      - fossils - conodonts, algal spores, brachiopods, fish teeth, bones, and scales
    - Fractured with oil staining



**Isopach of the  
Lower Bakken Shale**

10604.5 ft.



SESW Sec. 13, T.23N.,R.56E.

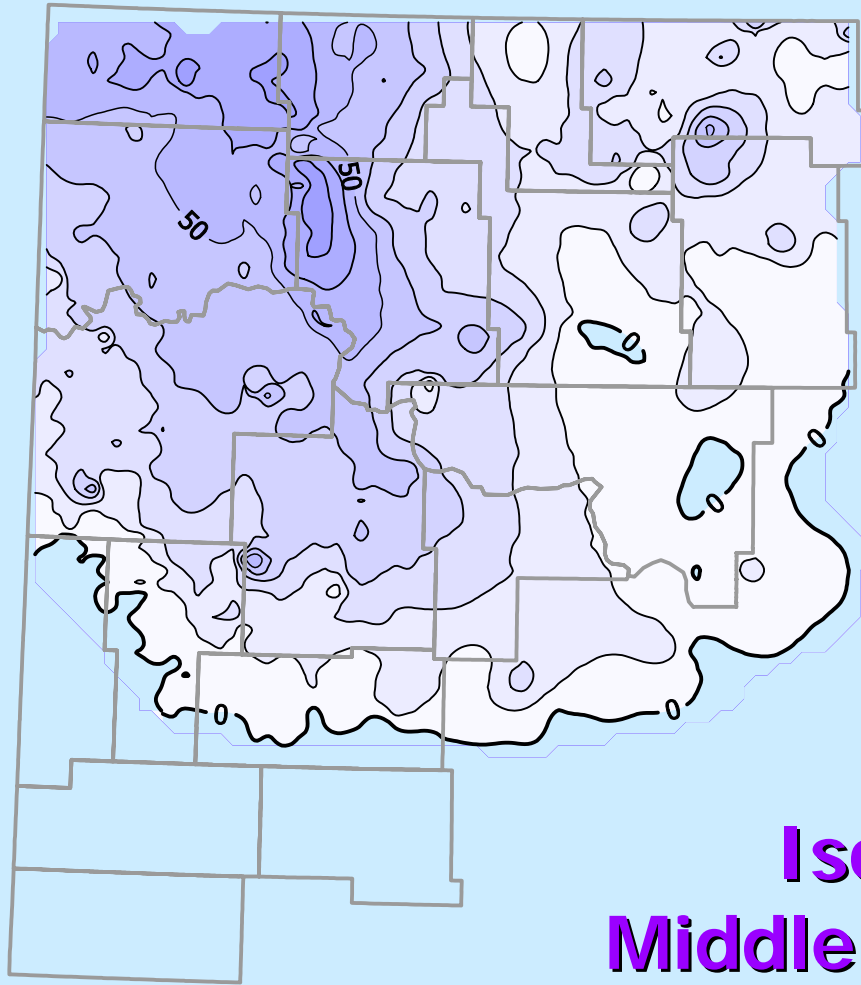
**AHEL #1 H8 Nevins**

**Bakken/Three Forks  
Contact**

# Stratigraphy

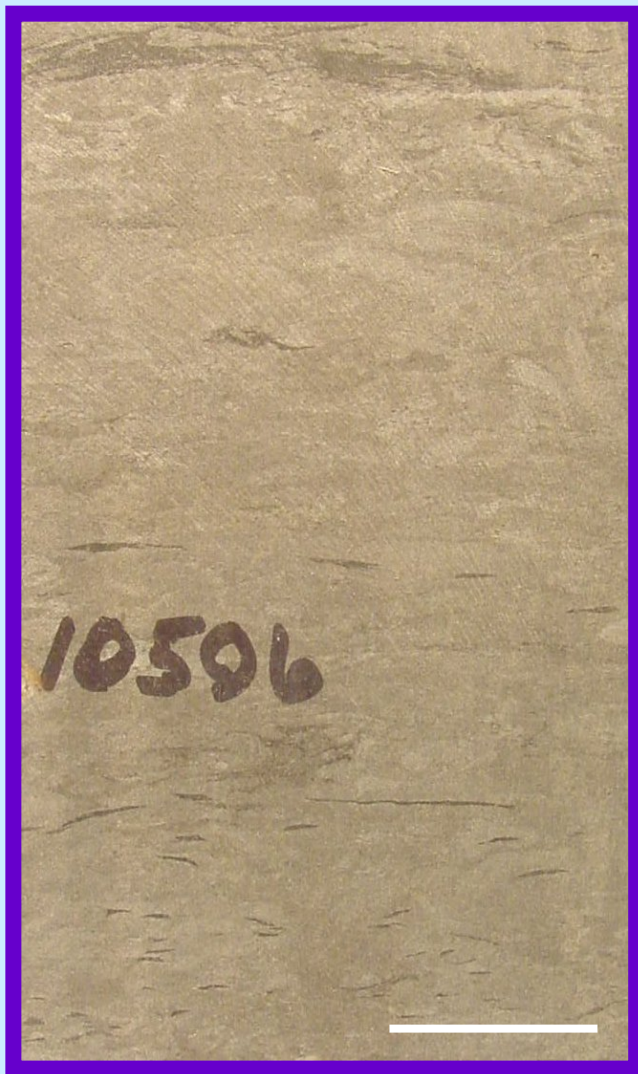
## Bakken Formation

- **Middle Member**
  - 85 ft thick
  - 5 different lithofacies
    - Calcareous siltstone to sandstone, dolostone, silty limestone, and oolitic limestone
  - Locally productive



**Isopach of the  
Middle Bakken Member**





SESW Sec. 13, T.23N.,R.56E.

**AHEL #1 H8 Nevins**

**Middle Member  
Lithofacies 2**



10585 ft.



SESW Sec. 13, T.23N.,R.56E.

**AHEL #1 H8 Nevins**

**Middle Member  
Lithofacies 2**



SESW Sec. 13, T.23N.,R.56E.

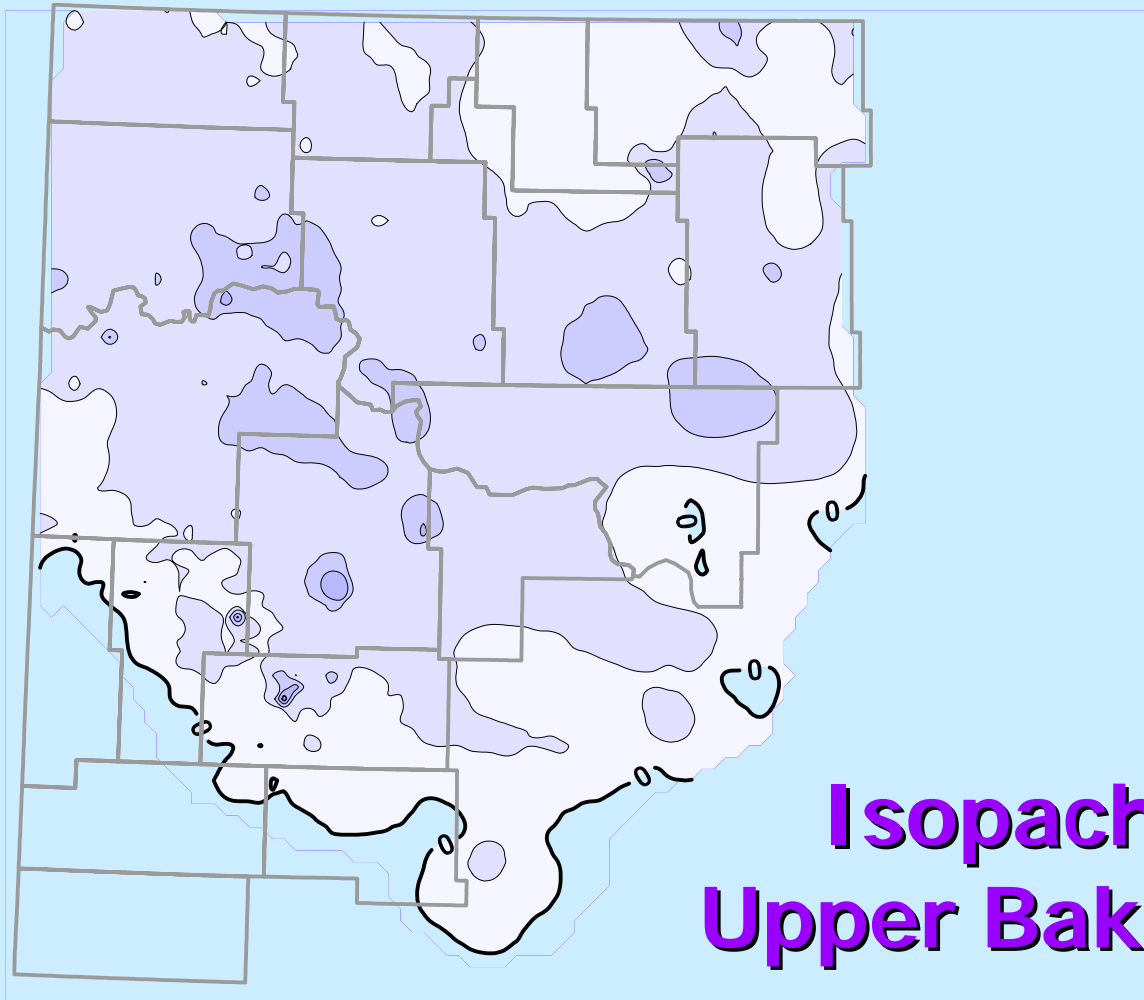
**AHEL #1 H8 Nevins**

**Upper Shale/Middle Mbr  
Contact**

# Stratigraphy

## Bakken Formation

- **Upper Member**
  - Maximum extent of the Bakken
  - 23 ft thick
  - Conformable and Unconformable
  - Laminated to massive with poorly sorted beds of silt-sized material
  - Lag sandstone



**Isopach of the  
Upper Bakken Shale**

10580 ft.

