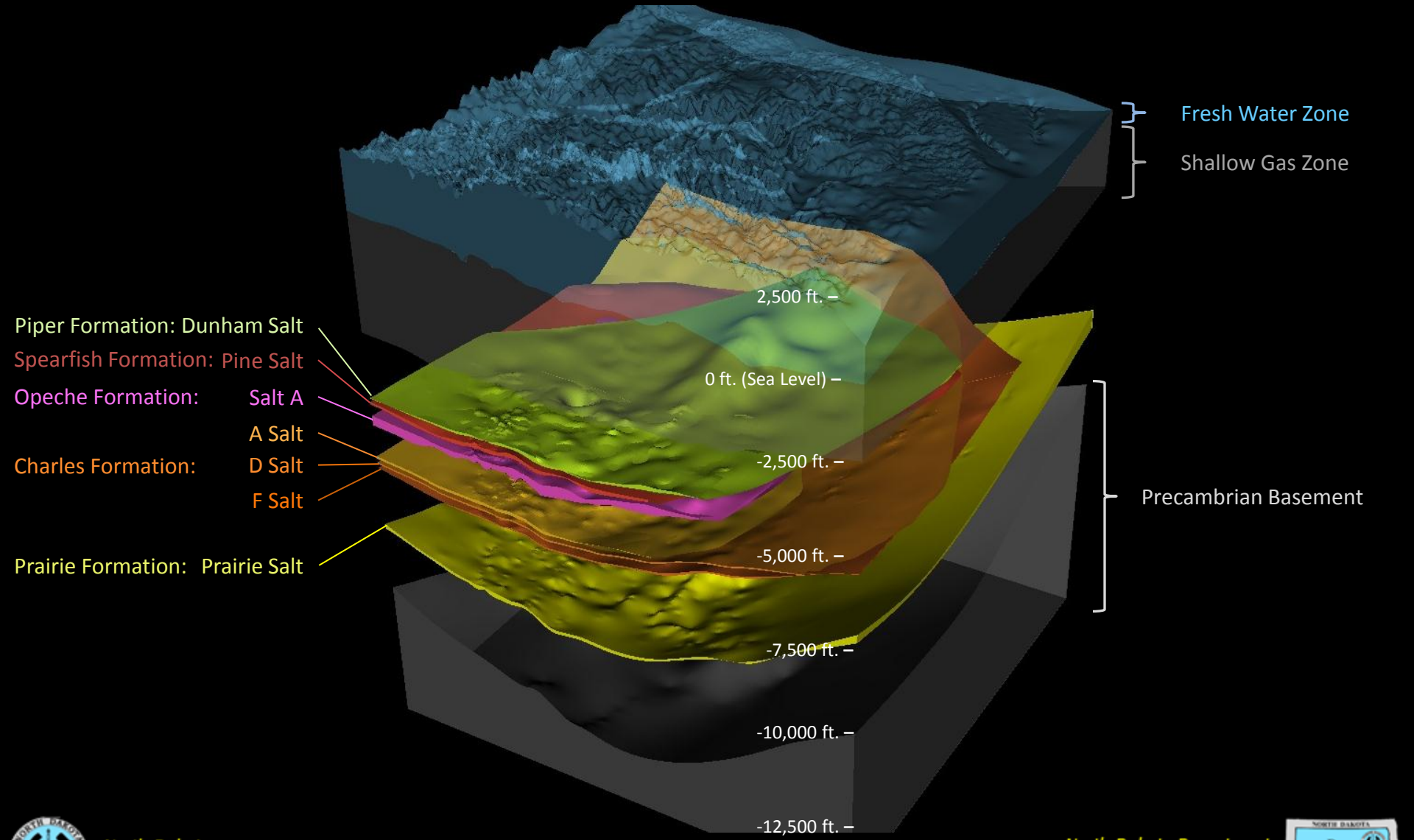
Three Dimensional Geologic Model of Subsurface Salt Intervals within the Williston Basin, Northwestern North Dakota

Timothy O. Nesheim and Julie A. LeFever



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Geologic Investigation No. 162

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Williston Basin Salt Intervals, Northwestern North Dakota

-The main intent of this publication is to display the distribution of regional salt intervals beneath northwestern North Dakota.

-The following model displayed is meant to be a visual teaching tool to aid non-geologists in visualizing and understanding the subsurface geology of North Dakota.

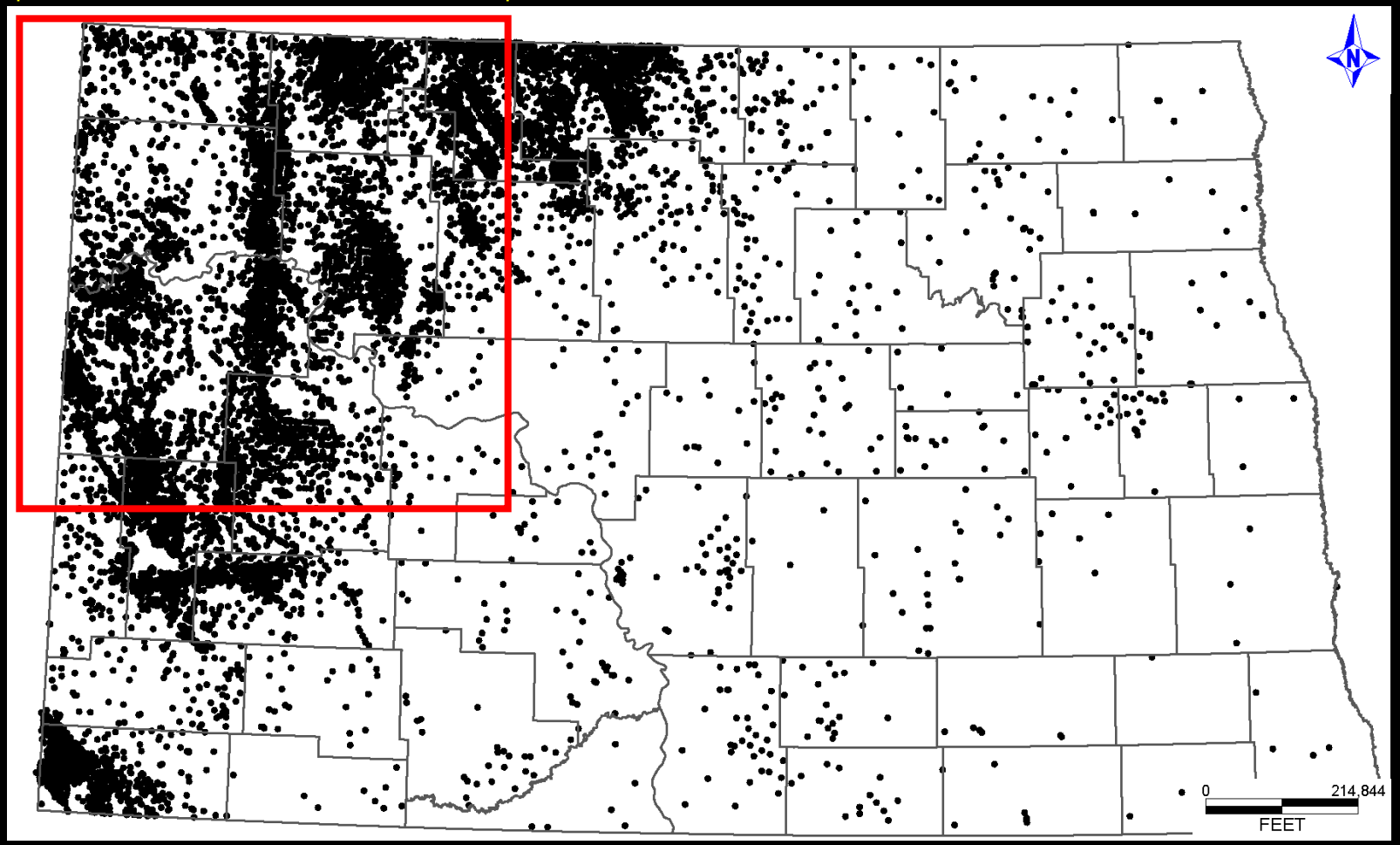
-The geological formations, groups, and salt intervals modeled by this project were generated using primarily geophysical log tops (from oil & gas wells) within the computer program Petra.

-The geological surfaces in this model were produced by anywhere from several thousand data points (e.g. Madison Formation) to less than a hundred data points (e.g. Precambrian). Questionable data points (geophysical log tops) were removed.

-Vertical exaggeration is used throughout most of this publication to help emphasize the subtle structural features within the Williston Basin of North Dakota.

-Multiple estimated control points where added to the Precambrian surface throughout the model area.

>16,000 Oil & Gas wells have been drilled in North Dakota



-Black dots show the location of oil and gas wells drilled in North Dakota

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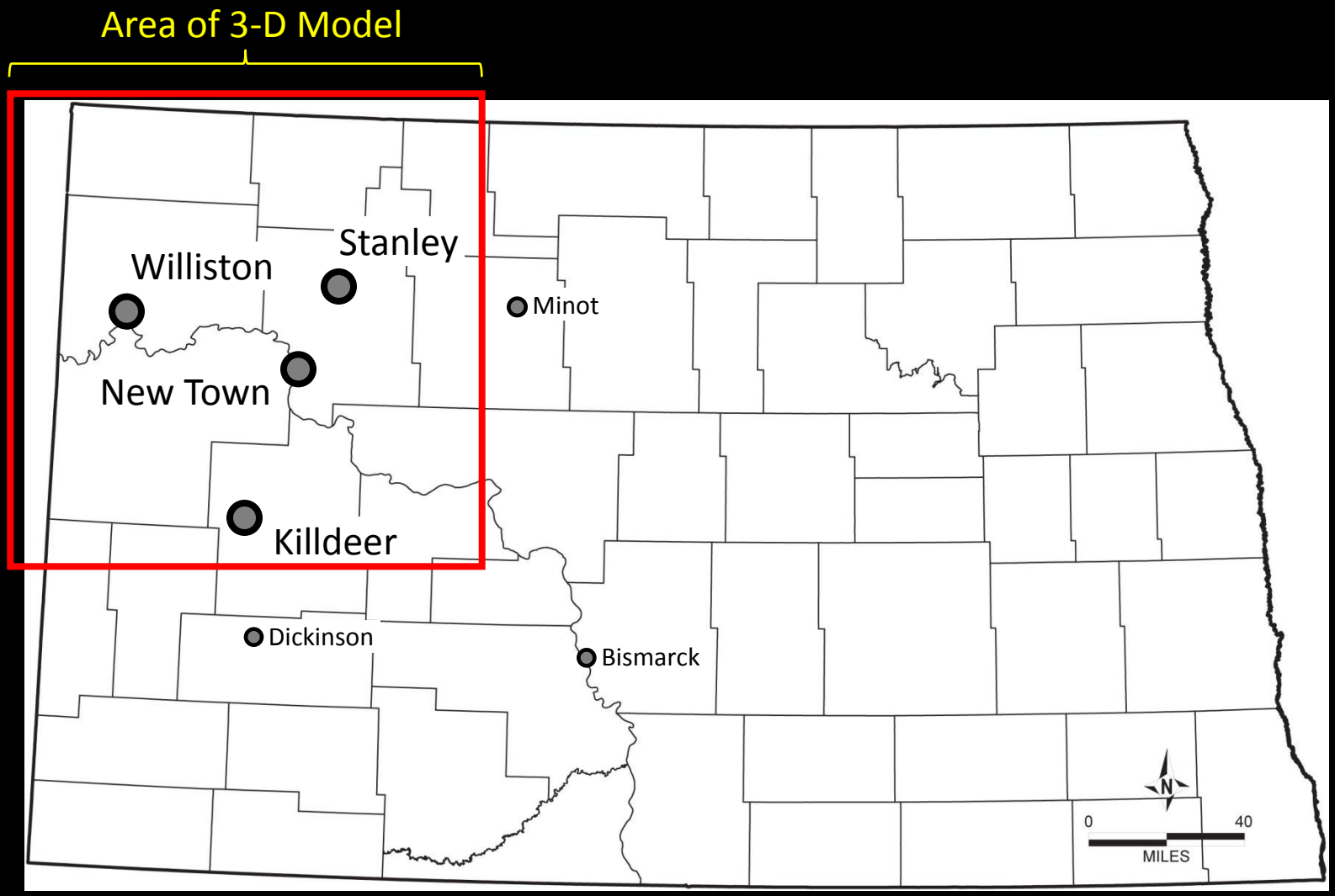

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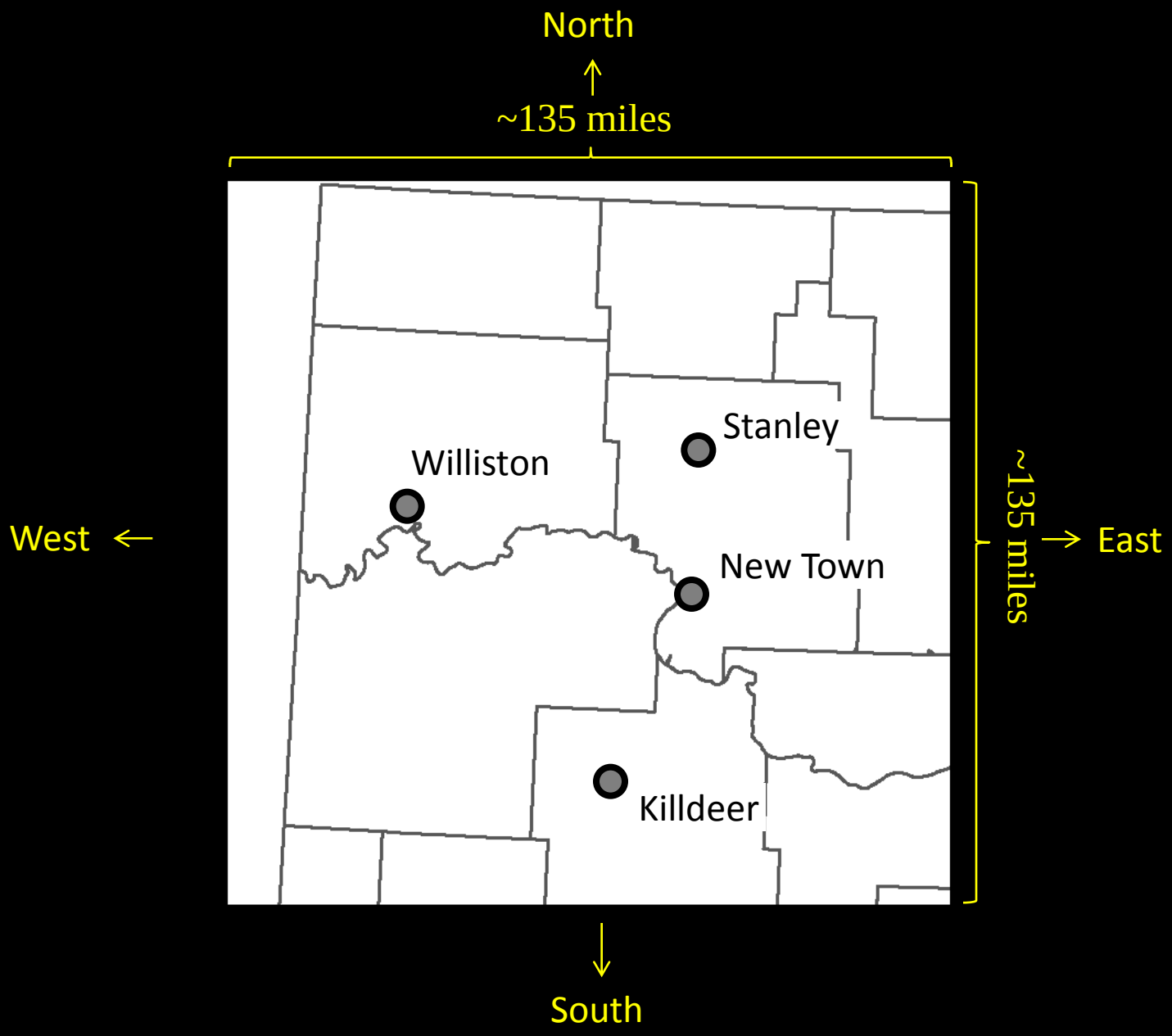

