Three-Dimensional Geologic Model of Northwestern North Dakota

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The primary purpose of this document is to illustrate the three-dimensional shape of several significant geologic units within the Williston Basin of North Dakota.

The geologic intervals depicted in this document were modeled using geophysical log tops (from oil & gas wells) within the computer program Petra.

Some of the geologic surfaces were generated from several thousand data points (e.g. Spearfish Formation) while other were generated by only a few hundred data points or less (e.g. Red River Formation). Questionable data points (geophysical log tops) were removed.

Vertical exaggeration is used throughout most of this document to help viewers see subtle features within the Williston Basin of North Dakota.

The surface topography of North Dakota, as well as the extent of water bodies such as Lake Sakakawea and the Missouri River, are only schematic.

While production statistics only show oil production through 2009, significant natural gas has also been produced and sold from North Dakota.
>19,000 Oil & Gas wells have been drilled in North Dakota

-Black dots show the location of oil and gas wells drilled in North Dakota
50:1 Vertical Exaggeration

~3 miles
West ←

~135 miles
→ East
30:1 Vertical Exaggeration

~3 miles
West ↔

~135 miles
→ East
10:1 Vertical Exaggeration

~3 miles
West ←
~135 miles
→ East
1:1, No Vertical Exaggeration
10:1 Vertical Exaggeration

~3 miles

West ←

~135 miles

→ East
30:1 Vertical Exaggeration

~3 miles

West ←

~135 miles

→ East
50:1 Vertical Exaggeration

~3 miles

West  <->  East

~135 miles

North Dakota Geological Survey

GI-137
Three-Dimensional Geologic Model of Northwestern North Dakota

Precambrian Basement
- Red River Formation
- Mission Canyon Formation
- Tyler Formation
- Spearfish Formation
- Dakota Group
- Bakken-Three Forks

Fresh Water Zone
- Prairie Formation
- Potash
- Shallow Gas

Deep Oil & Gas
- Oil & Gas
- Frac Propant
- Geothermal

Salt-Water Disposal
- Uranium/Coal

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Shallow Gas Prospects
- Pierre Fm.
- Niobrara Fm.
- Carlile Fm.
- Greenhorn Fm.
Shallow Gas Prospects

- Pierre Fm.
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Shallow Gas Prospects

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Nesson Anticline
Dakota Group

- New Castle Fm.
- Skull Creek Fm.
- Inyan Kara Fm.
Dakota Group
- New Castle Fm.
- Skull Creek Fm.
- Inyan Kara Fm.
Dakota Group

- New Castle Fm.
- Skull Creek Fm.
- Inyan Kara Fm.
Spearfish Formation

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Spearfish Formation

Cum. Oil Production: >50,000,000 BBLs
2009 Production: 389,192 BBLs
Tyler Formation
Tyler Formation

Cum. Oil Production: >83,000,000 BBLs
2009 Production: 572,879 BBLs

Kibbey & Charles Formations, added to depict the northern extent of the Tyler Formation

Northern boundary

Tyler Absent

Nesson Anticline

Partially Tyler Core Sequence
Three wells have produced oil from the Tyler Formation within the area of this diagram, which is north of the area of current/traditional Tyler production.
Mission Canyon Formation
Mission Canyon Formation
Mission Canyon Formation
Mission Canyon Formation

Nesson Anticline

Cum. Oil Prod.: >900,000,000 BBLs (Madison Group)

2009 Production: >9,700,000 BBLs
Bakken-Three Forks
- Bakken Fm. (light grey)
- Three Forks Fm. (dark grey)
Bakken-Three Forks
-Bakken Fm. (light grey)
-Three Forks Fm. (dark grey)
Bakken-Three Forks

-Bakken Fm. (light grey)

-Three Forks Fm. (dark grey)
Bakken-Three Forks

- Bakken Fm. (light grey)
- Three Forks Fm. (dark grey)
Bakken-Three Forks

- Bakken Fm. (light grey)
- Three Forks Fm. (dark grey)

Parshall Field

Cum. Oil Production: >120,000,000 BBLs
2009 Oil Production: 49,481,620 BBLs
Prairie Formation
Prairie Formation
Prairie Formation

Thickens & shallows towards the north
Prairie Formation

~50 Billion Tons of Potash in northwestern North Dakota
Red River Formation
Red River Formation
Red River Formation

Cum. Oil Production: >215,000,000 BBLs
2009 Oil Production: 14,054,604 BBLs

Nesson Anticline

Red River Rock - Type Examples
Brownish-grey dolomite
Grayish-brown dolomite
Slightly fossiliferous limestone

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Precambrian Basement
Precambrian Basement

**Tickmarks:**
- N
- S
- W
- E

**Locations:**
- Little Knife Anticline & Billings Nose
- Nesson Anticline
- Antelope Anticline
- Newport Impact Structure

**Precambrian Rock Types:**
- Chlorite schist/gneiss
- Mafic granulite
- Andesitic gneiss

**North Dakota Geological Survey**
More than 8,000 Oil & Gas wells have been drilled in northwestern North Dakota, but only 27 wells have penetrated the Precambrian basement, making it the least understood geologic group of in the Williston Basin.

The Precambrian surface in this diagram was generated by combining the 27 Precambrian well penetrations with the structure contour surface of the Red River Formation.
Horizontal Wells
Horizontal Wells

Williston
New Town
Killdeer
Stanley

West ←

East →
Horizontal Wells

Williston
Killdeer
New Town
Stanley

West ←

→ East
The remainder of this document will focus on showing horizontal wells drilled into the Bakken-Three Forks system.

An interval consisting of the Kibbey & Charles Formations has been added, which is colored dark grey for imaging purposes.
Horizontal Wells

50:1 Vertical Exaggeration

- Fresh water zone
- Kibbey & Charles Fms.
- Bakken-Three Forks Fms.
- Precambrian basement

Bakken/Three Forks horizontal wells

West ← East
Horizontal Wells

30:1 Vertical Exaggeration

West  East
Horizontal Wells

South

Point of reference

North
Horizontal Wells

Point of reference

South → North
Horizontal Wells

Point of reference

South

North
Horizontal Wells

Point of reference

South ←

North →
Horizontal Wells
Horizontal Wells

South ⬅️ North
Horizontal Wells
-Sanish Field
Horizontal Wells
-Parshall Field
Parshall Field

South  North
Traditionally, oil & gas wells in the Williston Basin were only drilled vertically. Currently, Bakken-Three Forks wells are drilled downwards ~2 miles (vertically) and then up to 2 miles horizontally.
Parshall Field
Sanish Field
Sanish Field