SESW Sec. 13, T.23N.,R.56E.

**AHEL #1 H8 Nevins**

**Bakken Formation**

Upper Shale Member

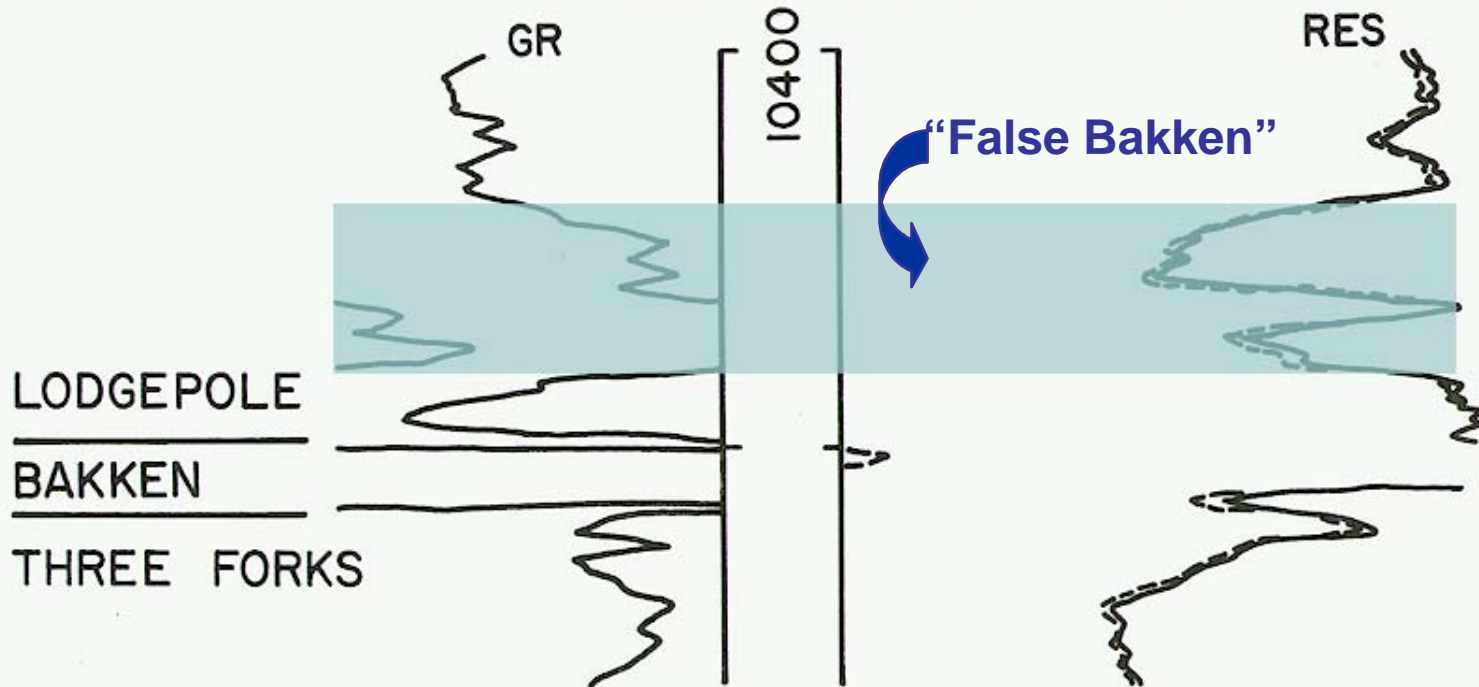


# Stratigraphy

- **Lodgepole Formation**
  - Conformable
  - 900 ft thick
  - “False Bakken”; Pelmatozoan Limestone
  - 5 major lithofacies representing a marine transgression



SWSE 20 - T.143N.-R.101W.  
JERRY CHAMBERS EXPLORATION CO.  
BLACKTAIL FEDERAL NO. 1-20  
Elkhorn Ranch Field





SESW Sec. 13, T.23N.,R.56E.

**AHEL #1 H8 Nevins**

**Lodgepole Fm.**

False Bakken



**10564 ft.**



**SESW Sec. 13, T.23N.,R.56E.**

**AHEL #1 H8 Nevins**

**Lodgepole Fm.**  
**Pelmatozoan Limestone**

# Bakken Formation

- **Depositional Environments/Age**
  - Stratified water column offshore, marine environment
  - Bakken Shales
    - Anoxic bottom conditions
  - Middle Member
    - Aerobic marine to marginal marine conditions
  - Devonian/Mississippian

# Depositional History

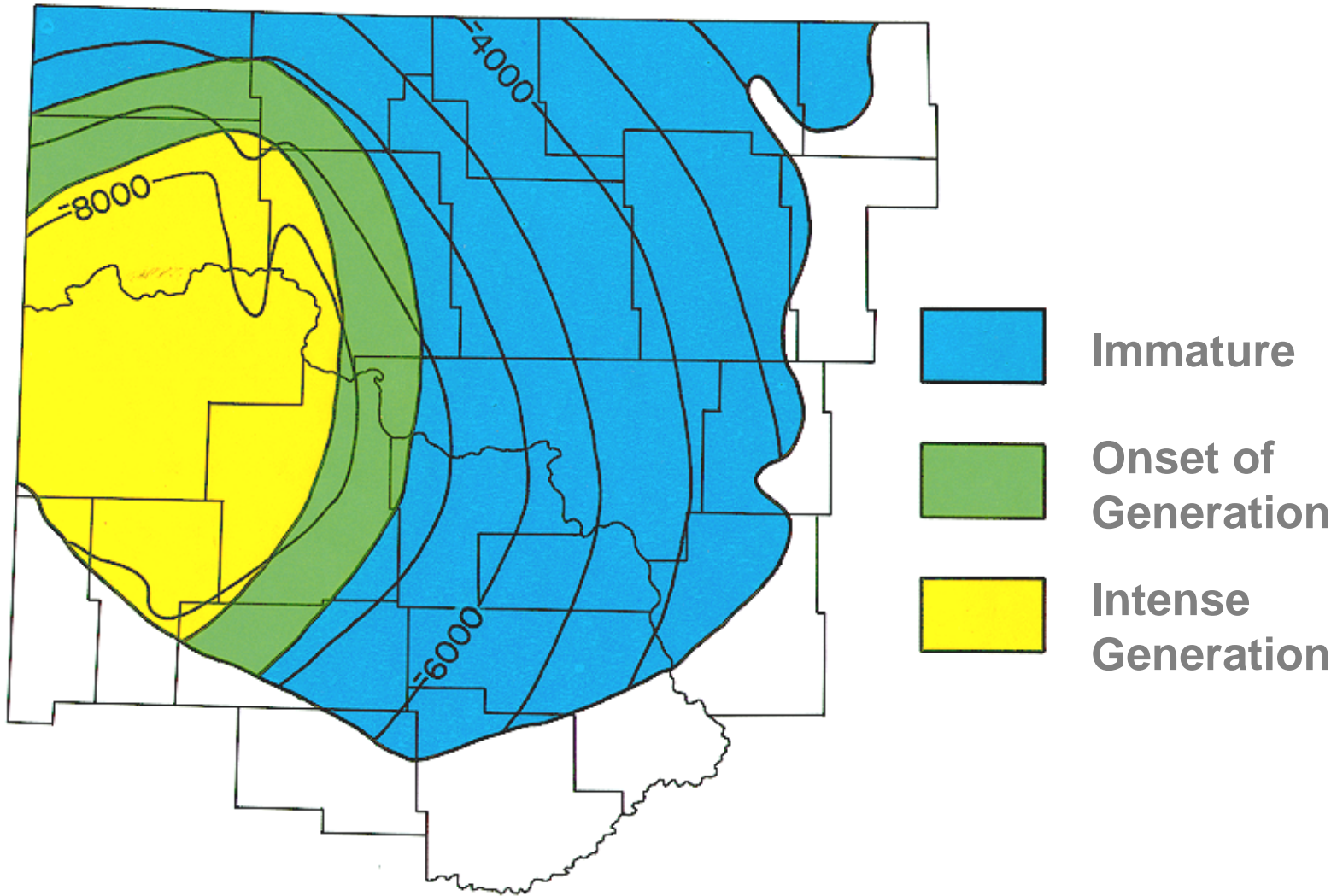
- **Three Forks Formation**
  - Shallow marine to terrestrial sedimentation
- **Bakken Formation**
  - Transgression
    - Shales – anoxic conditions
    - Middle Member – normal, shallow marine
    - Non-deposition/erosion
- **Lodgepole Formation**
  - Normal marine conditions

# Source Rock Potential

- **Total Organic Content – 0 to 40%**
  - Decrease towards depositional edge
- **Kerogen**
  - 70-90% amorphous
  - 0-20% herbaceous
  - 30% coaly
  - 5% woody
- **Formed in subaquatic oxygen-restricted environment**

# Source Rock Potential

- **Hydrocarbon Generation**
  - Depth of 9000 ft
  - 100° C
- **Volume of Oil Generated**
  - Up to 413 billion barrels (ND & MT)