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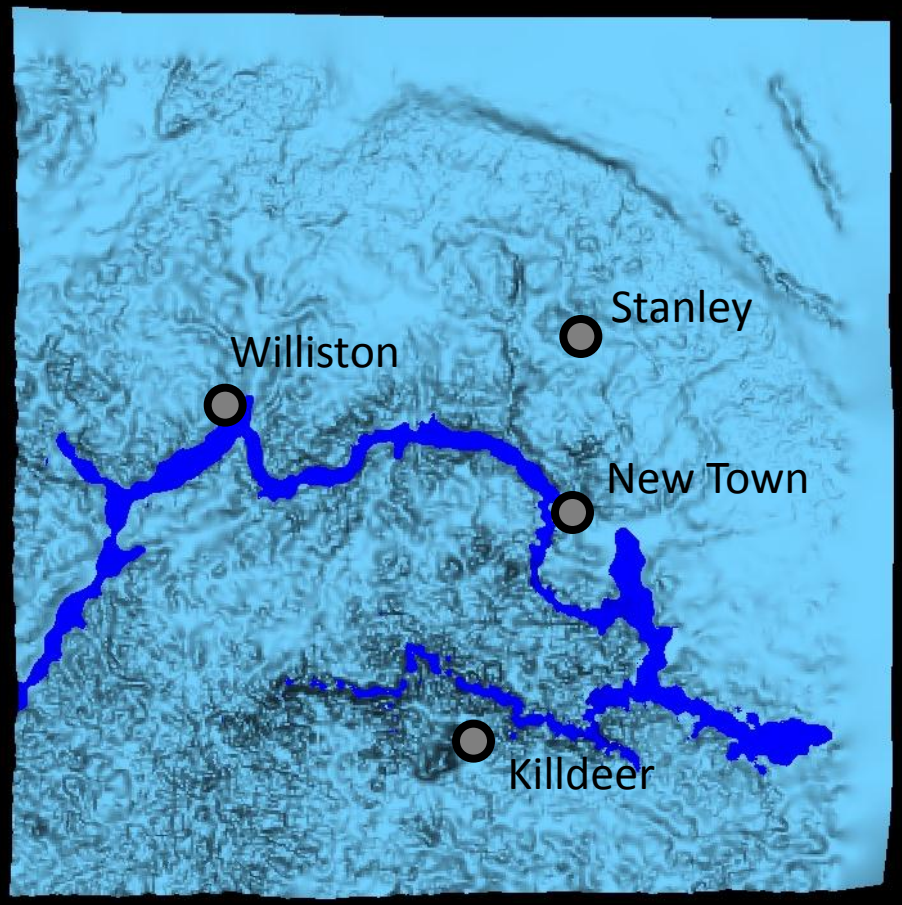

West ←

→ East

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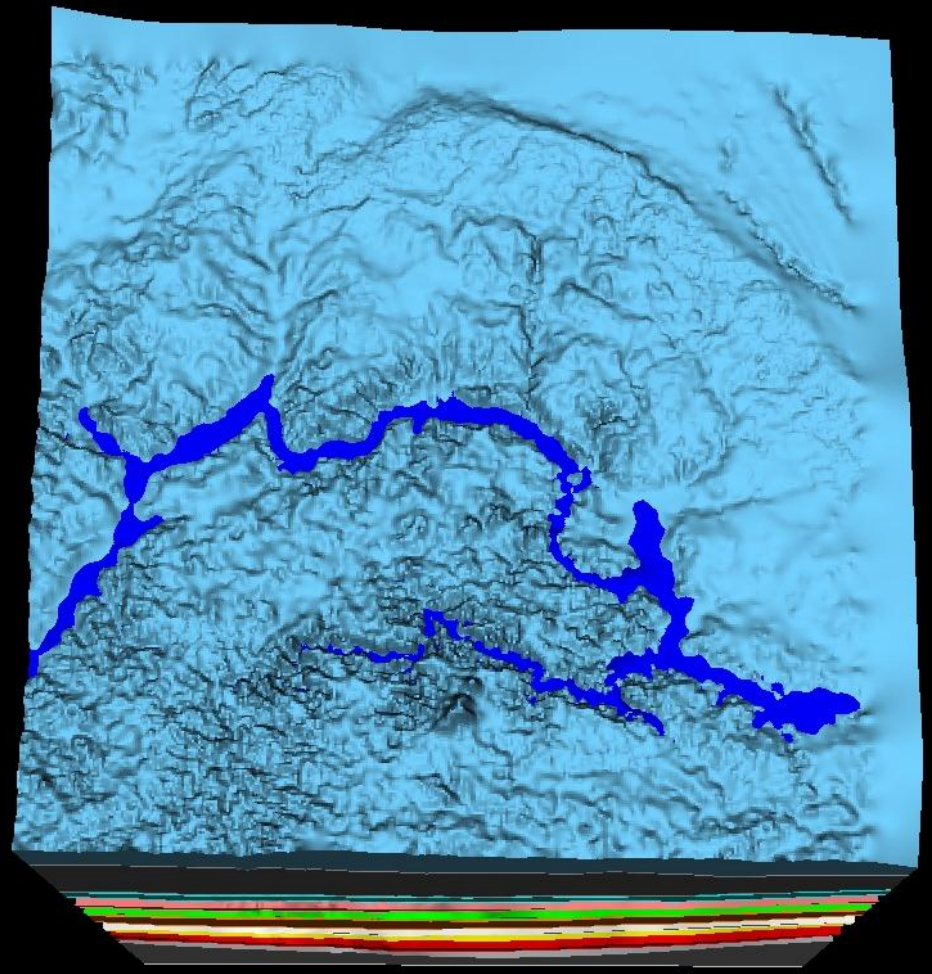
West ←



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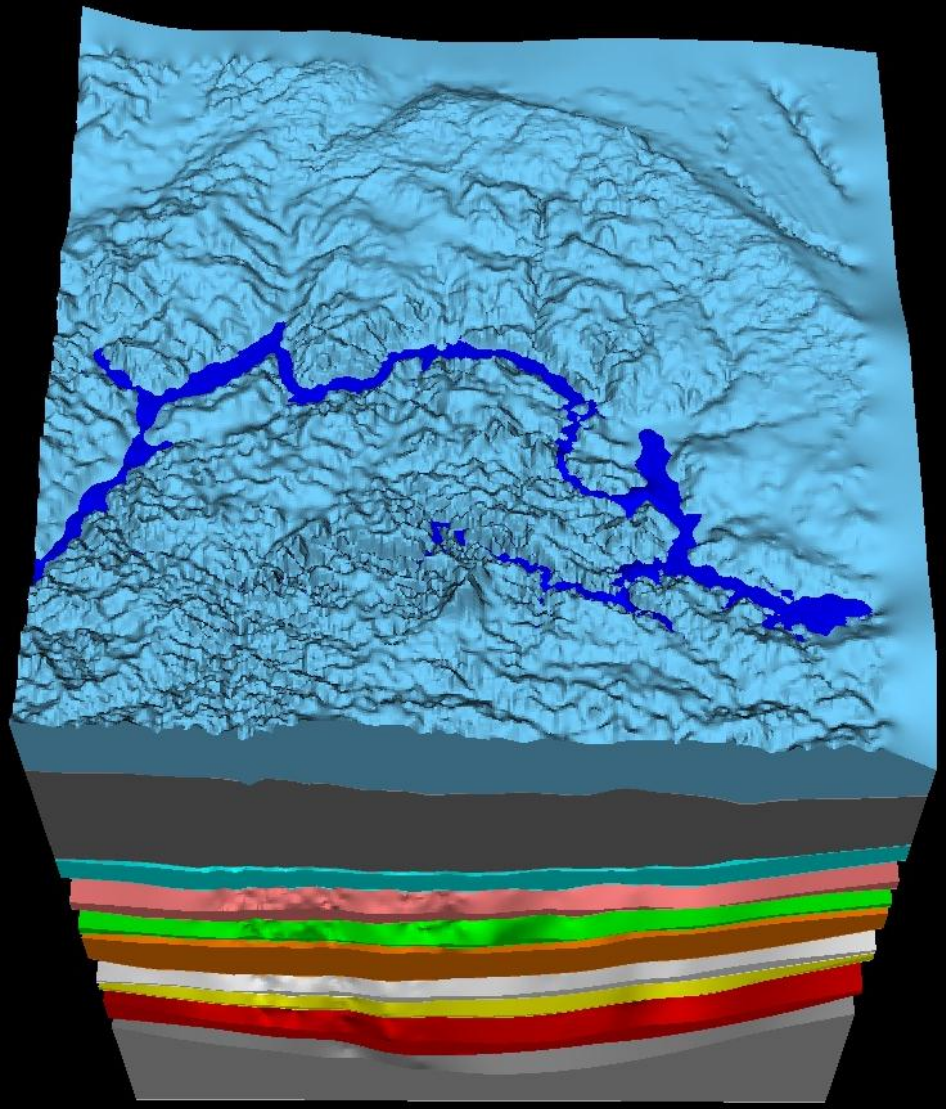

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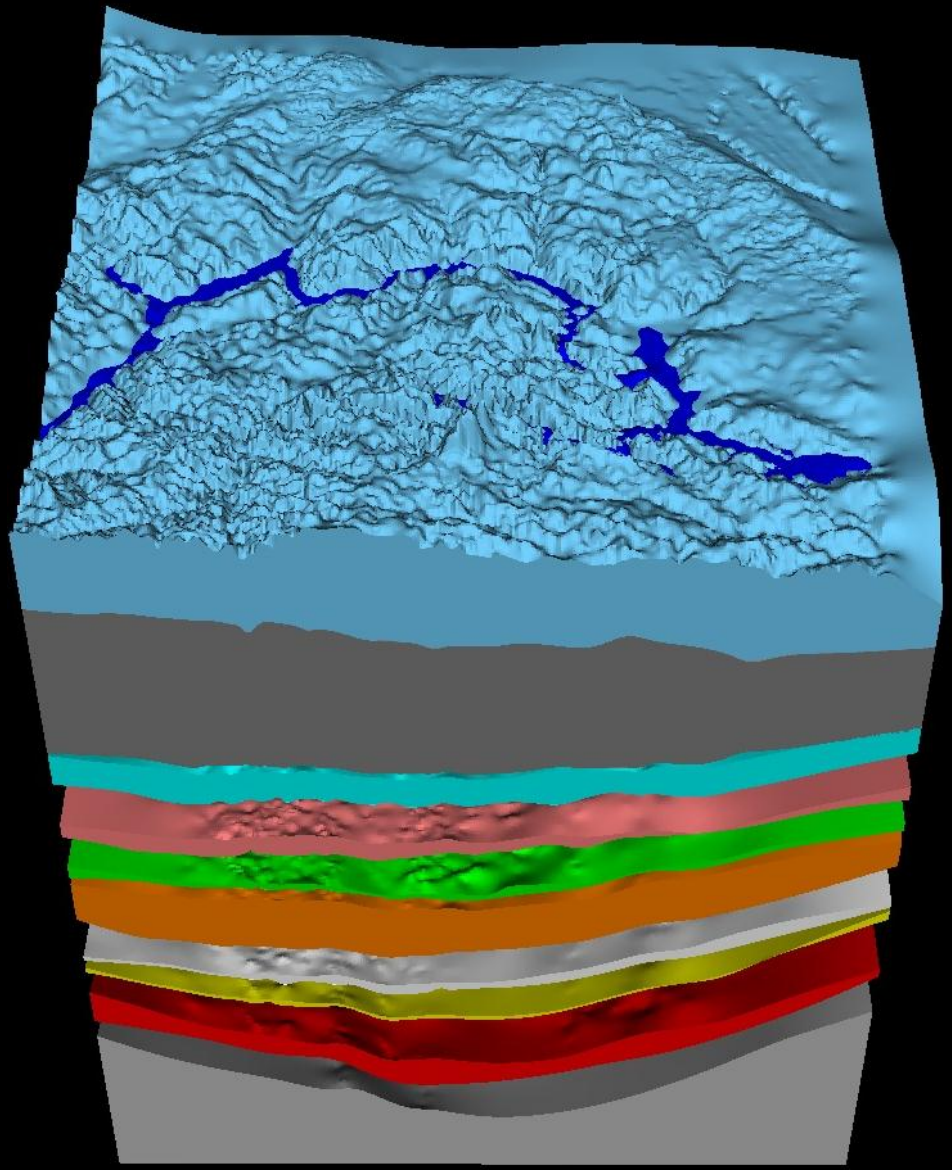

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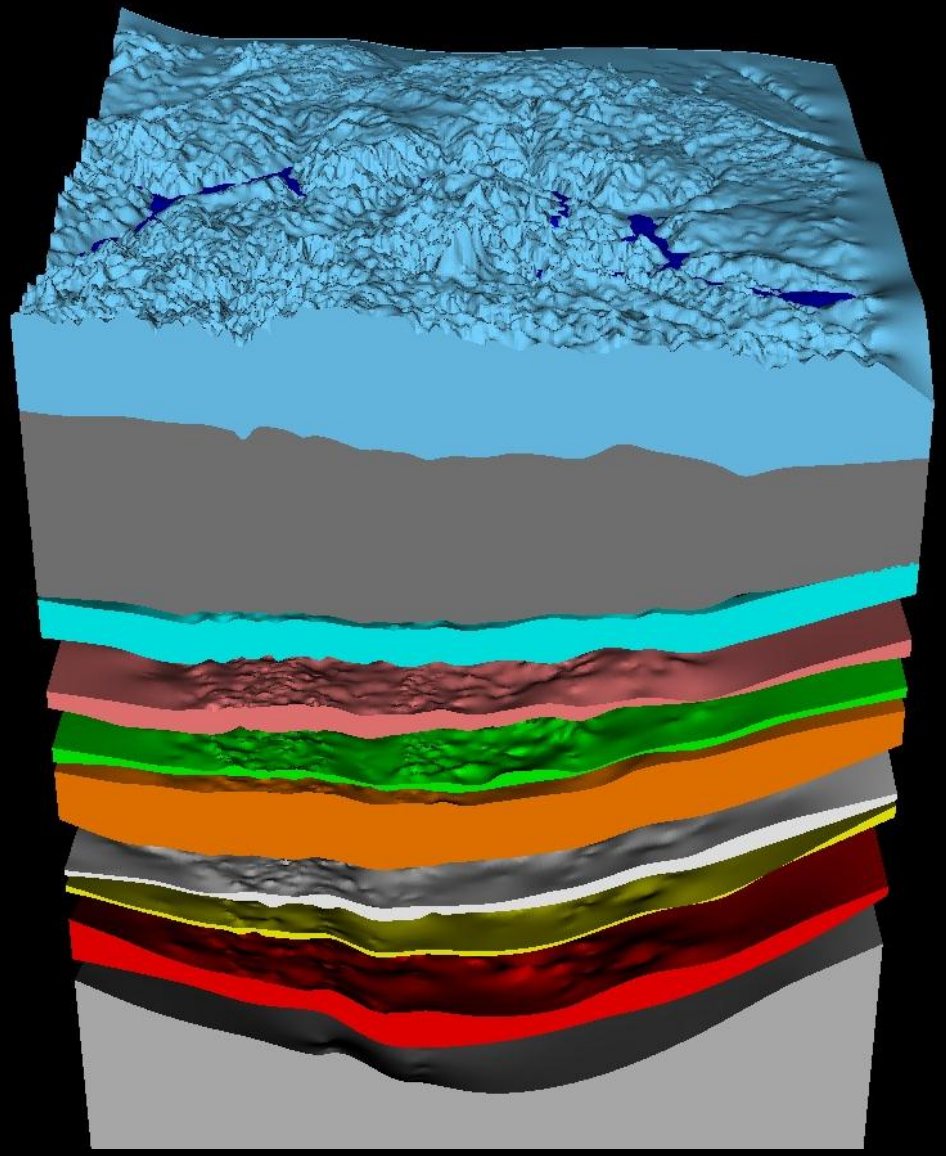