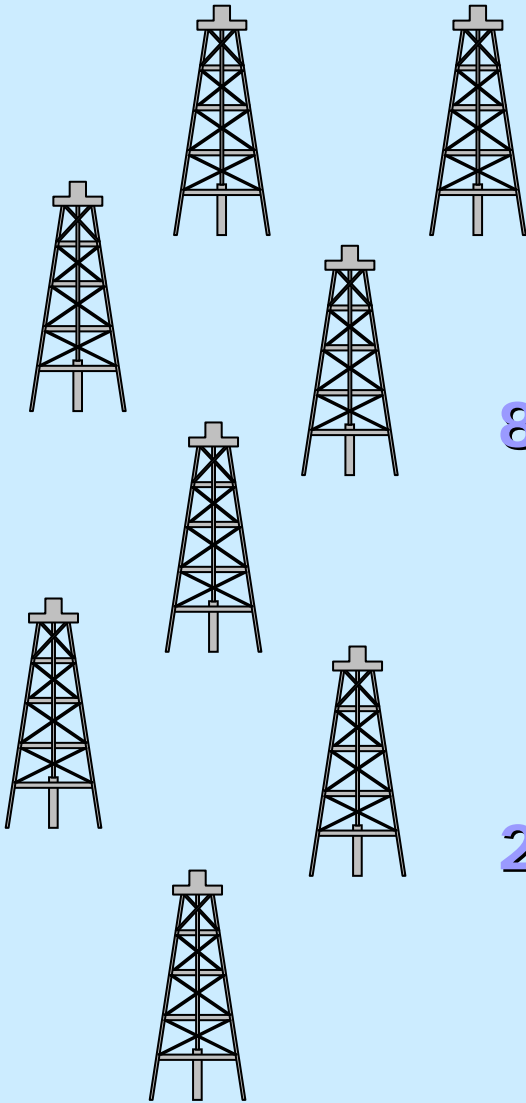
**Source Rock Maturity Zones**

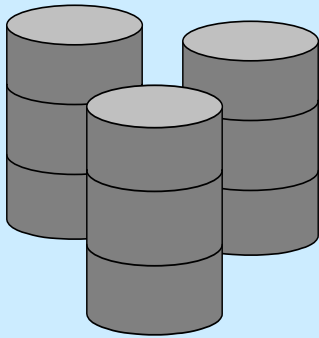
# Richland County

## 80 Producing Fields

1. Red River Fm
2. Madison Fm
3. Bakken Fm
4. Duperow Fm
5. Interlake Fm

20 Fields produce(d) from the Bakken Formation



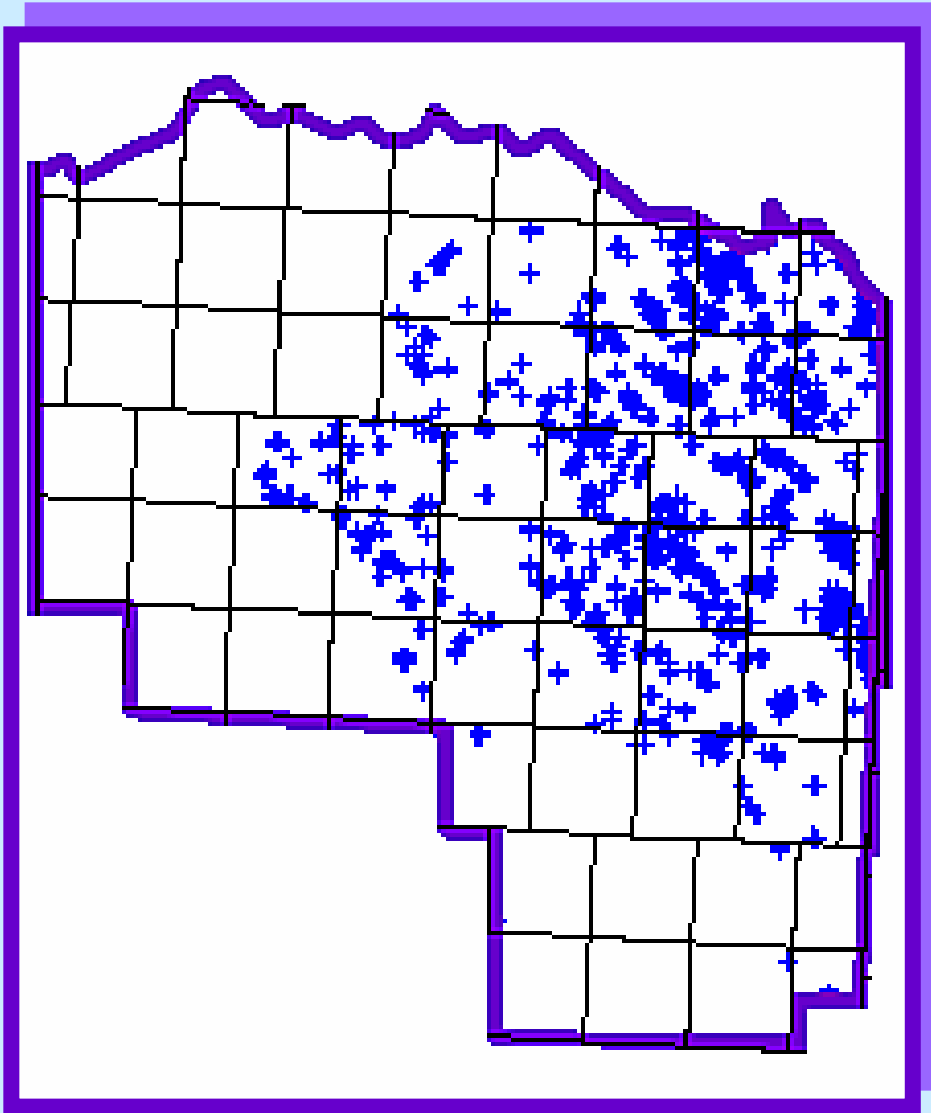


## Bakken Formation Richard County, MT

- **Historically** –  
46 wells have produced from the Bakken  
+ a few commingled wells
- **Currently** –  
31 wells reported production in 2000  
Total production for 2000 = 145,323 bbls oil