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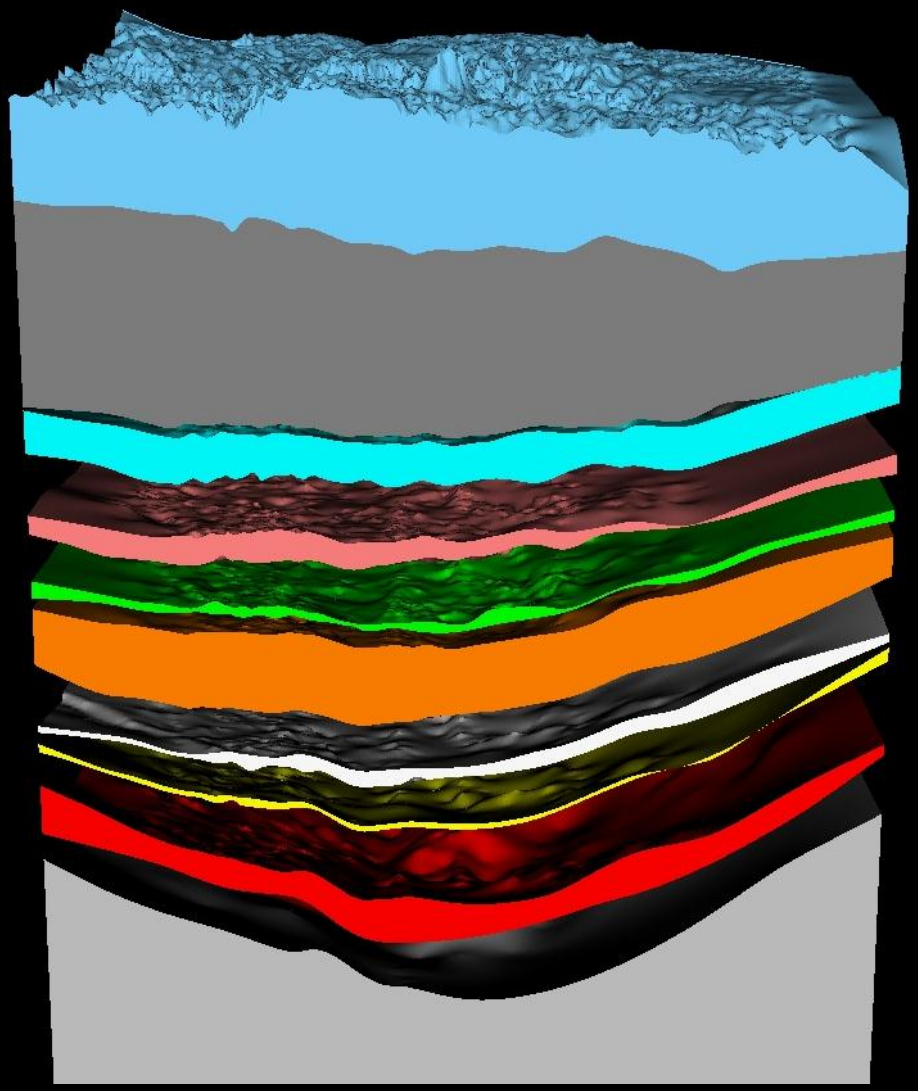

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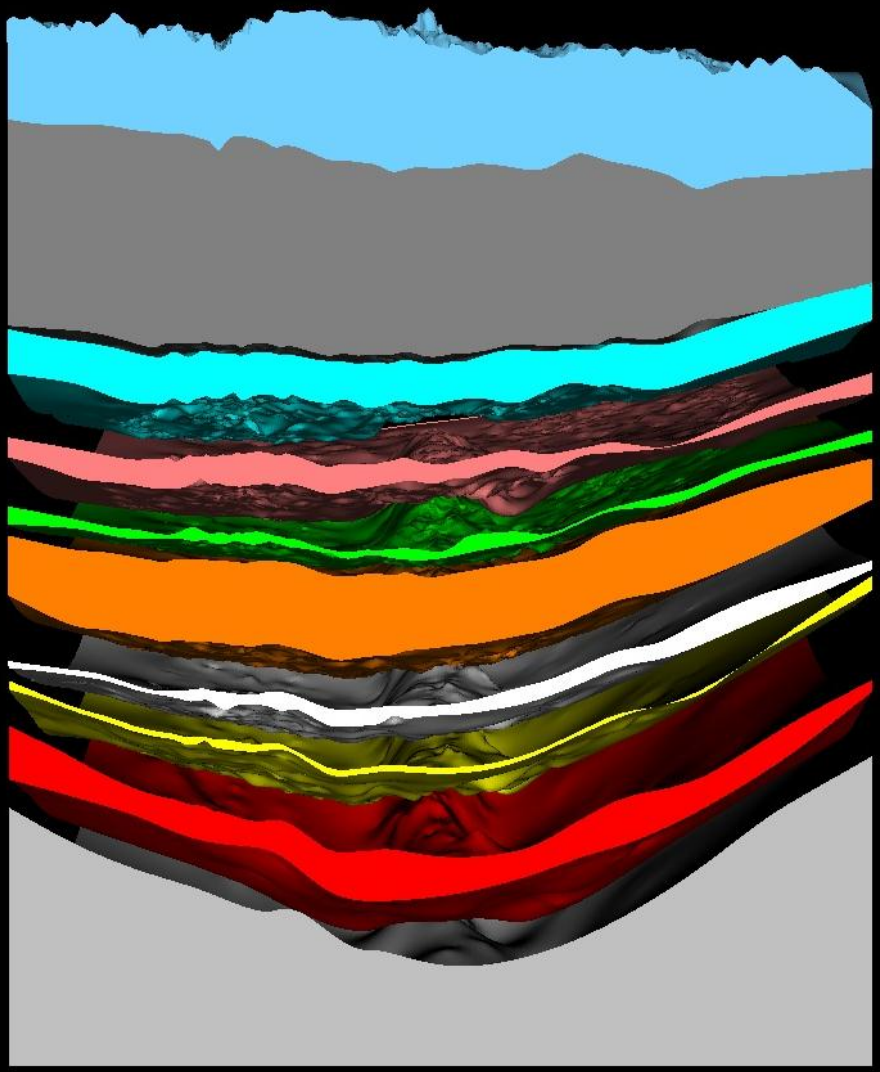

→ East

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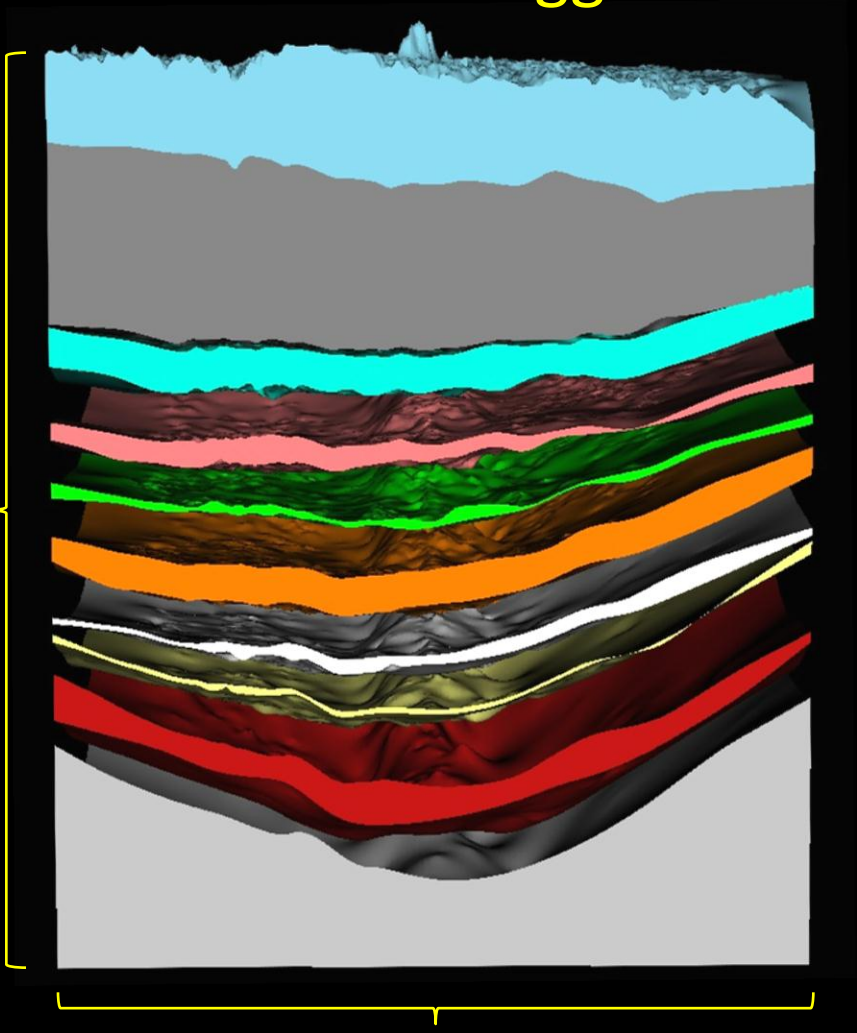
50:1 Vertical Exaggeration



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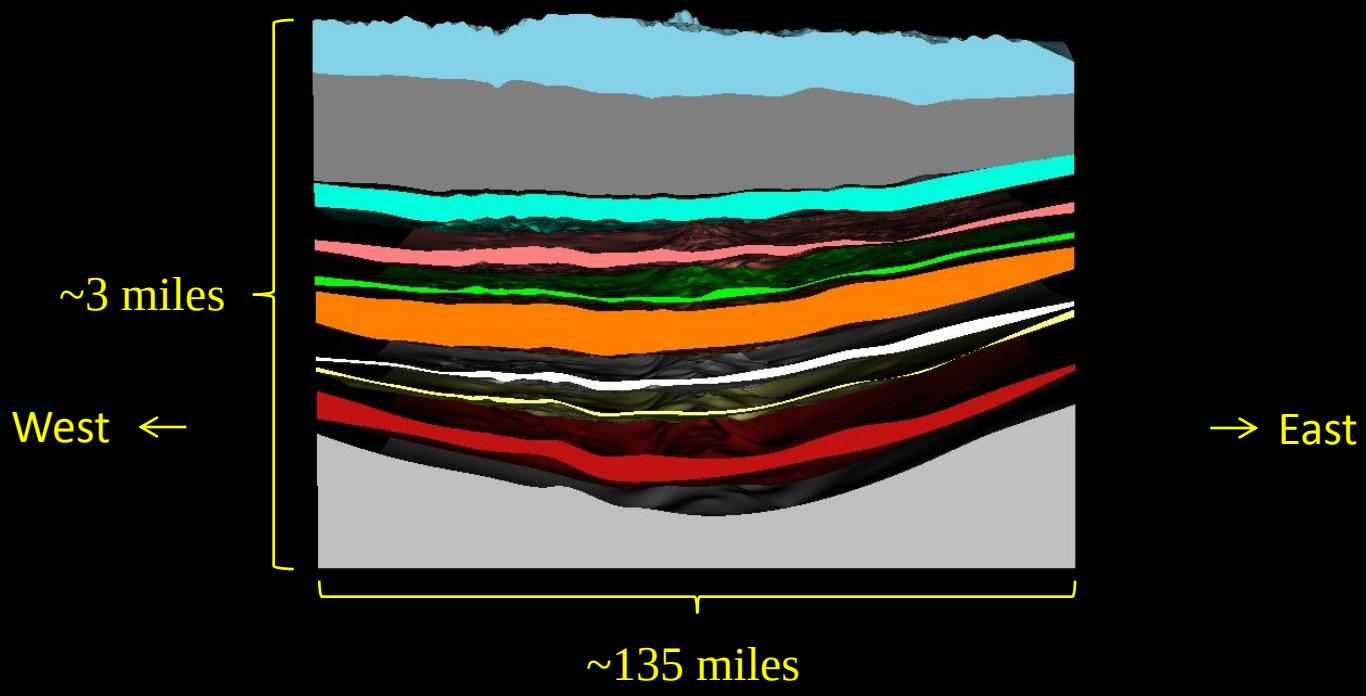
30:1 Vertical Exaggeration



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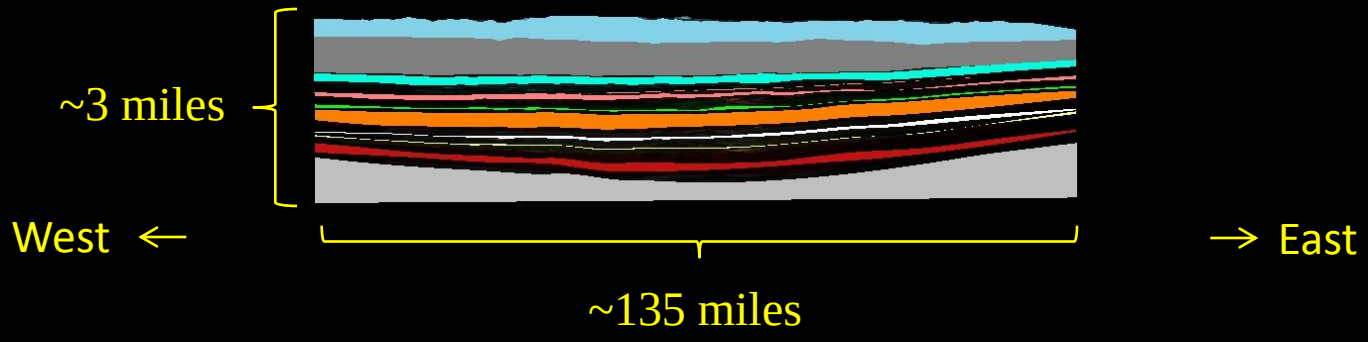
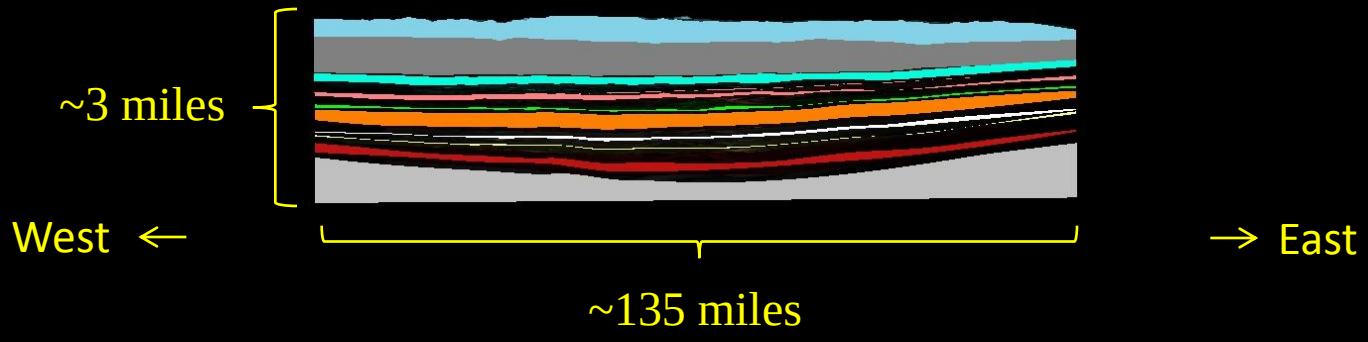
10:1 Vertical Exaggeration



1:1, No Vertical Exaggeration

West ← ~135 miles → East

10:1 Vertical Exaggeration



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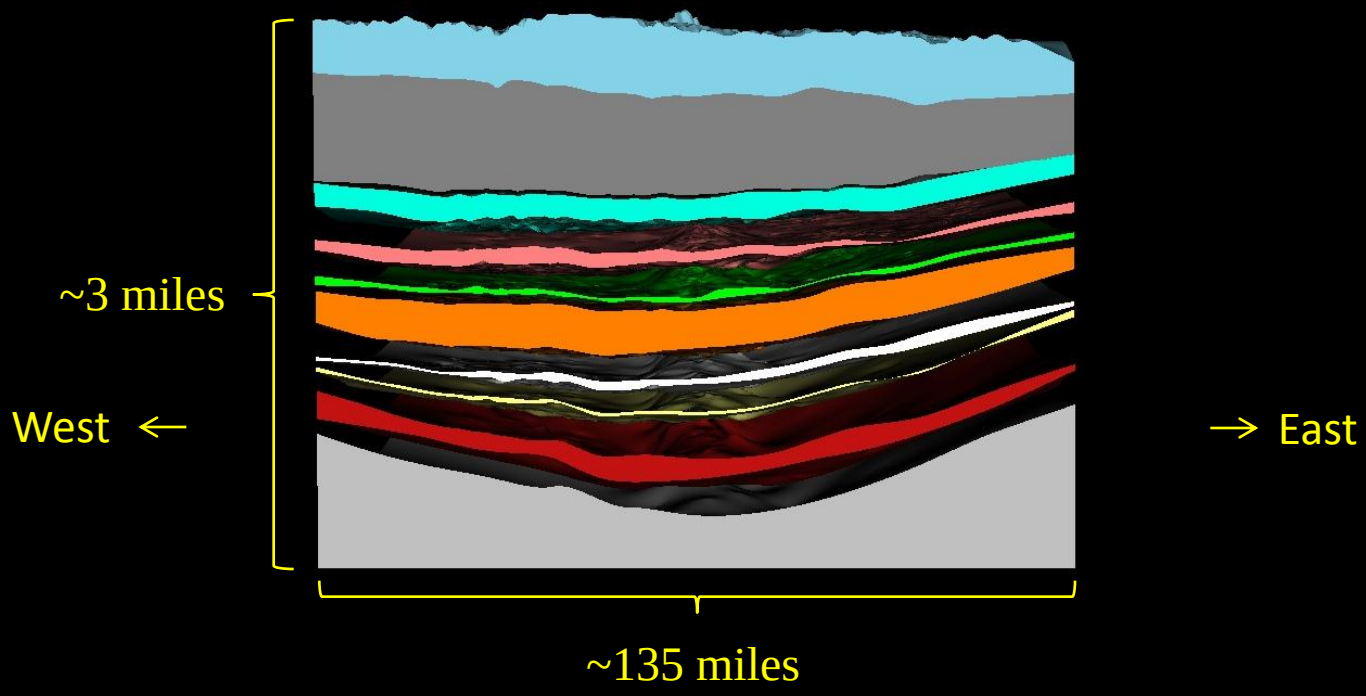

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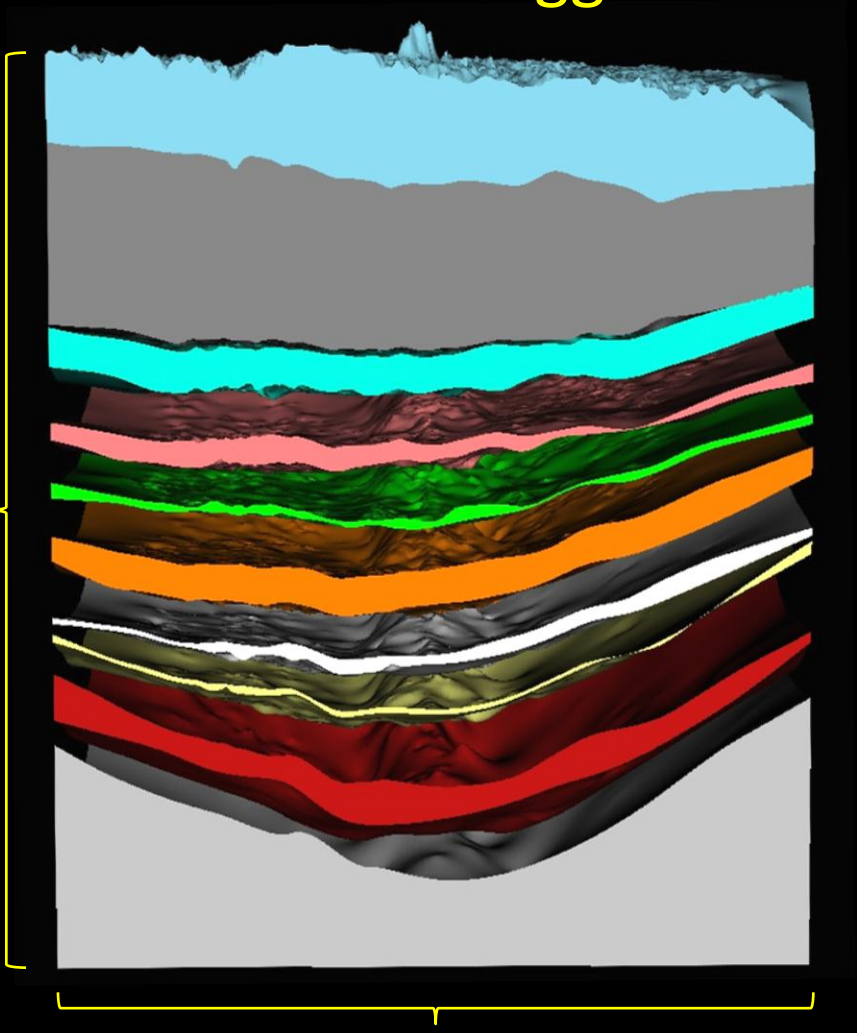
50:1 Vertical Exaggeration



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Three-Dimensional Model of Northwestern North Dakota

Uranium/Coal
Shallow Gas
Frac Propant
Geothermal

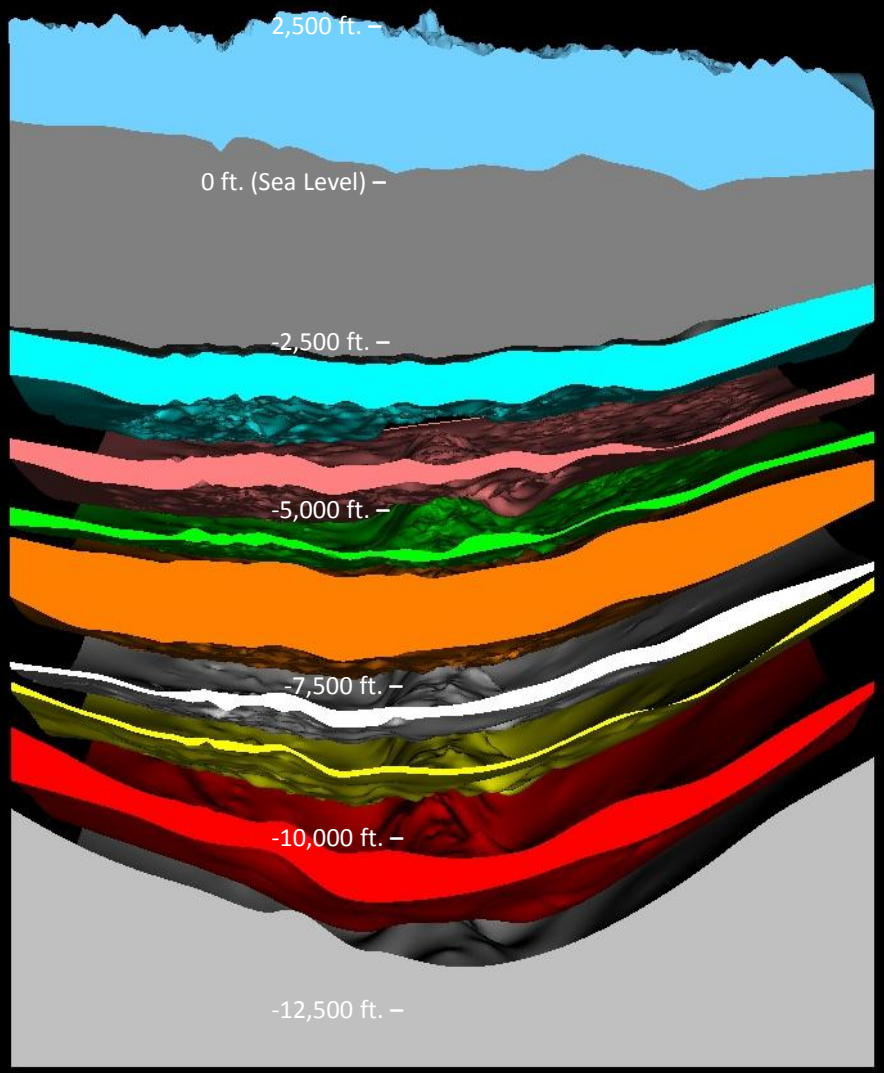
Salt-Water Disposal

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

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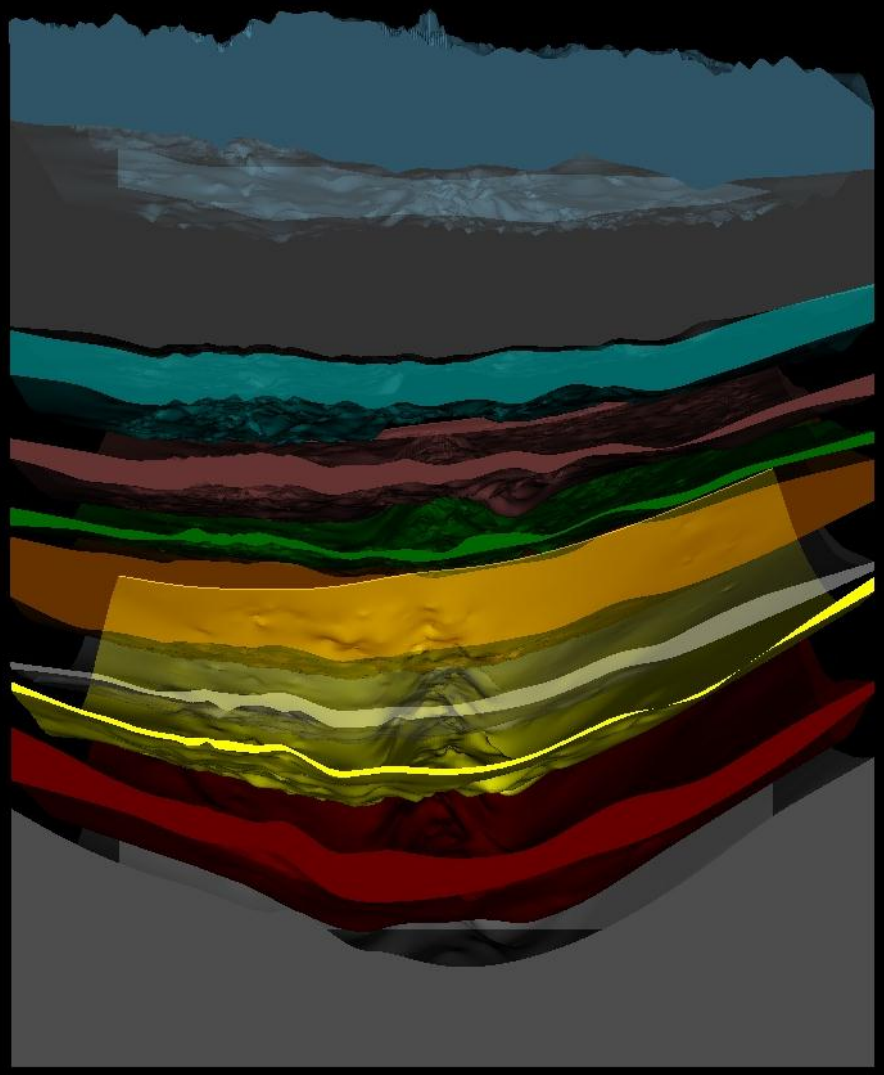