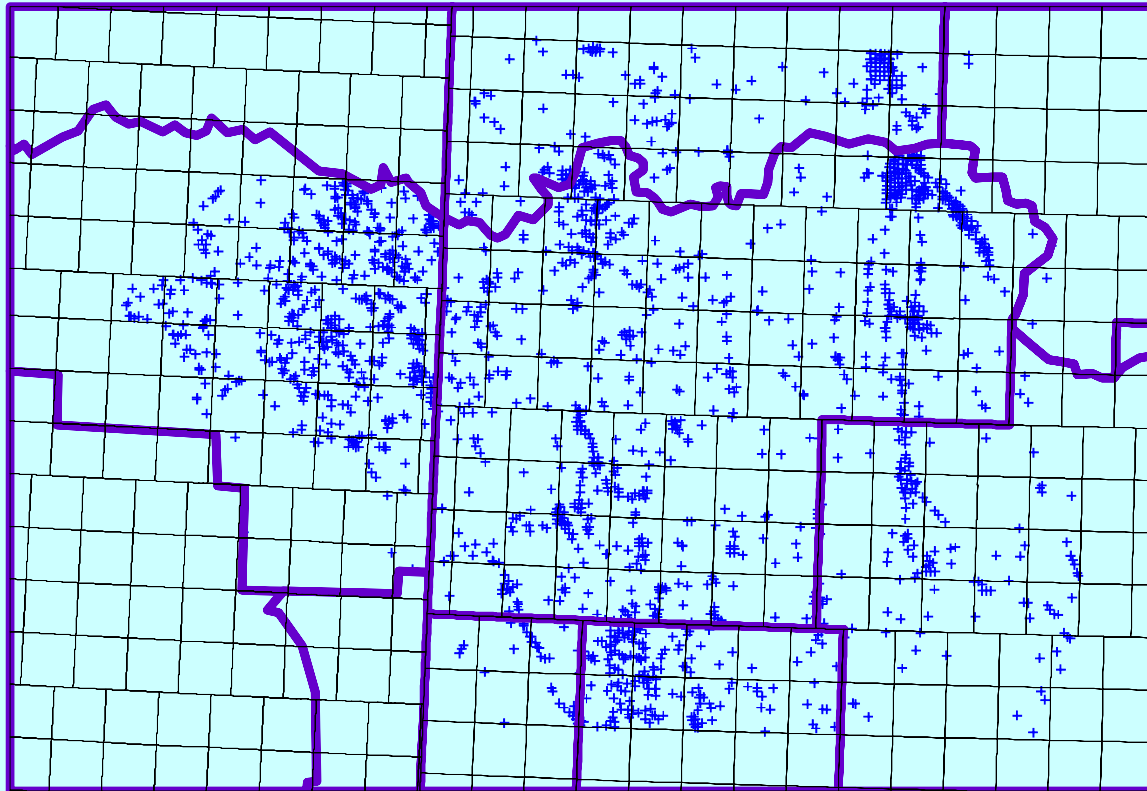


# Richland County

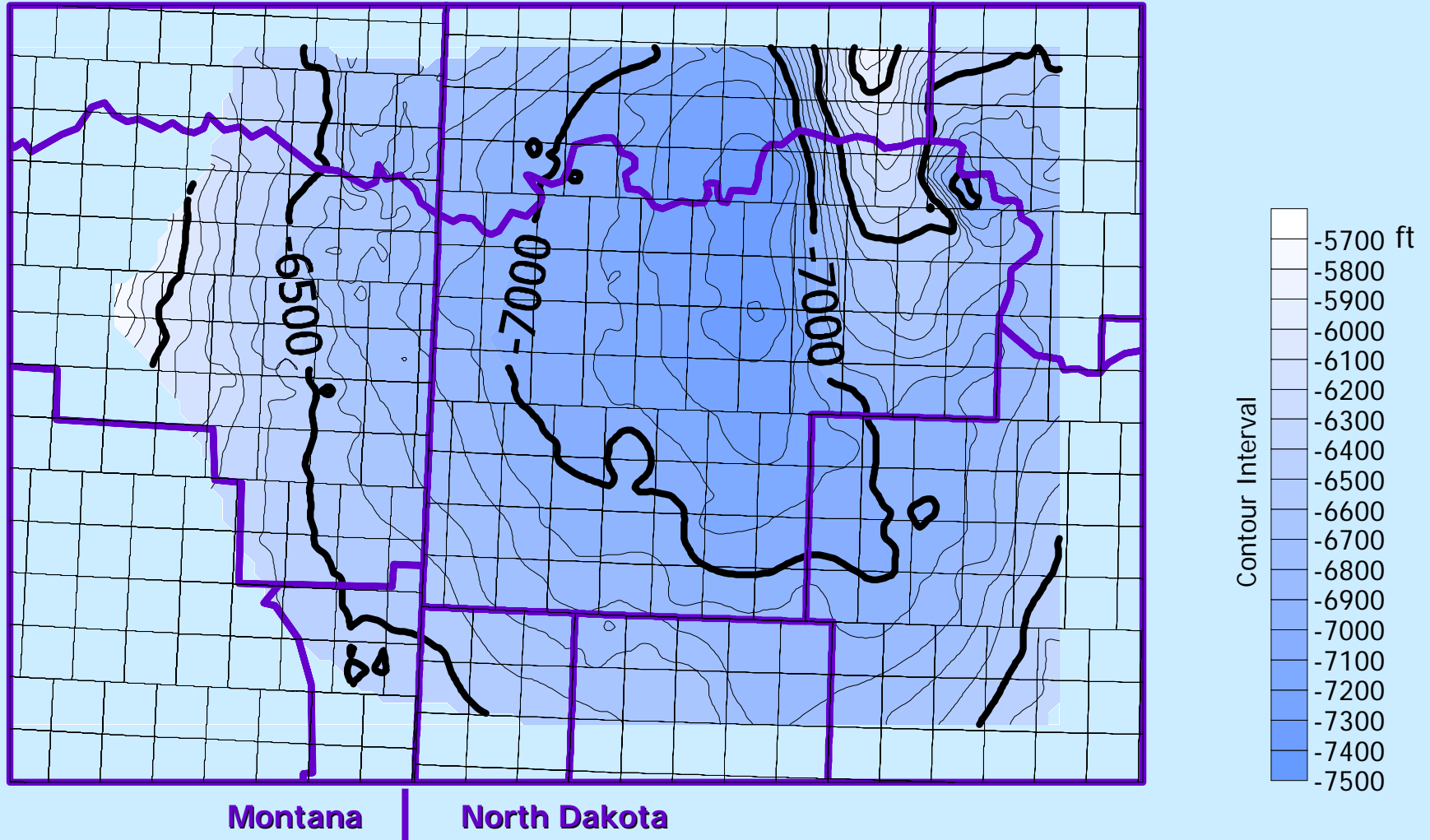


1. 555 Wells Examined in Richland County
2. Data Included:
  1. Last Charles Salt
  2. Lower Lodgepole
  3. Bakken Formation
  4. Porosity zone
  5. Three Forks Formation
  6. Devonian Prairie Salt
3. Combined with Existing ND Data

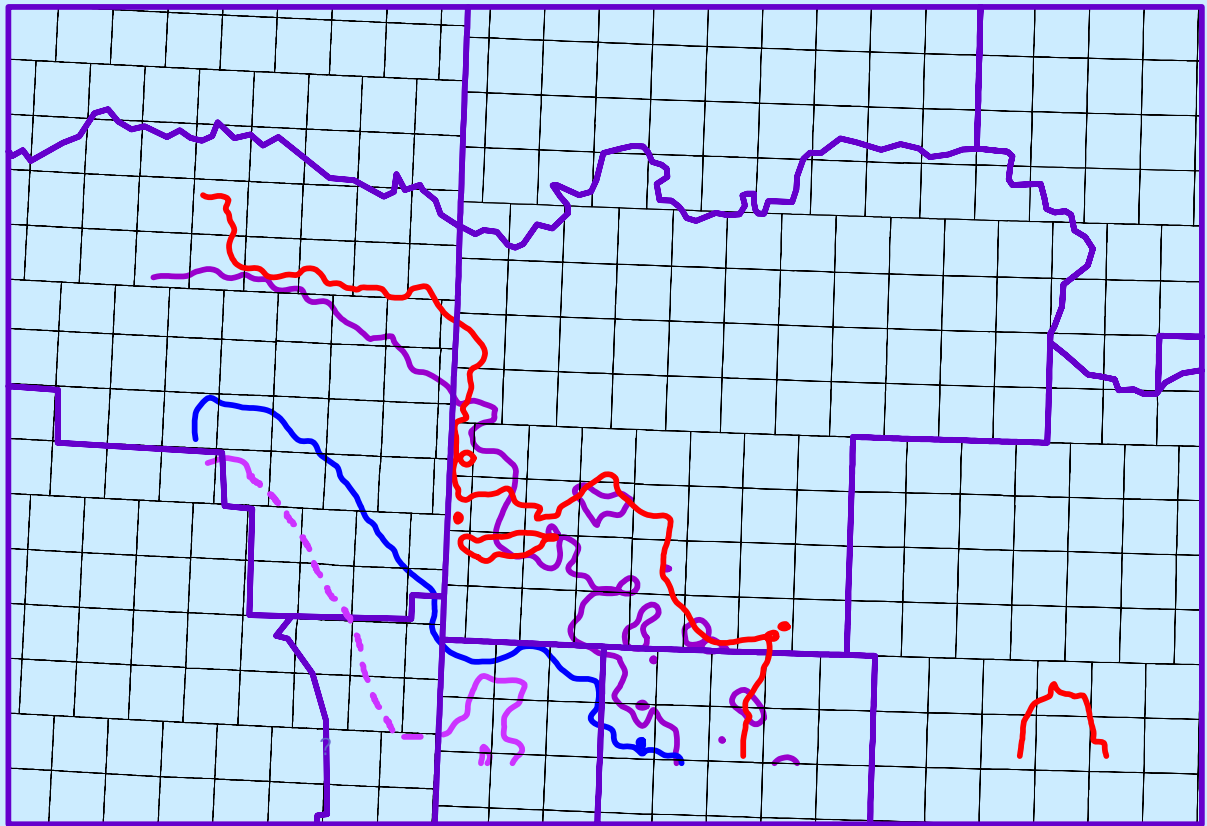
# Extent of Data



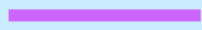
# BLC Structure Map



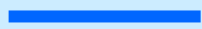
# Formation Limits



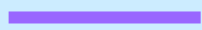
**Bakken Formation**



Upper



Middle



Lower

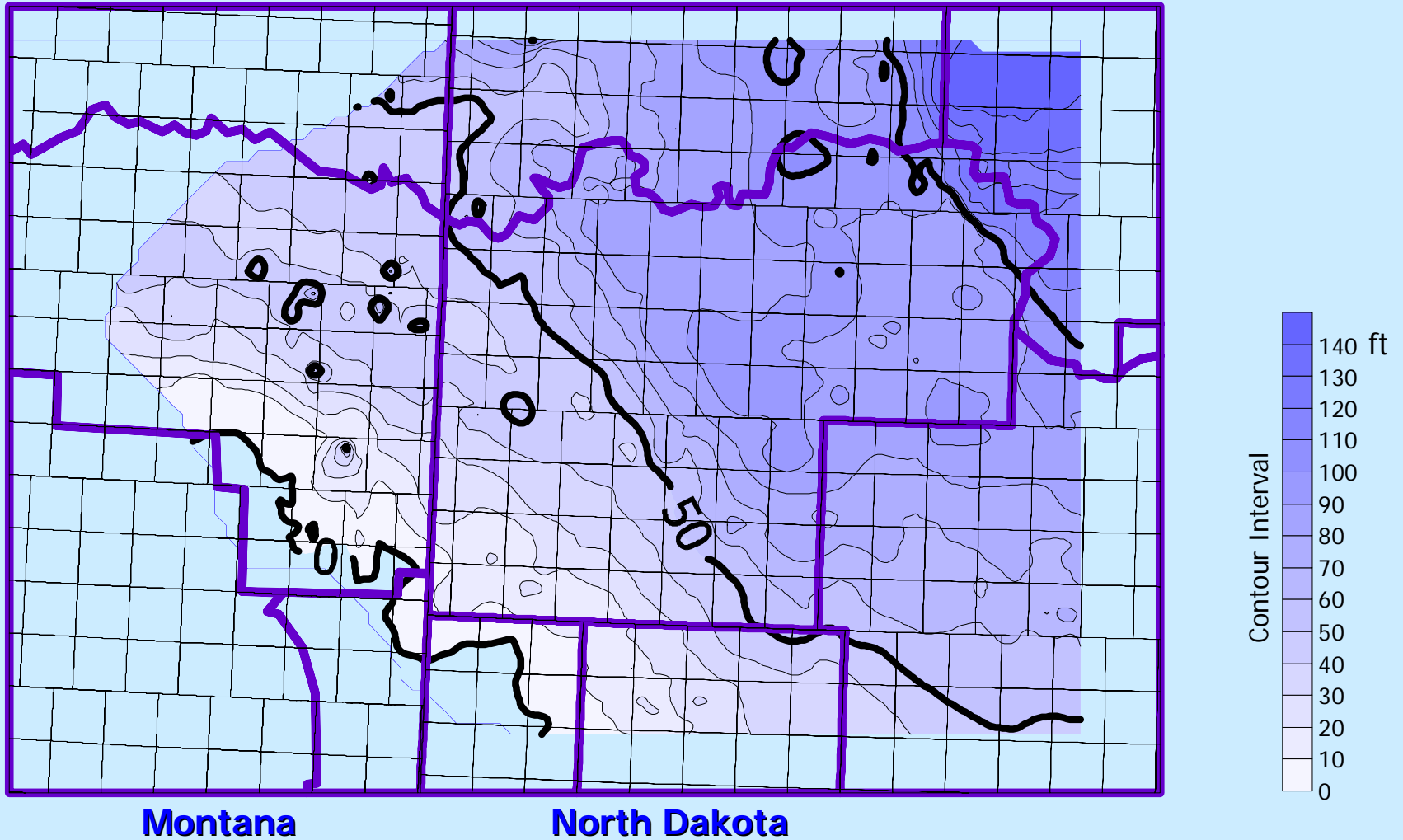
**Prairie Salt Edge**



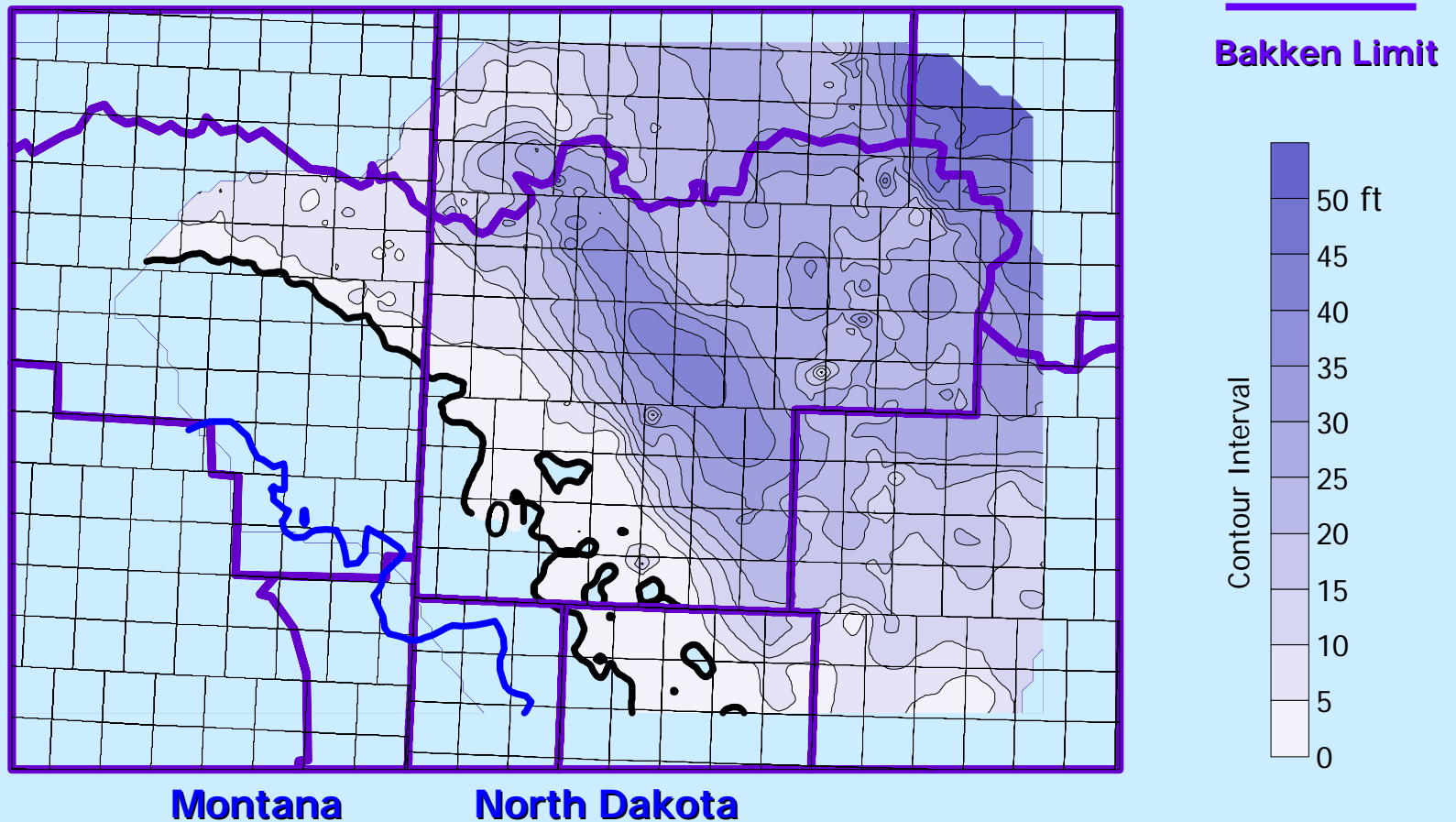