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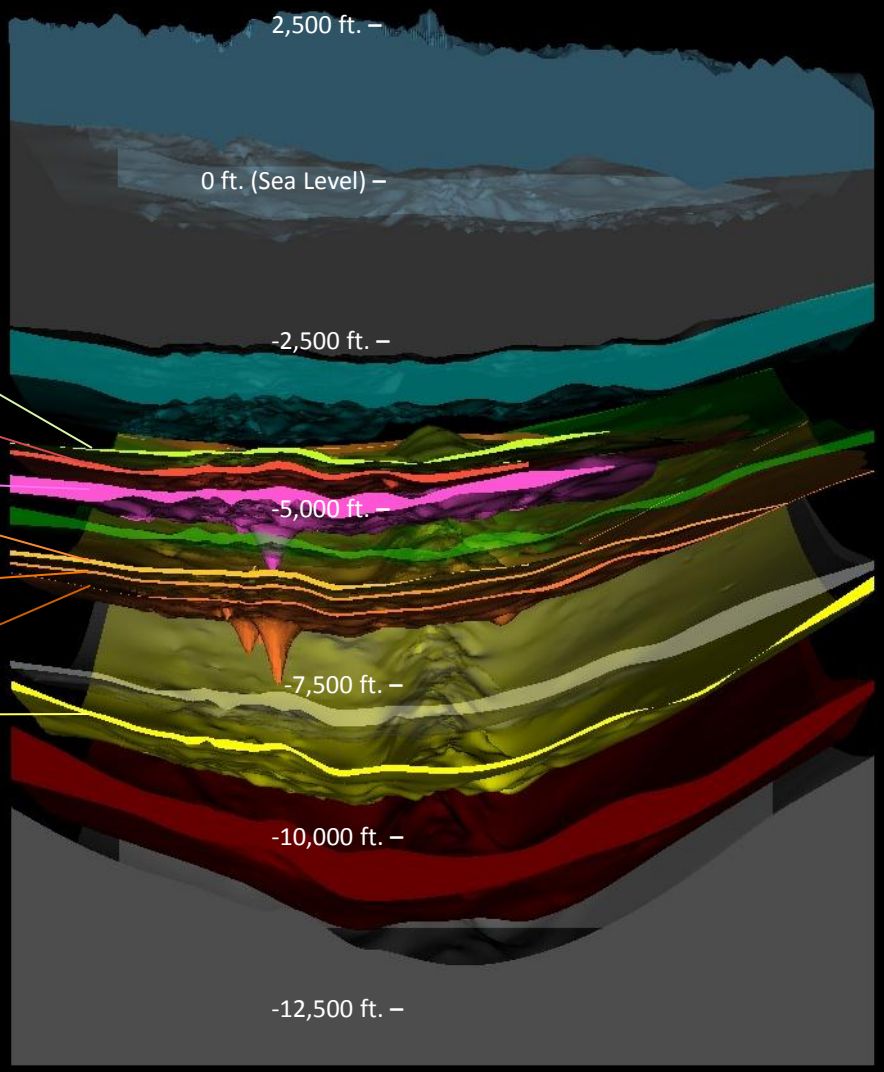
Significant Salt Intervals of Northwestern North Dakota

(Salt Intervals that extend >5,000 square miles and average >40 ft. in thickness)



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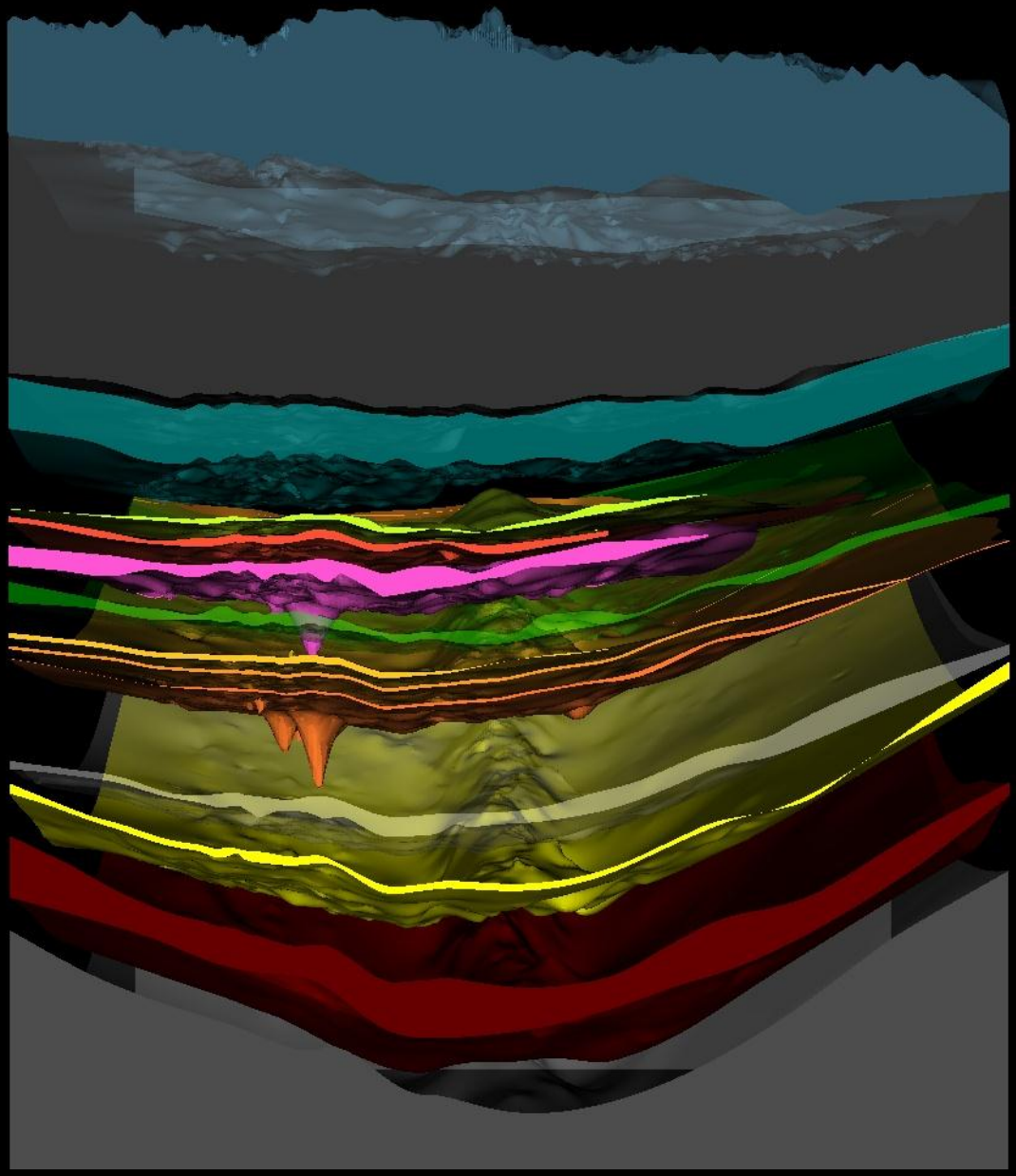

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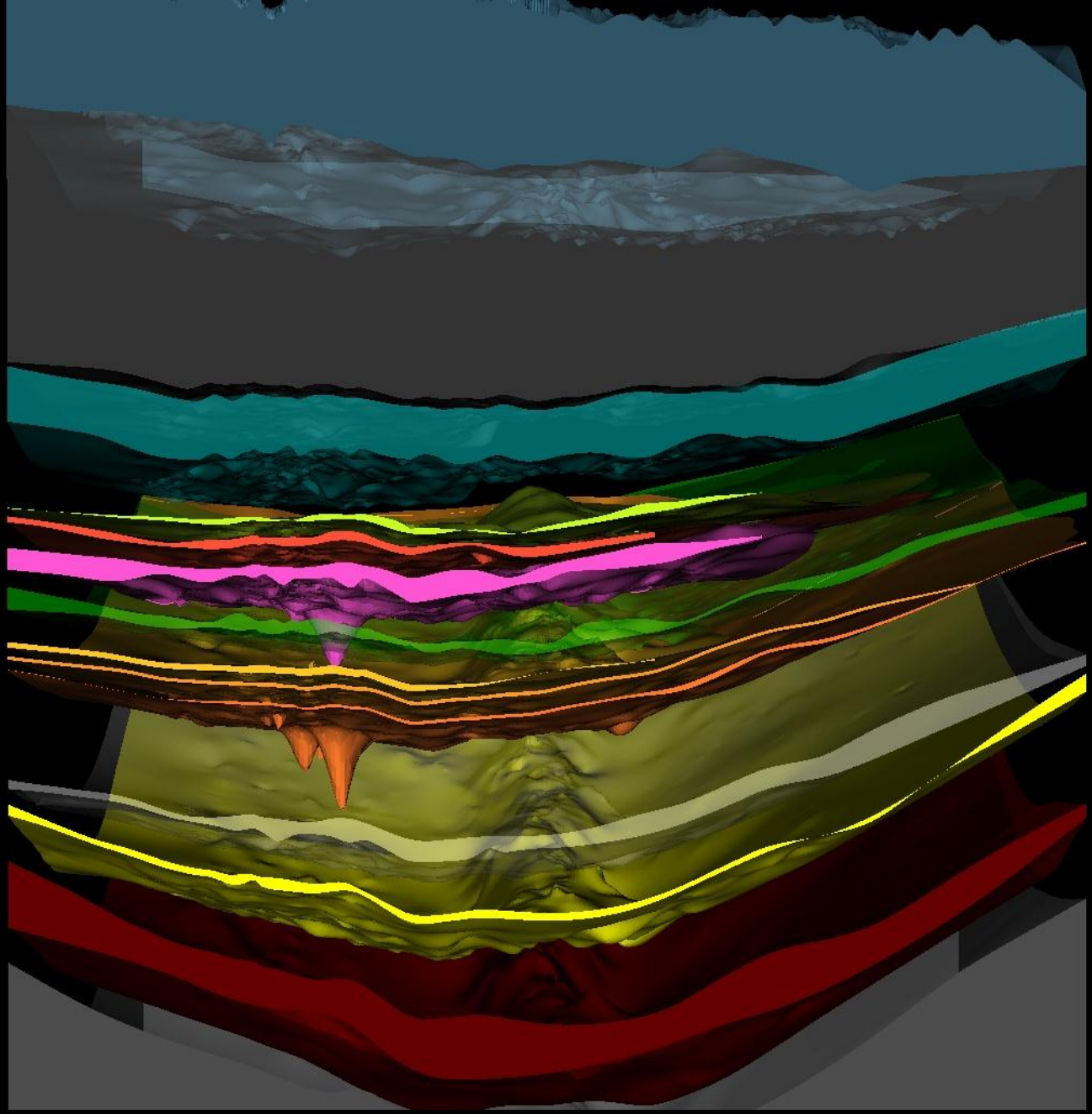

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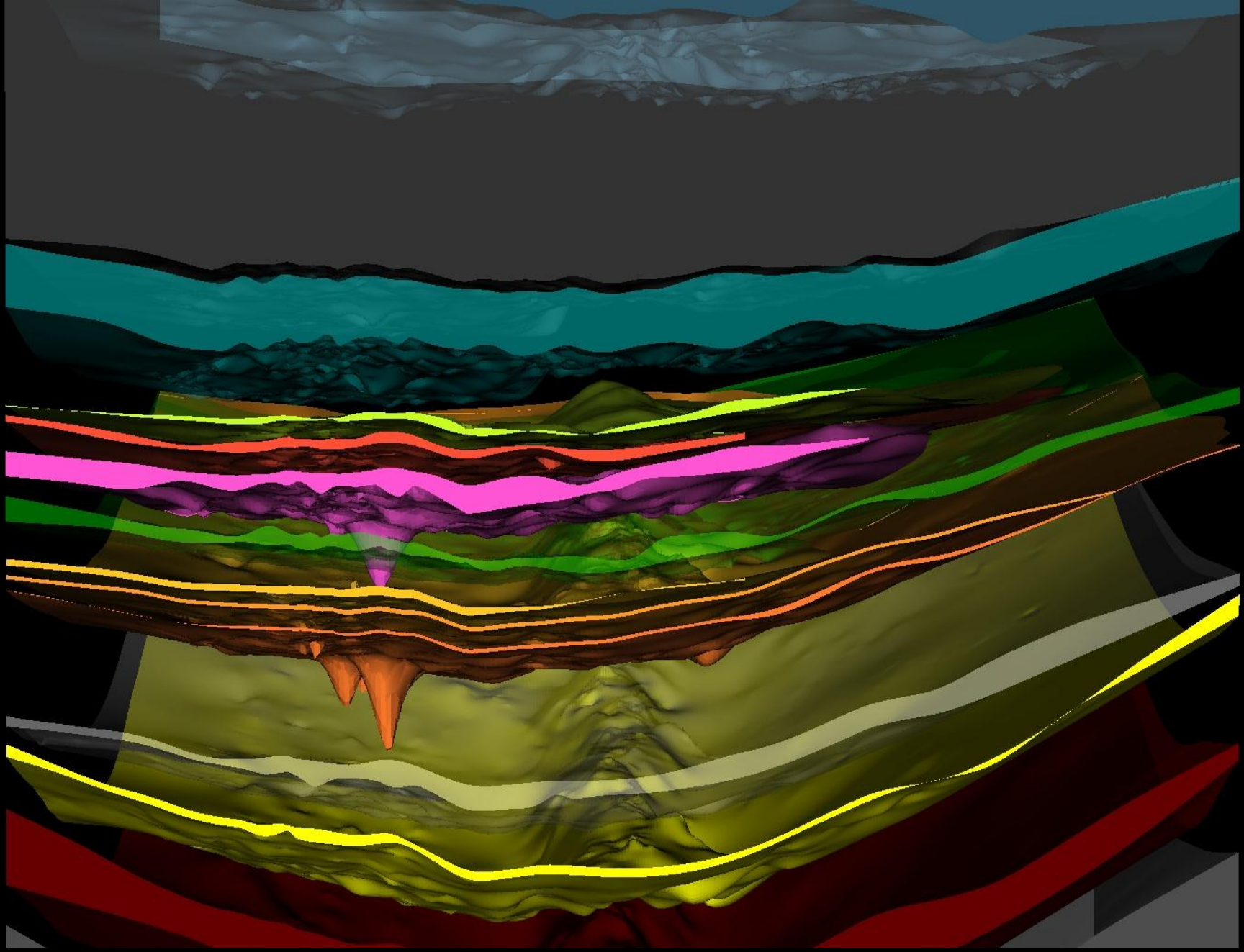

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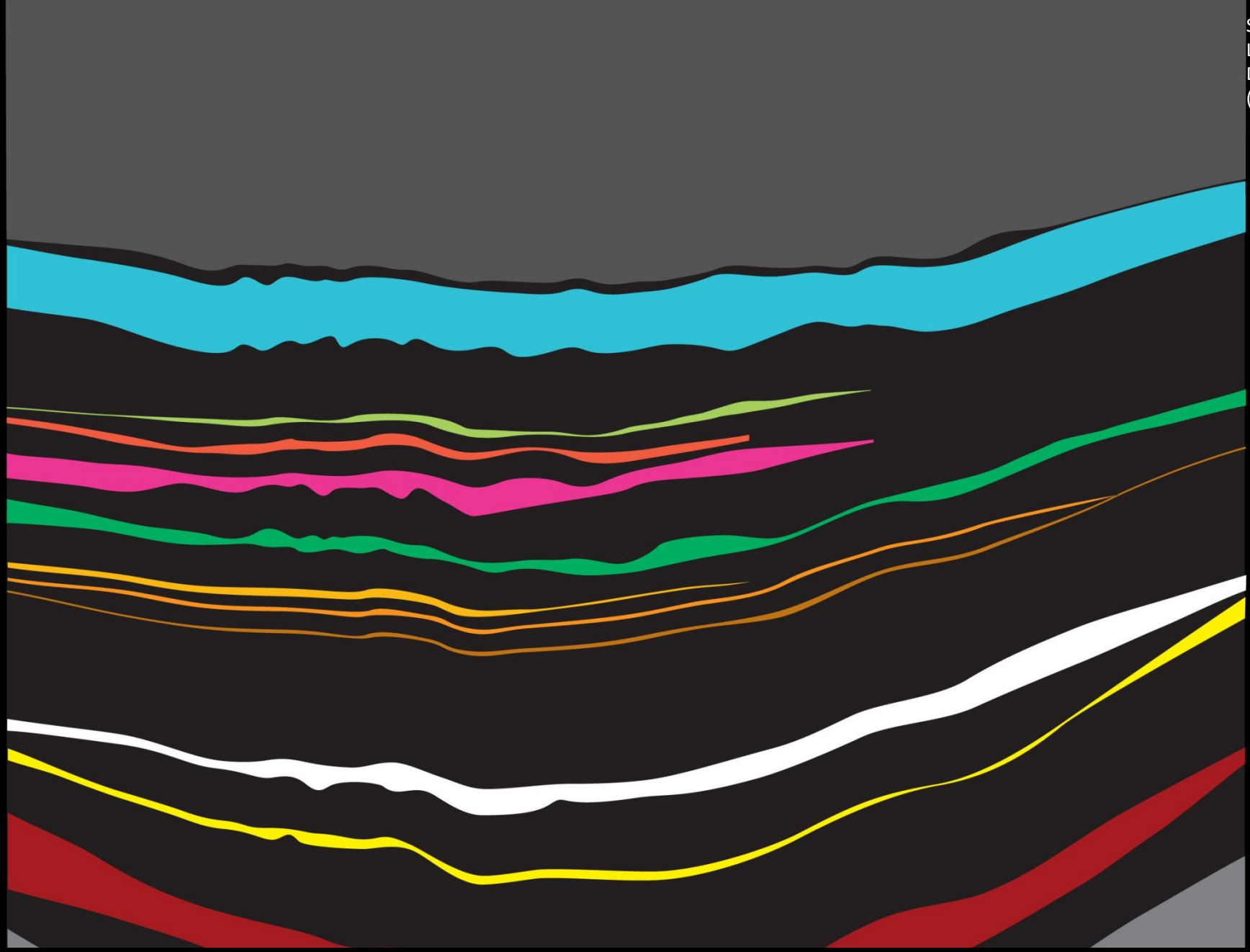