Montana

North Dakota

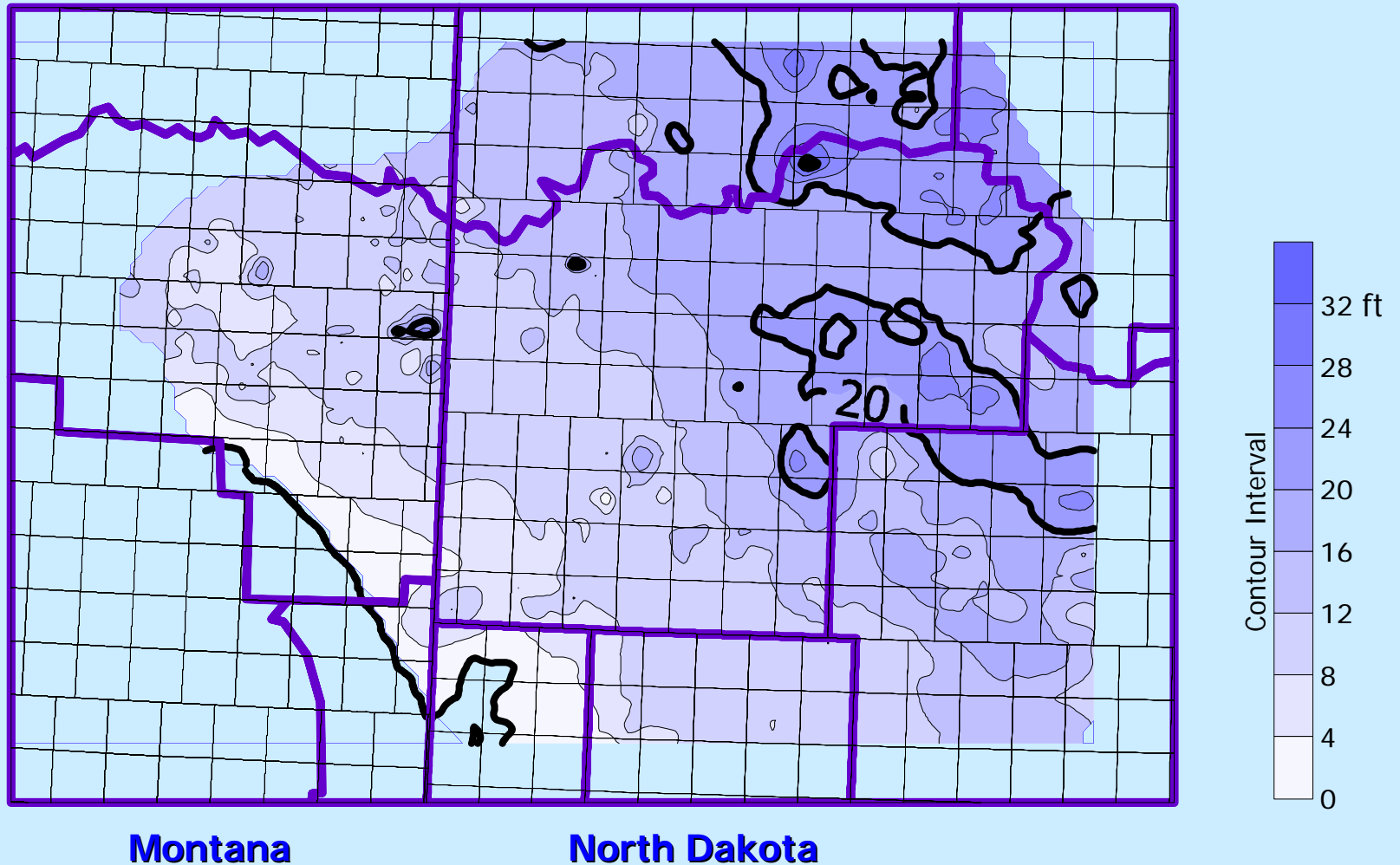
# Isopach of the Bakken Formation



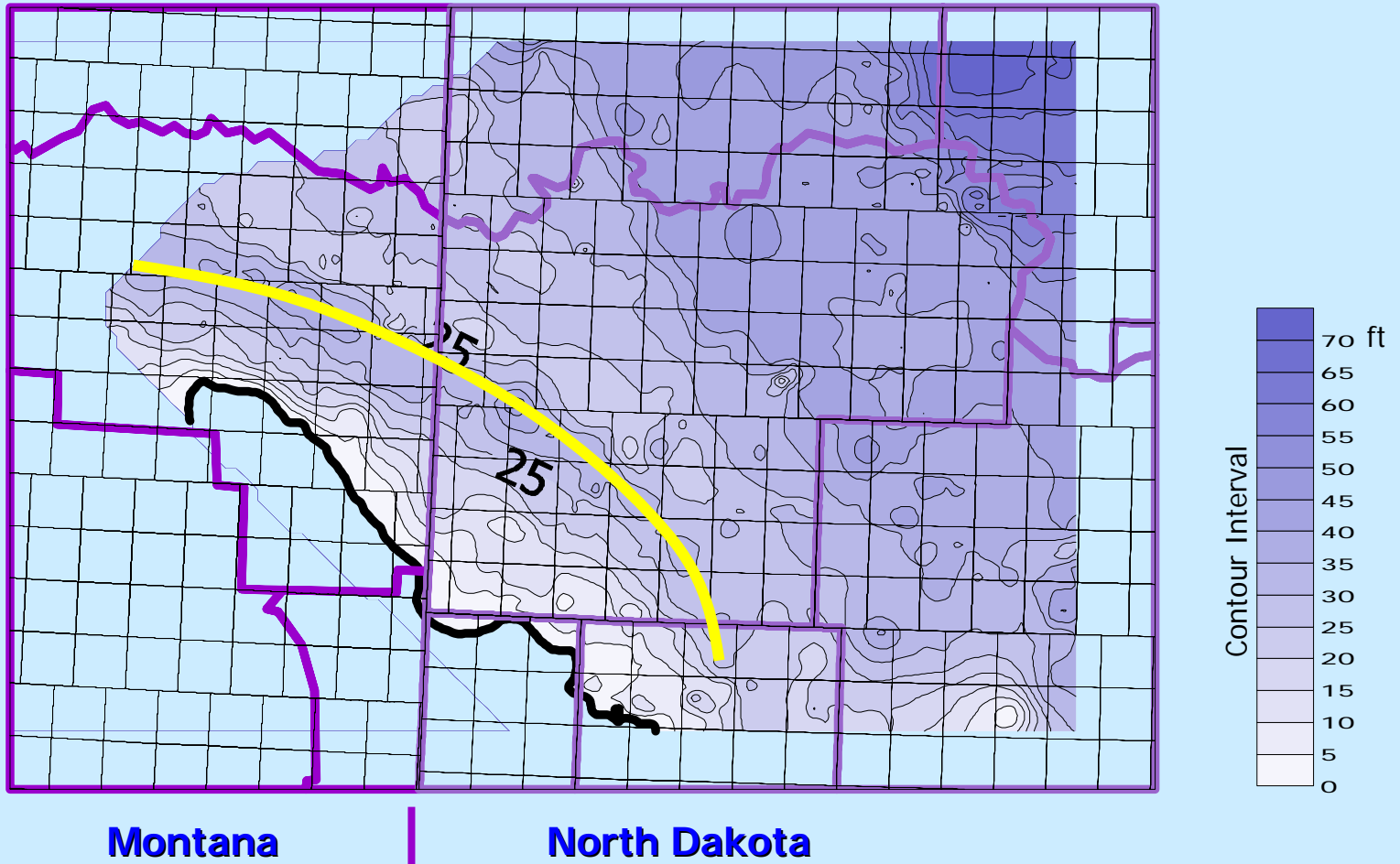
# Isopach of the Lower Member Bakken Formation



# Isopach of the Upper Member Bakken Formation



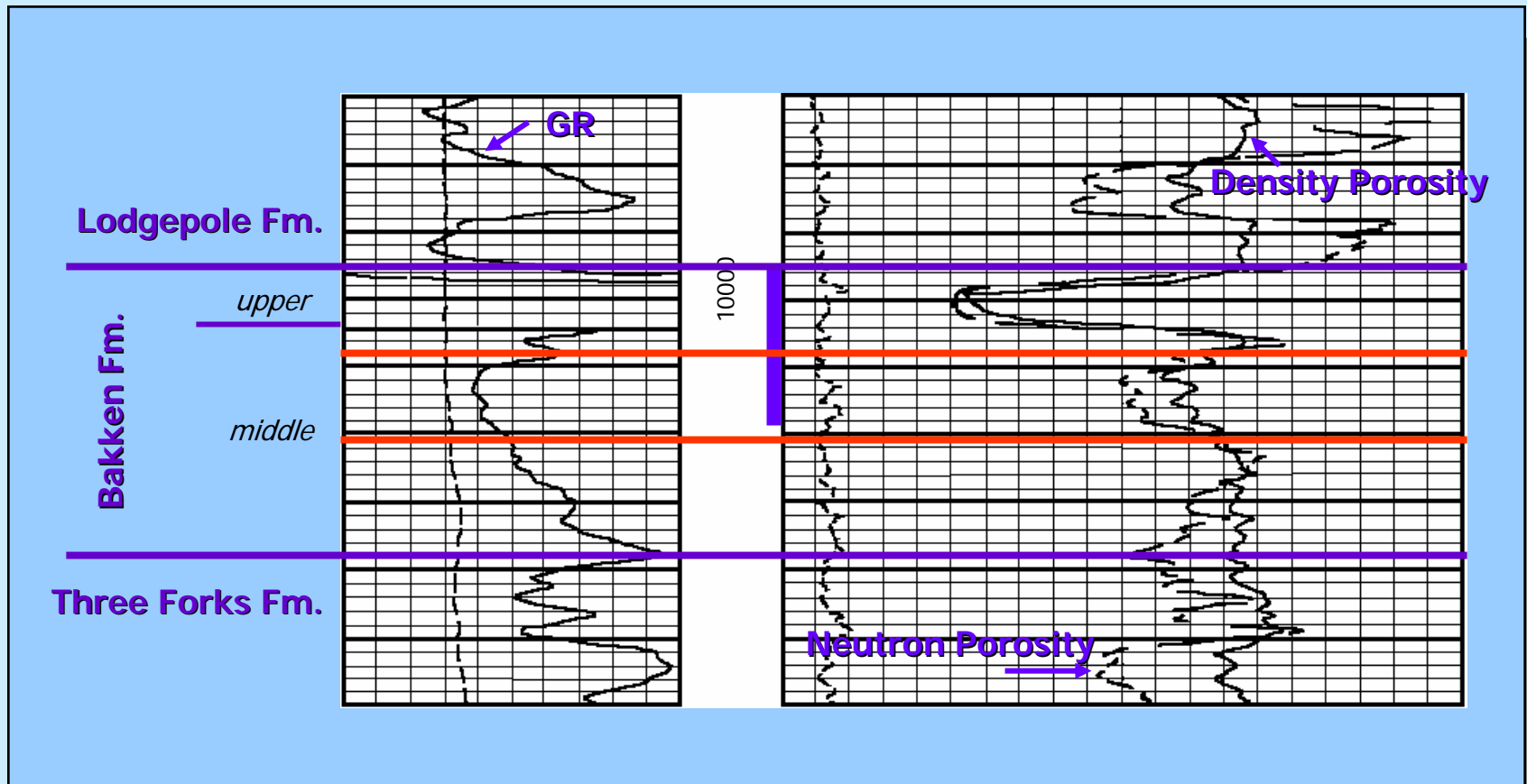
# Isopach of the Middle Member Bakken Formation