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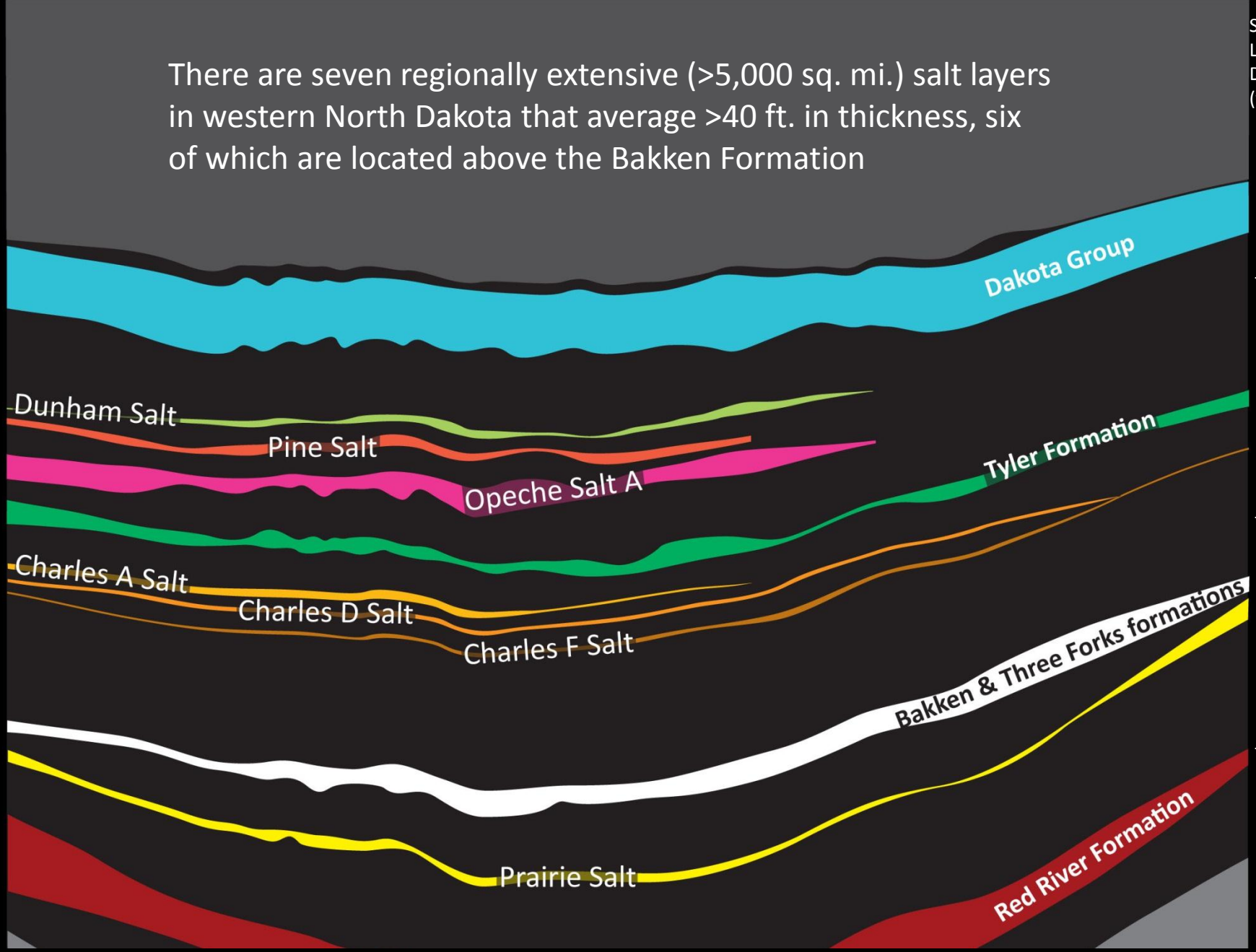
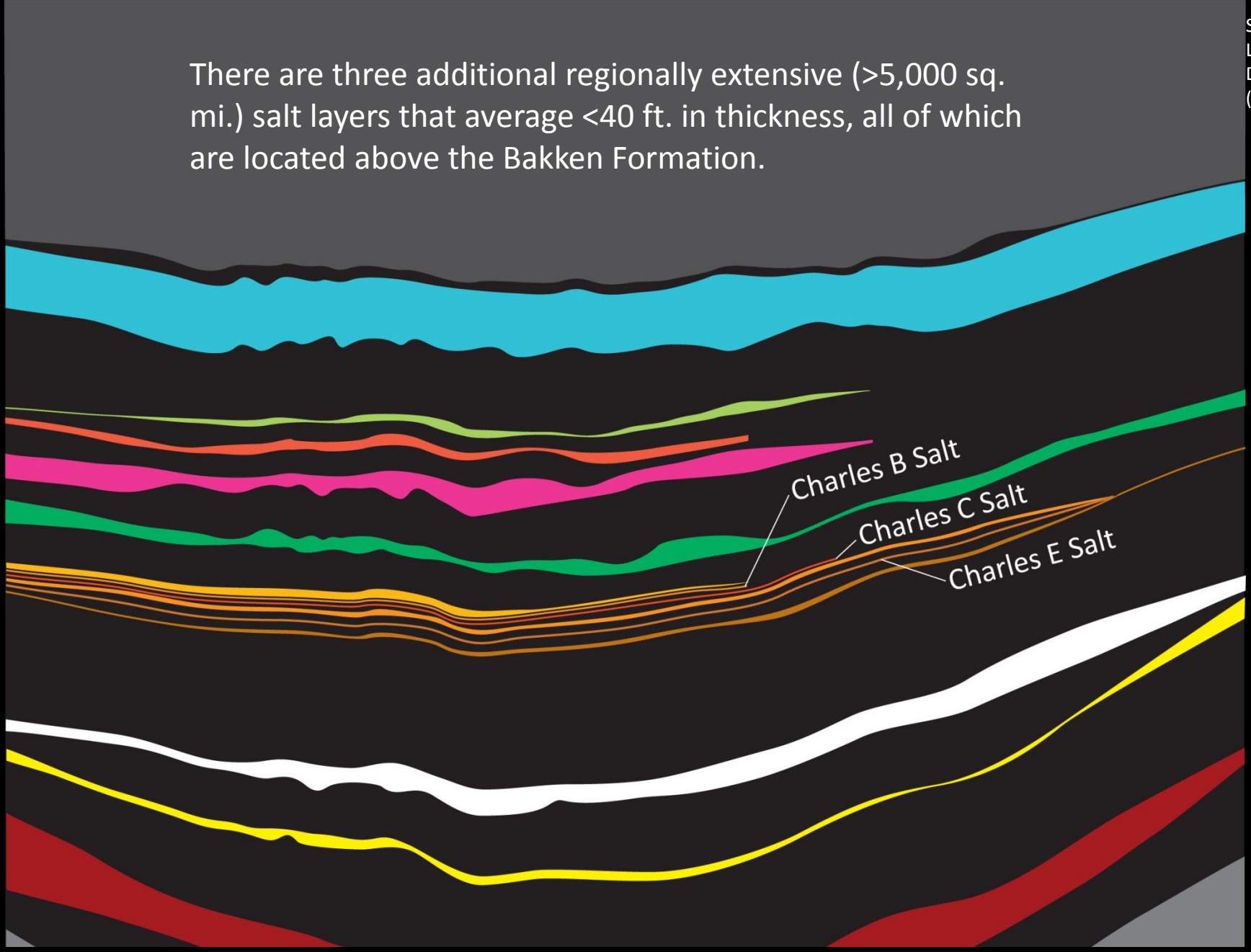
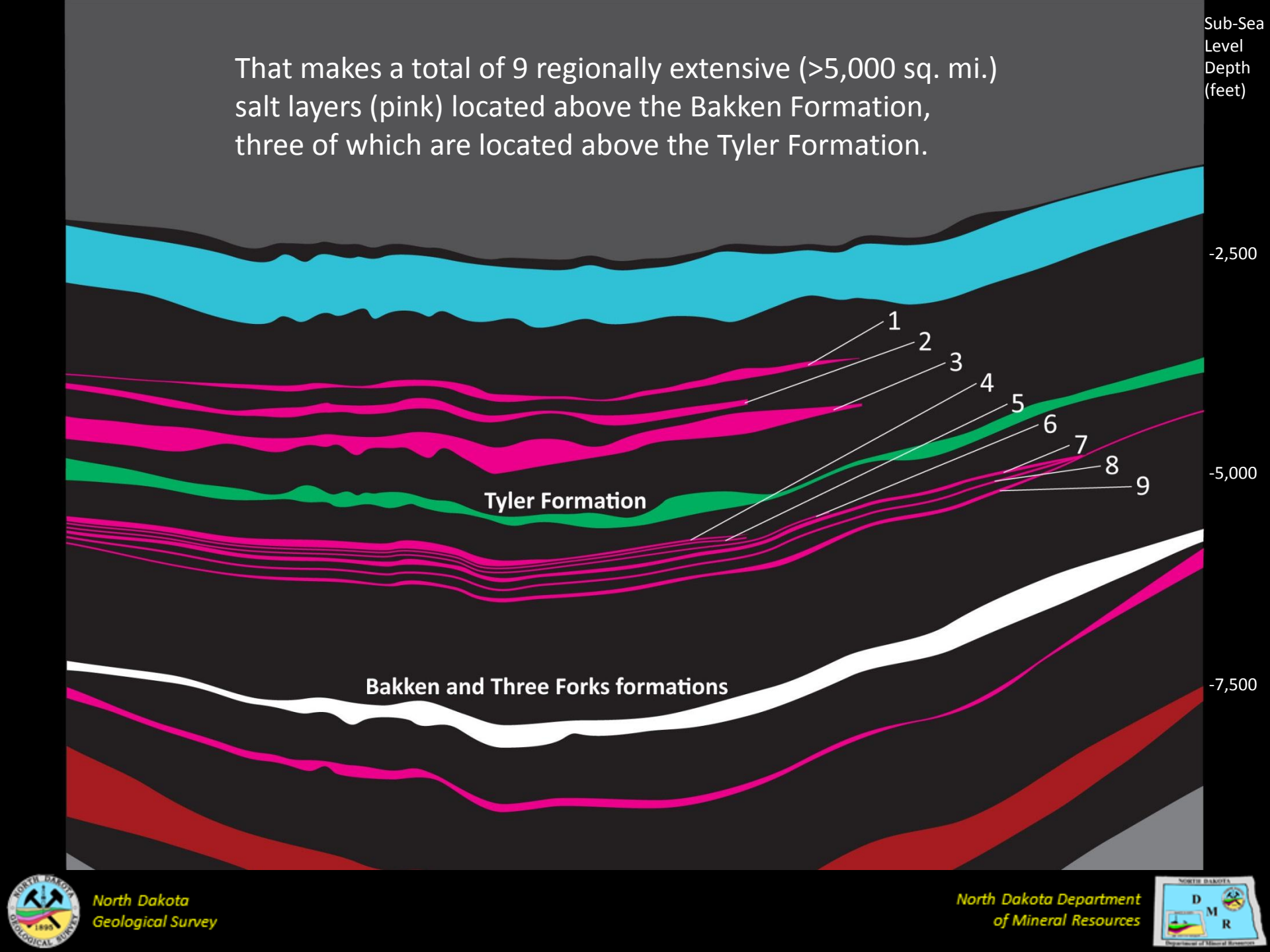
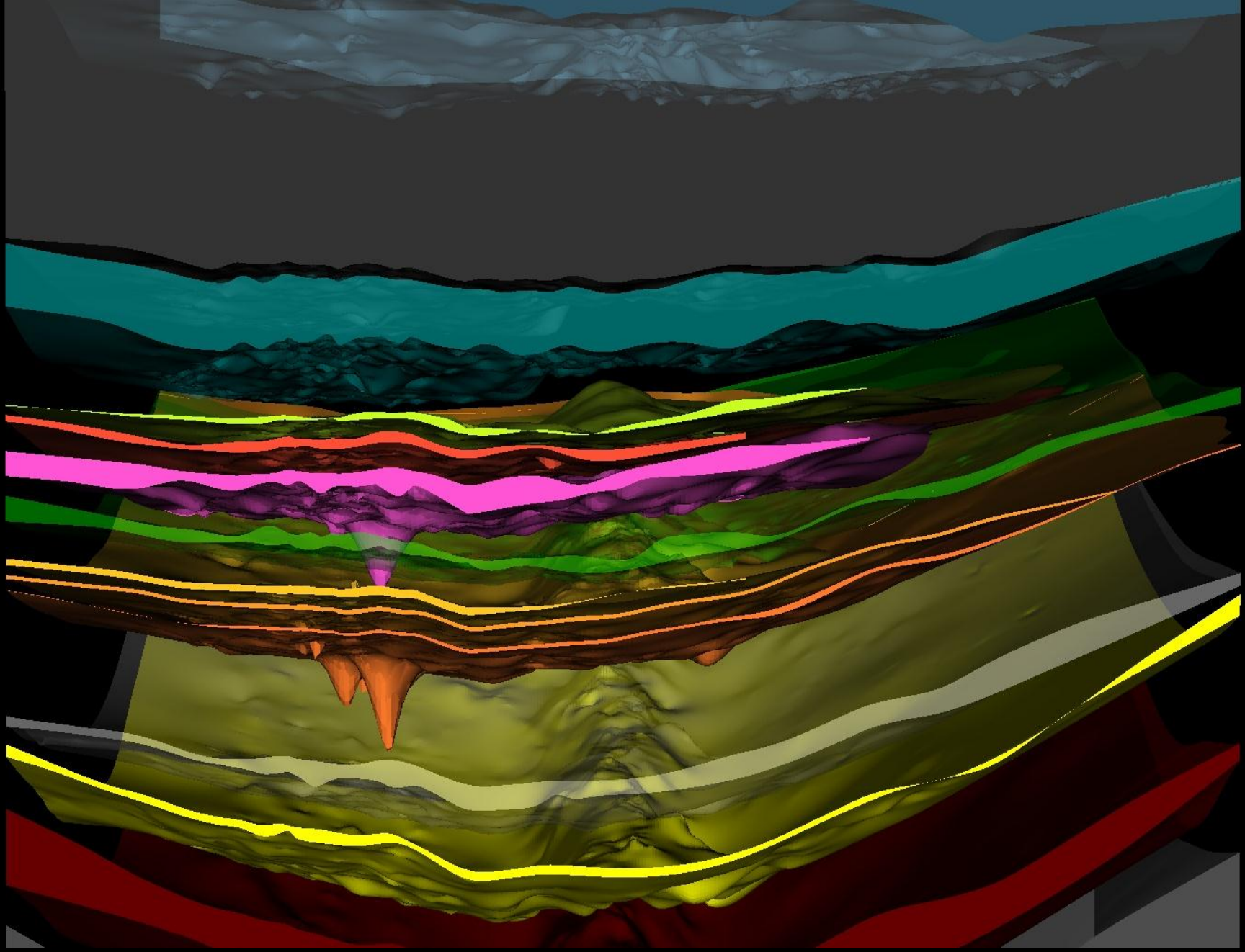

There are seven regionally extensive (>5,000 sq. mi.) salt layers in western North Dakota that average >40 ft. in thickness, six of which are located above the Bakken Formation
Sub-Sea Level Depth (feet)
-2,500
-5,000
-7,500
Dakota Group
Dunham Salt
Pine Salt
Opeche Salt A
Tyler Formation
Charles A Salt
Charles D Salt
Charles F Salt
Bakken & Three Forks formations
Prairie Salt
Red River Formation

There are three additional regionally extensive (>5,000 sq. mi.) salt layers that average <40 ft. in thickness, all of which are located above the Bakken Formation.