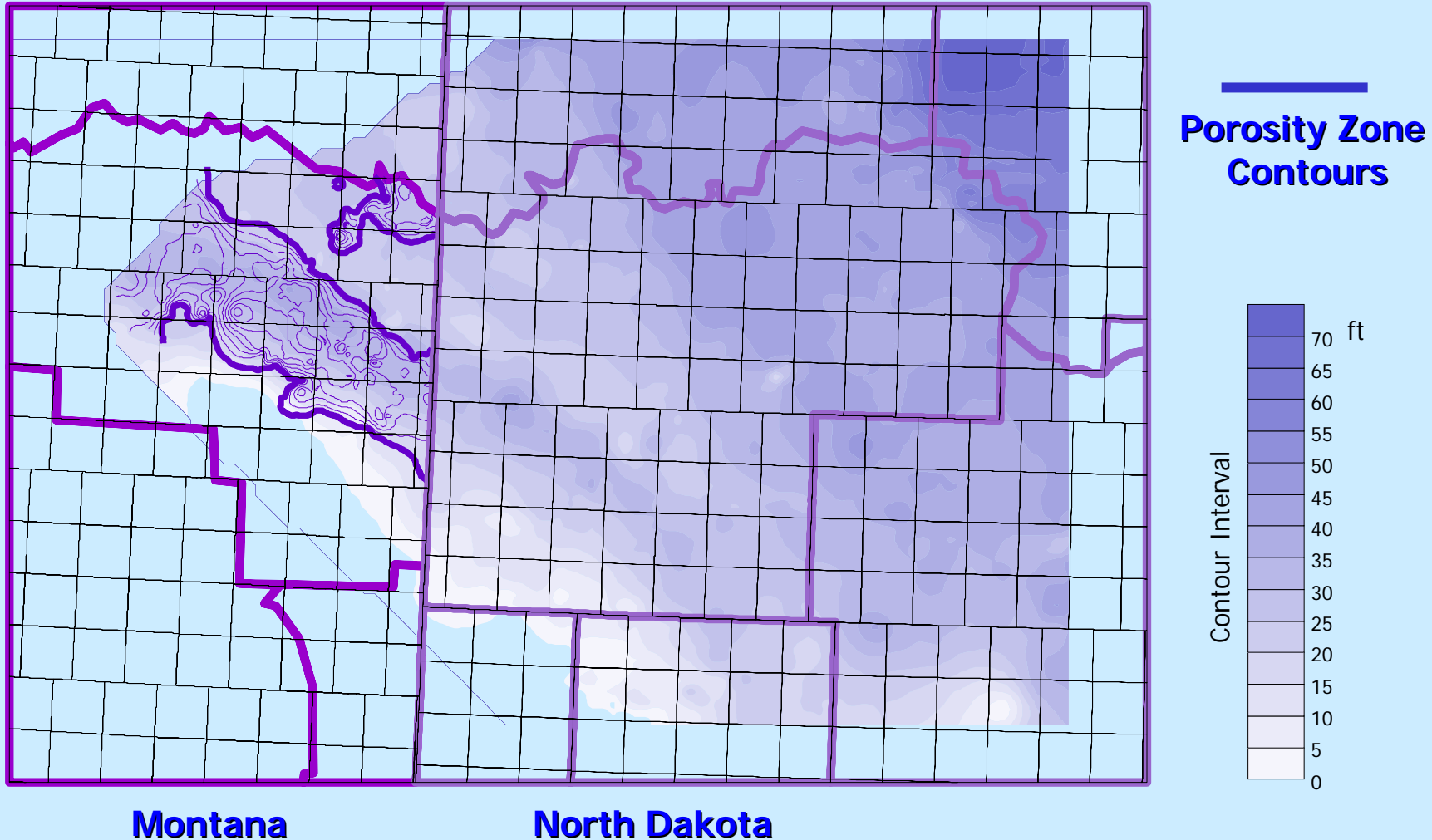


# Balcron Oil - #44-24 Vaira

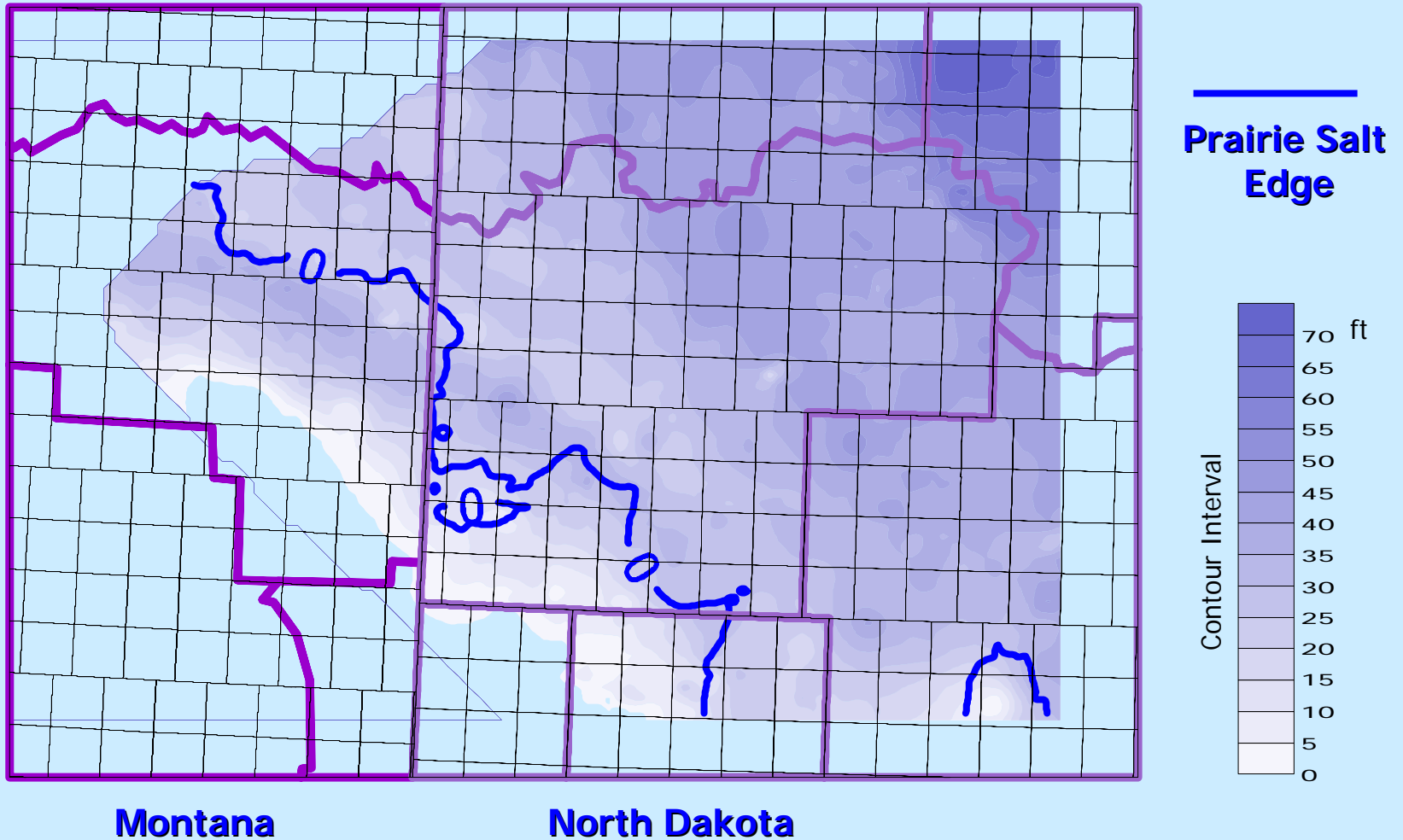
SESE Sec. 24, T.24N., R.54E.