That makes a total of 9 regionally extensive (>5,000 sq. mi.) salt layers (pink) located above the Bakken Formation, three of which are located above the Tyler Formation.
Sub-Sea Level Depth (feet)
-2,500
-5,000
-7,500
1
2
3
4
5
6
7
8
9
Tyler Formation
Bakken and Three Forks formations



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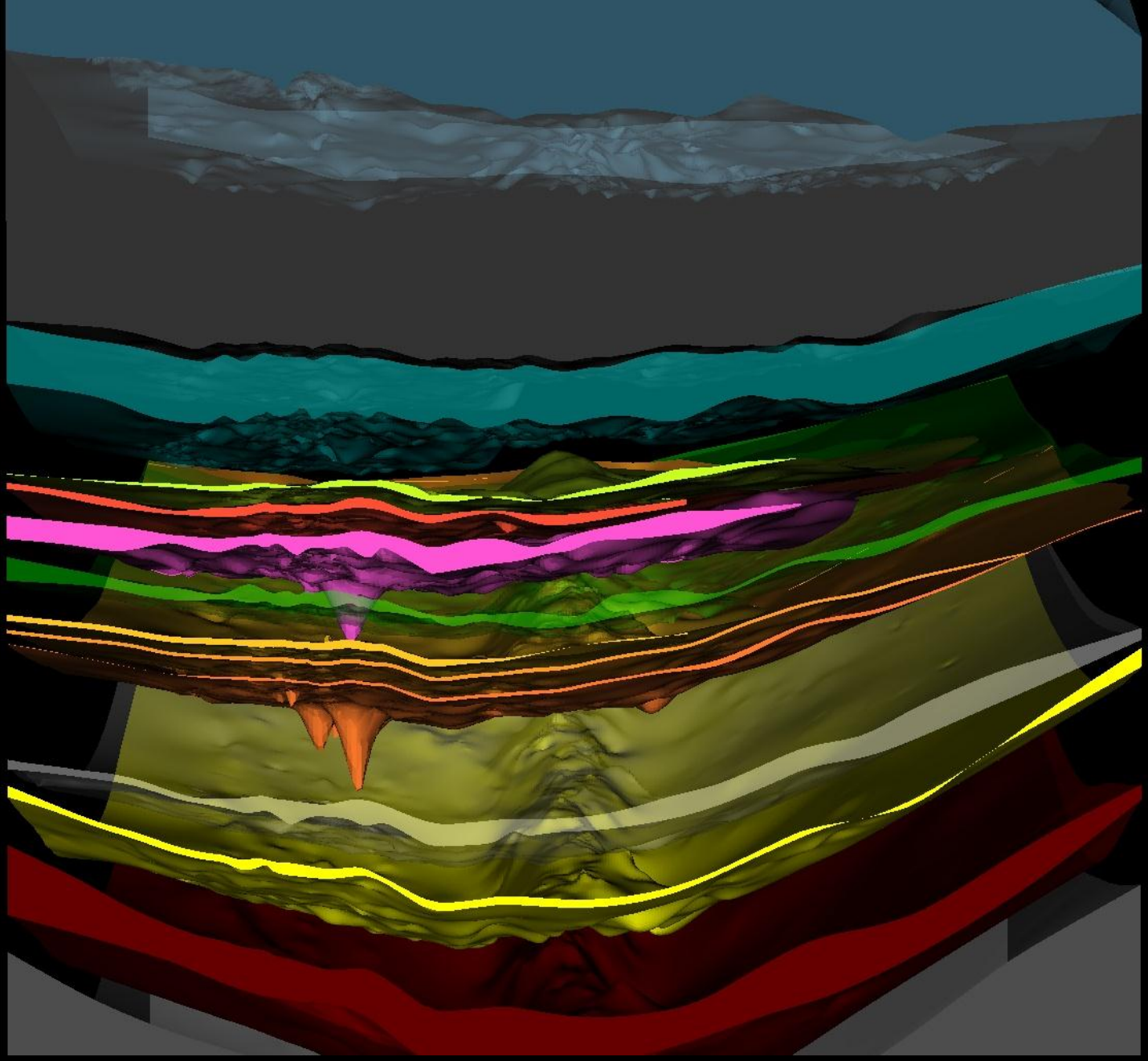

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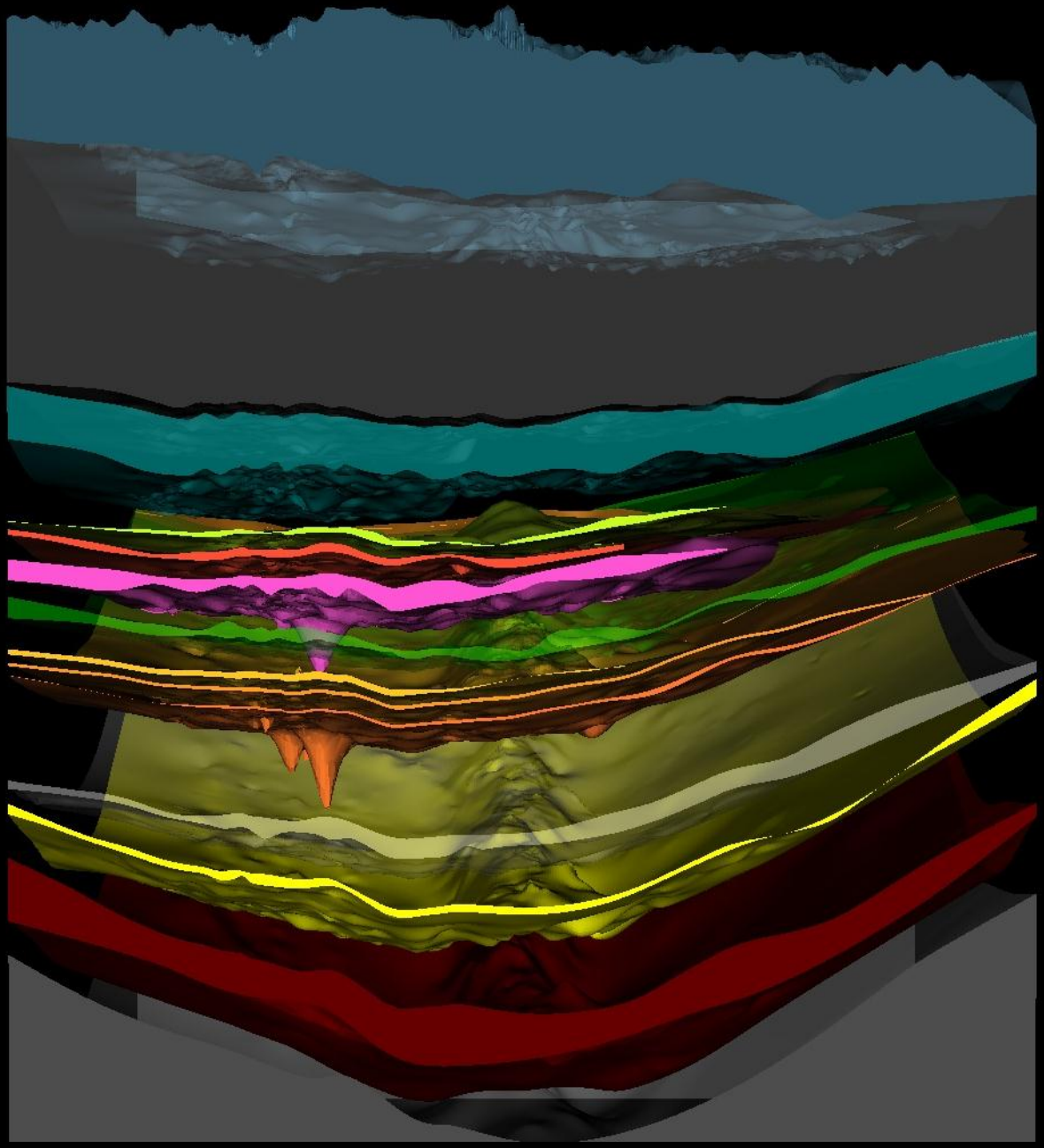

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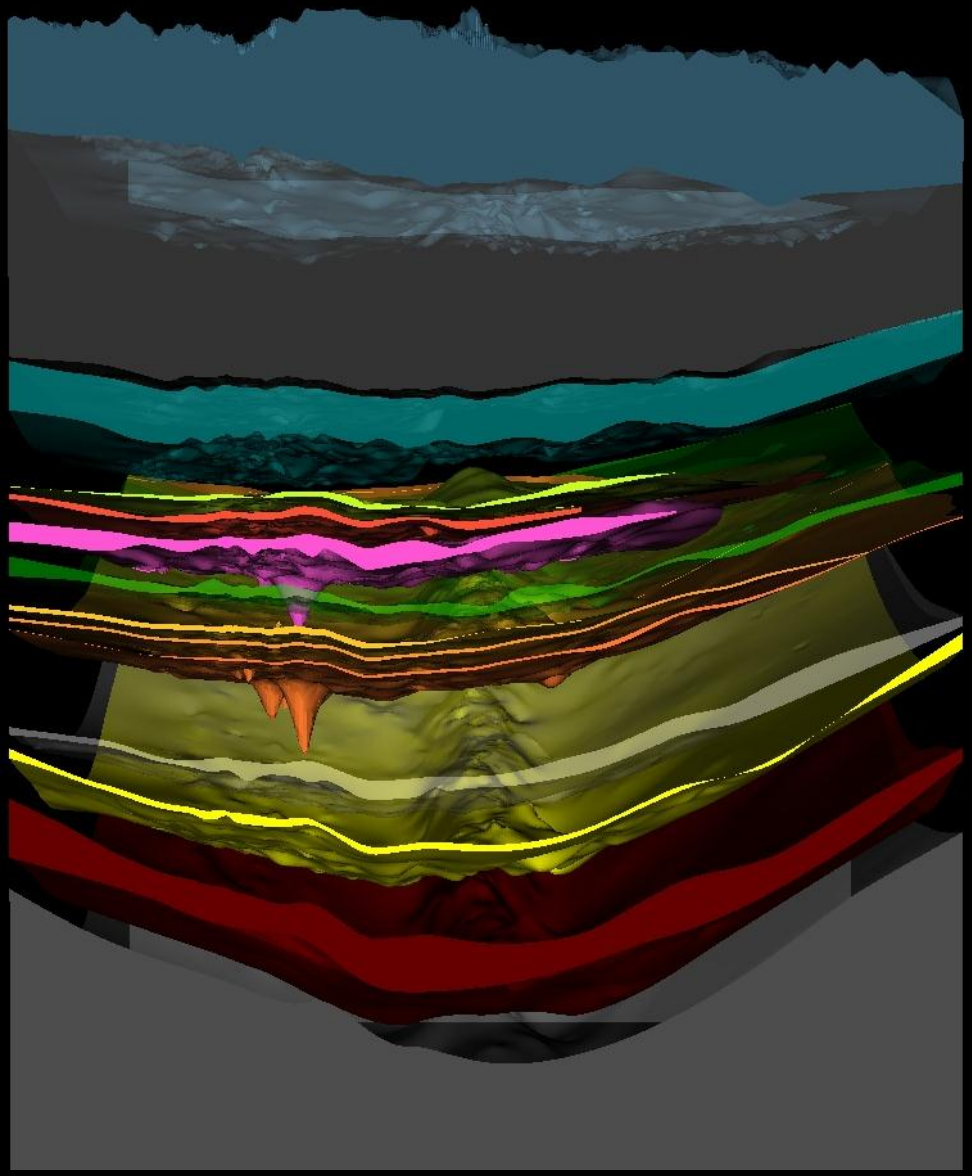

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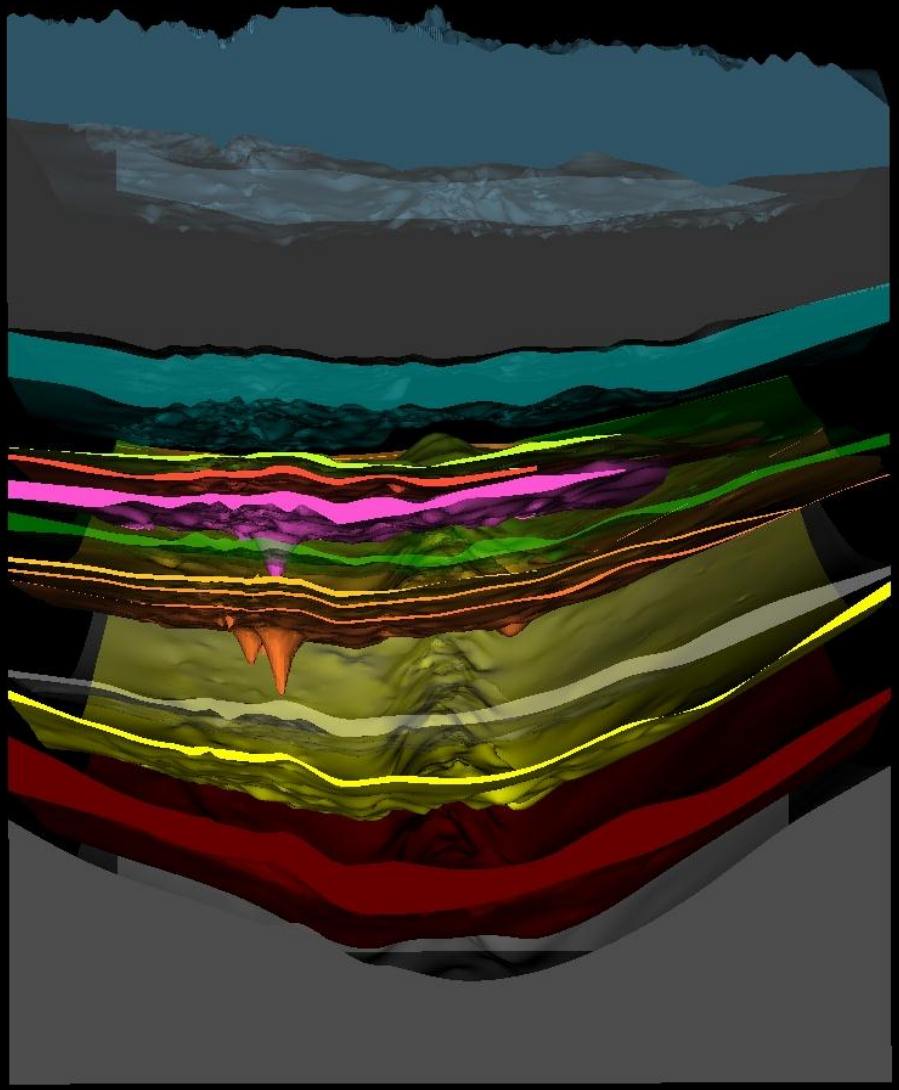