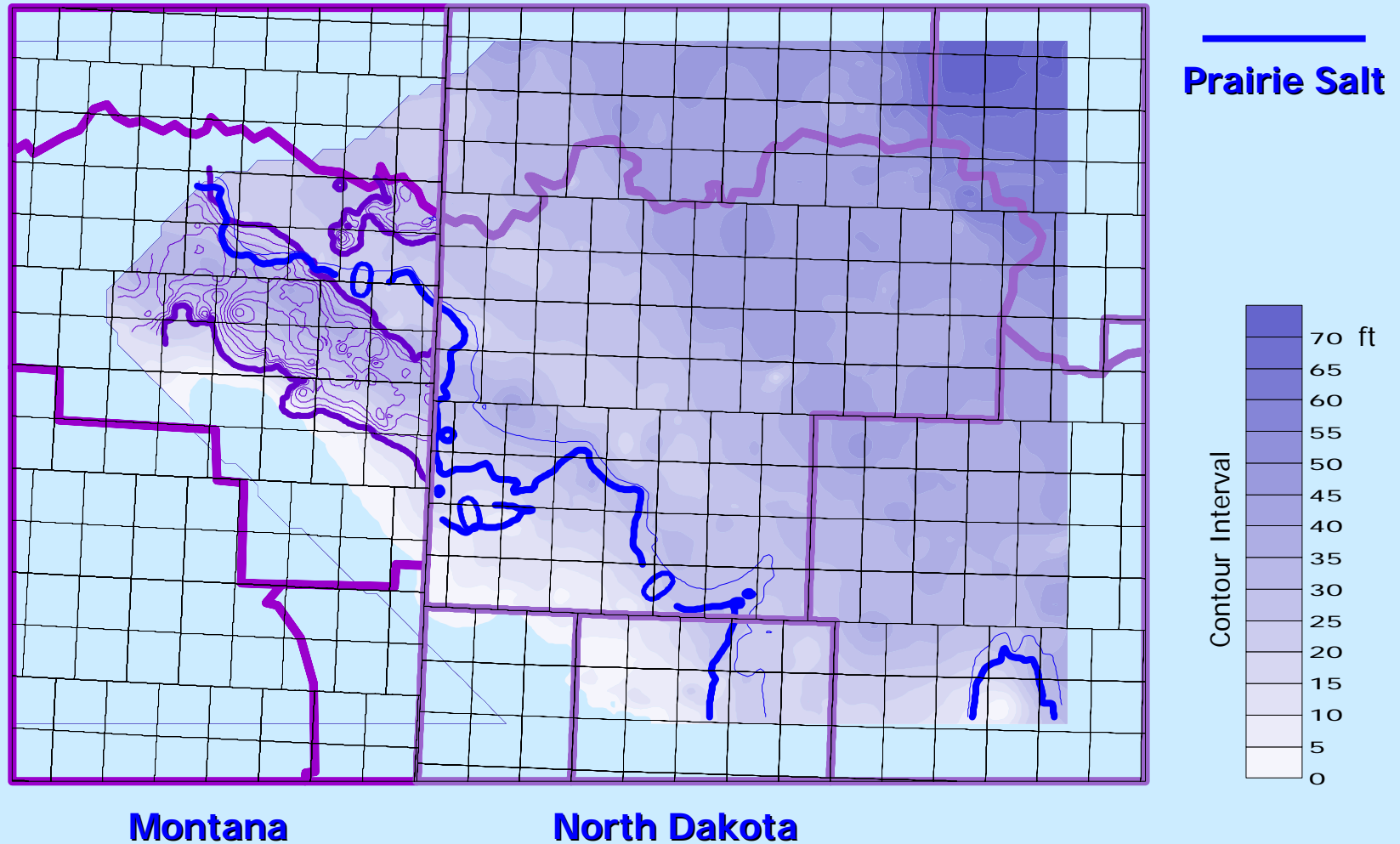
# Bakken Middle Member Porosity Zone



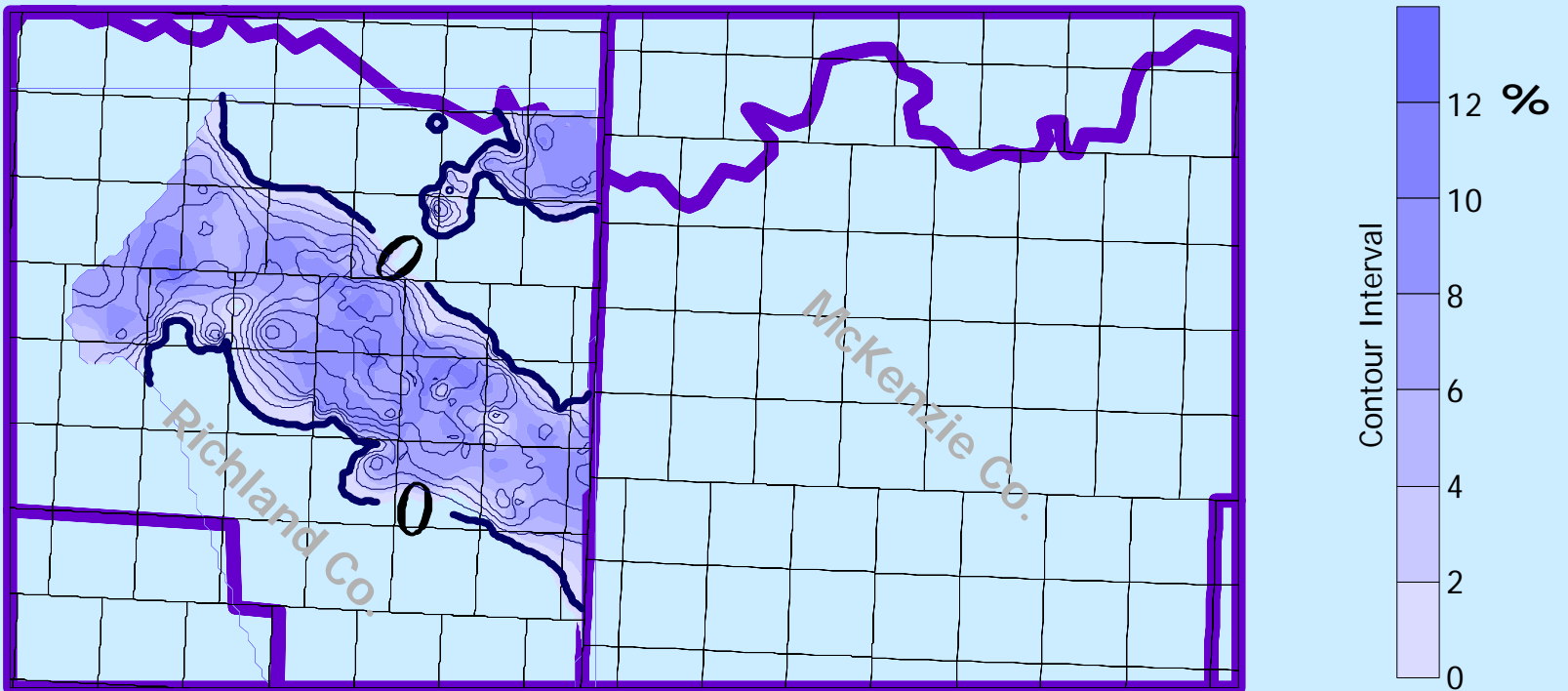
# Bakken Middle Member Prairie Salt



# Bakken Middle Member Prairie Salt

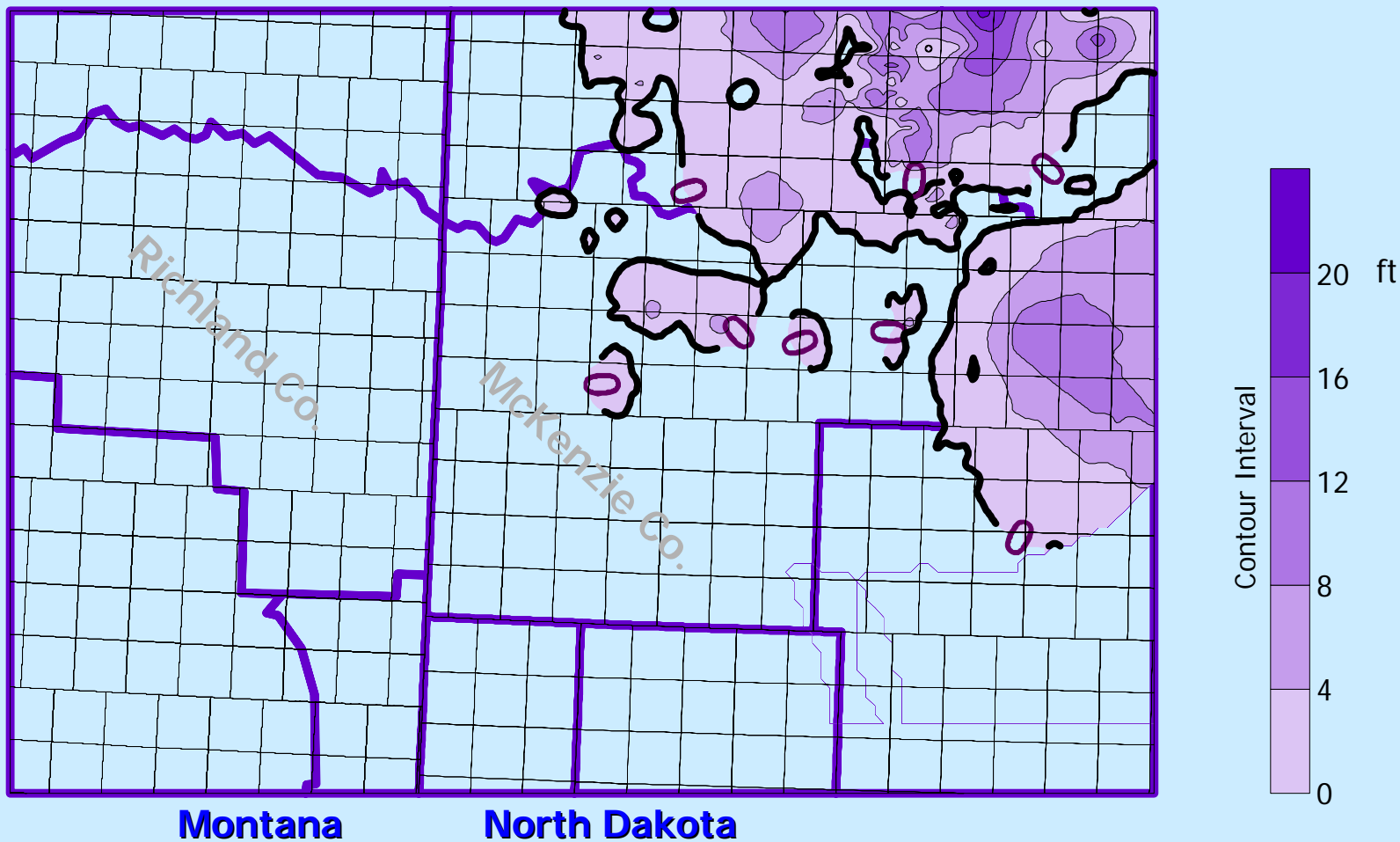


# Middle Member Porosity Zone



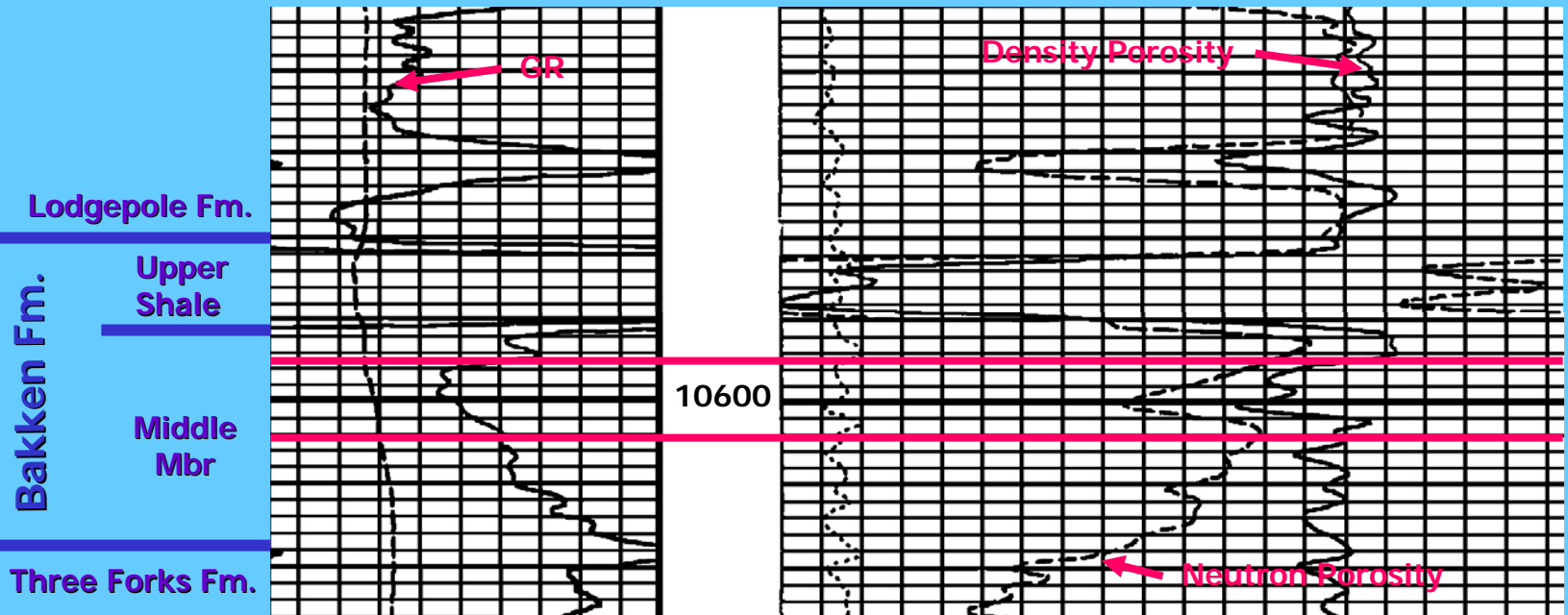
Contour Interval: 2 ft.

# Bakken Middle Member Sandstone Unit



# Shell Oil Company - #12-6-44 U.S.A.

SENWNW Sec. 6-T.148N.-R.104W.



# Can the Bakken Play Extend into North Dakota?

**YES!**

- Production from the same interval
- Mappable log characteristics from MT into ND
- Prominent trends illustrated on Bakken maps
- Other intervals within the middle member that have similar potentials