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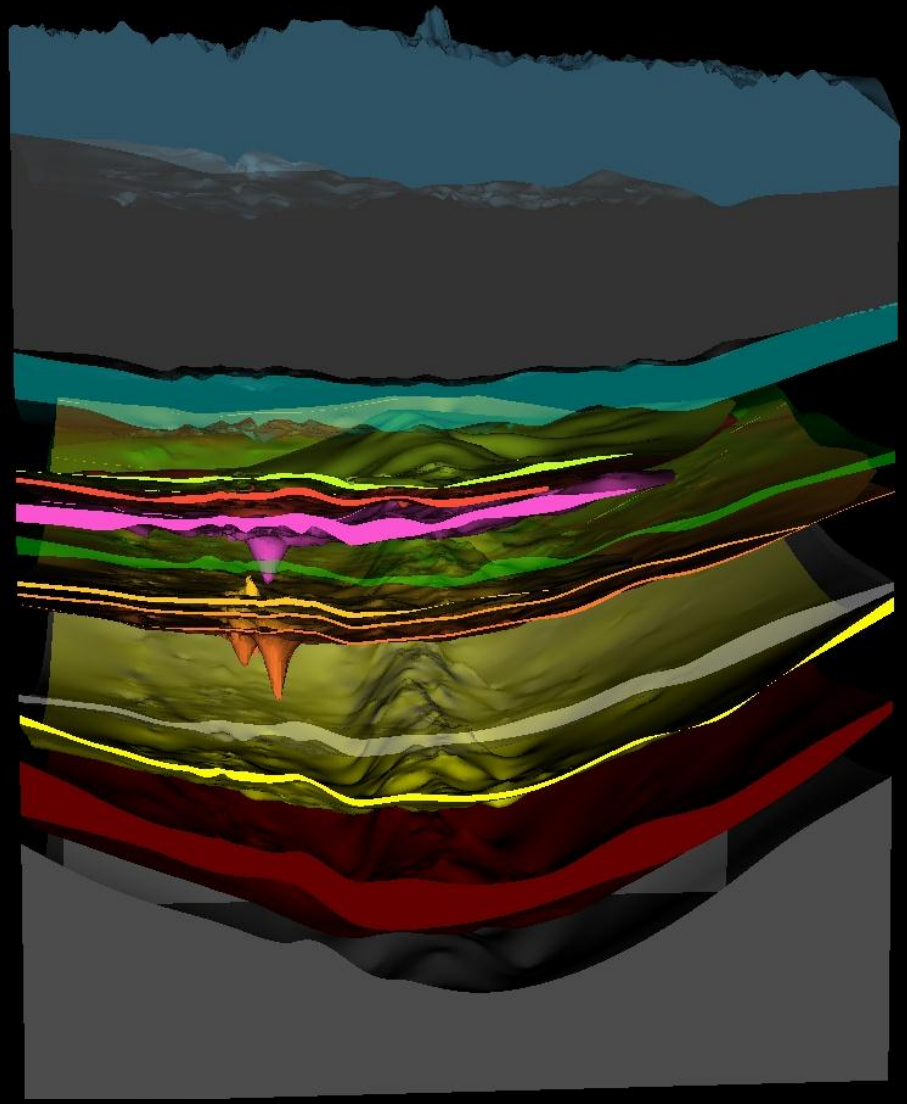

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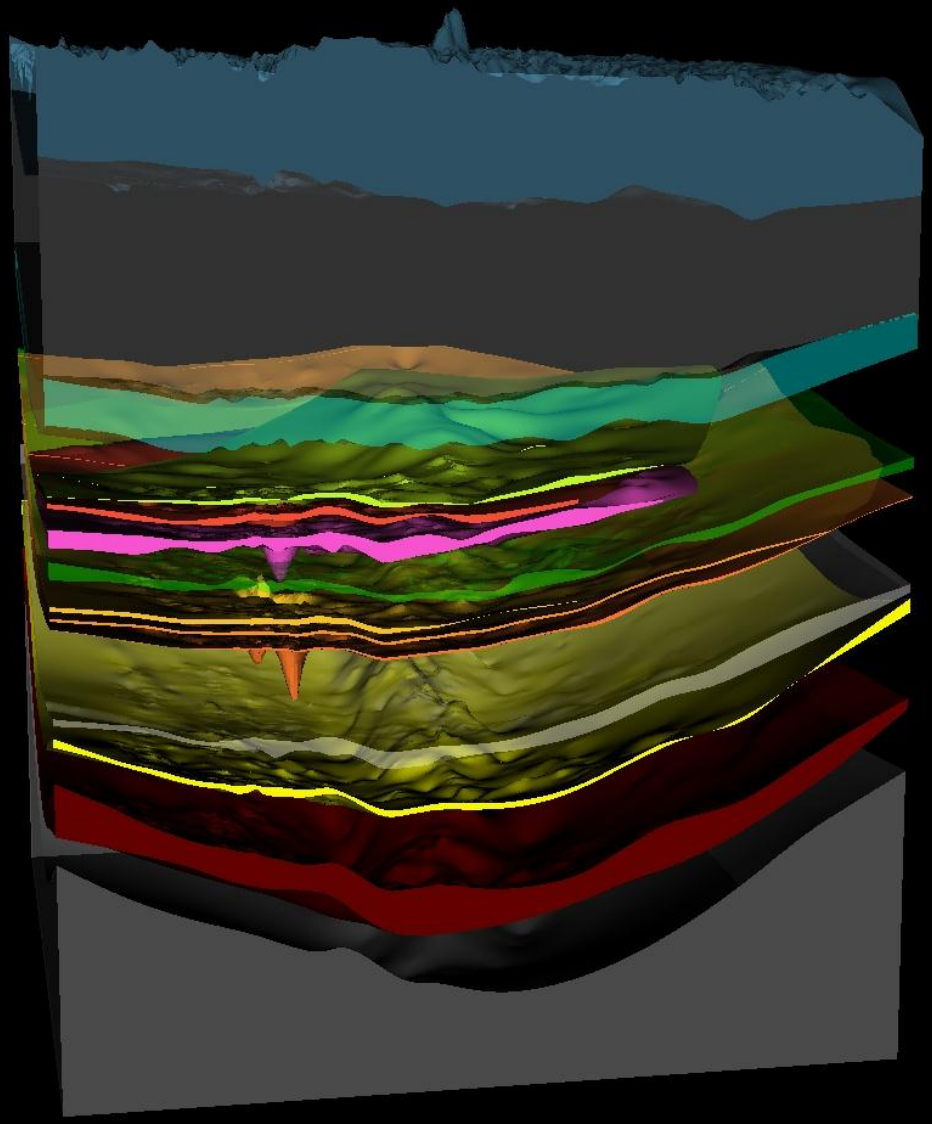

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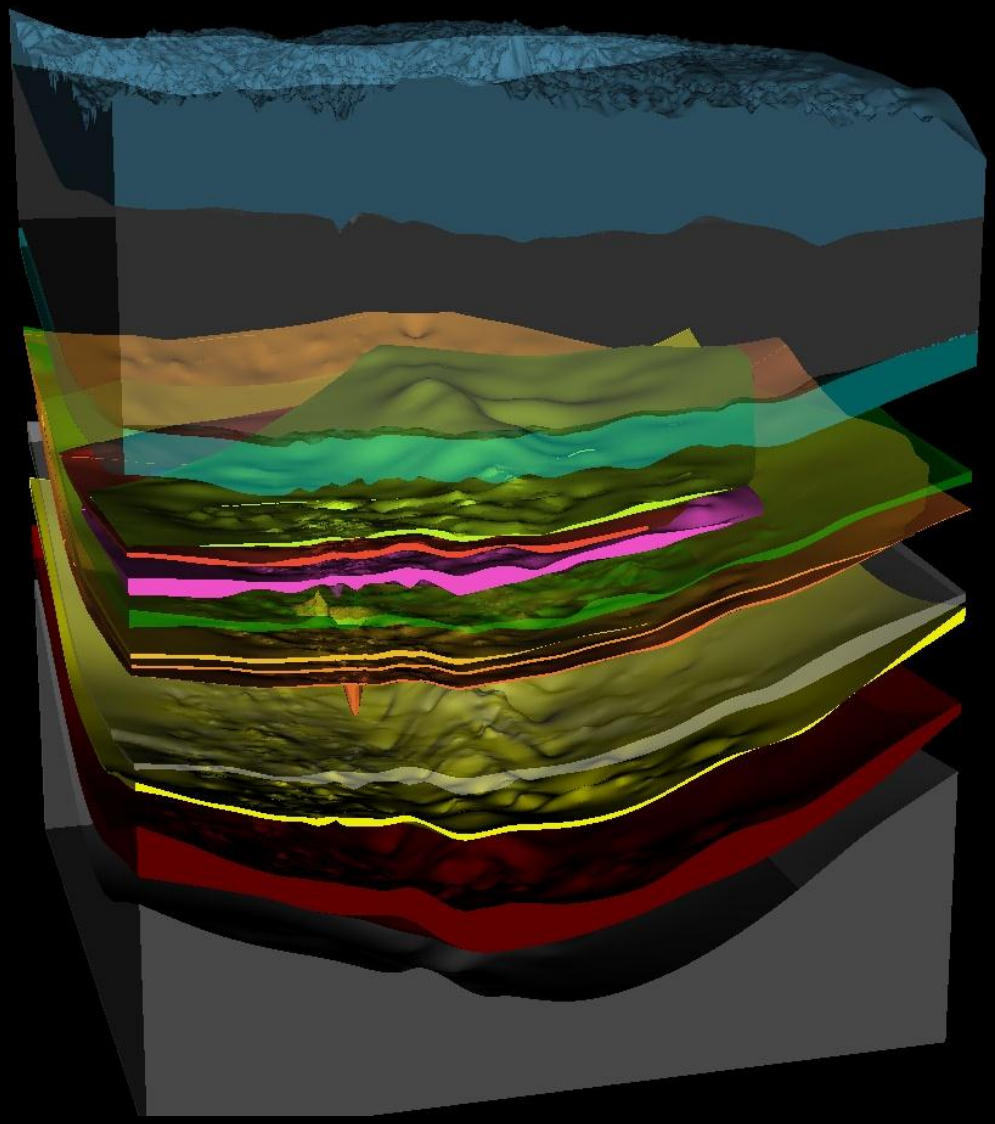

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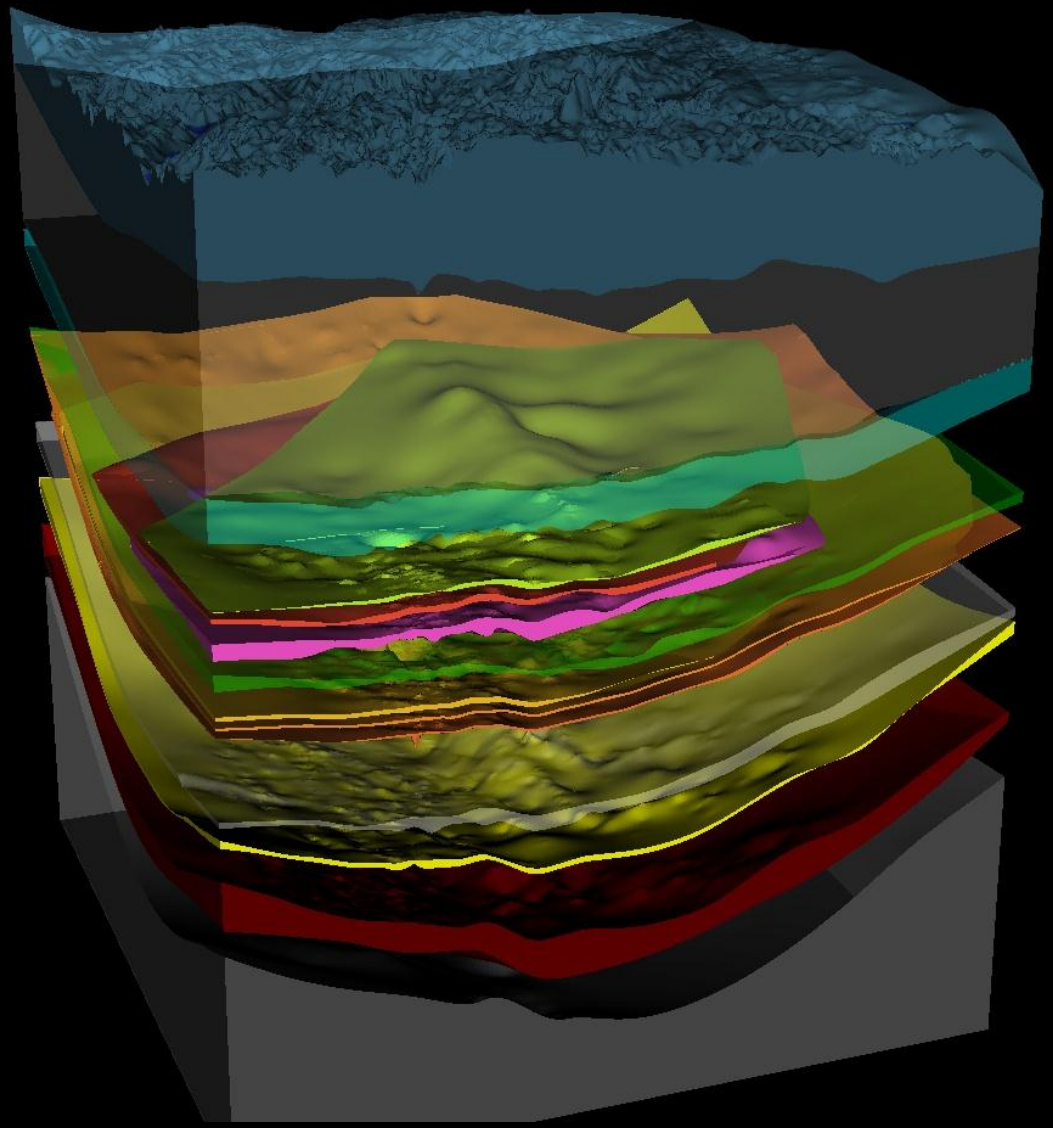

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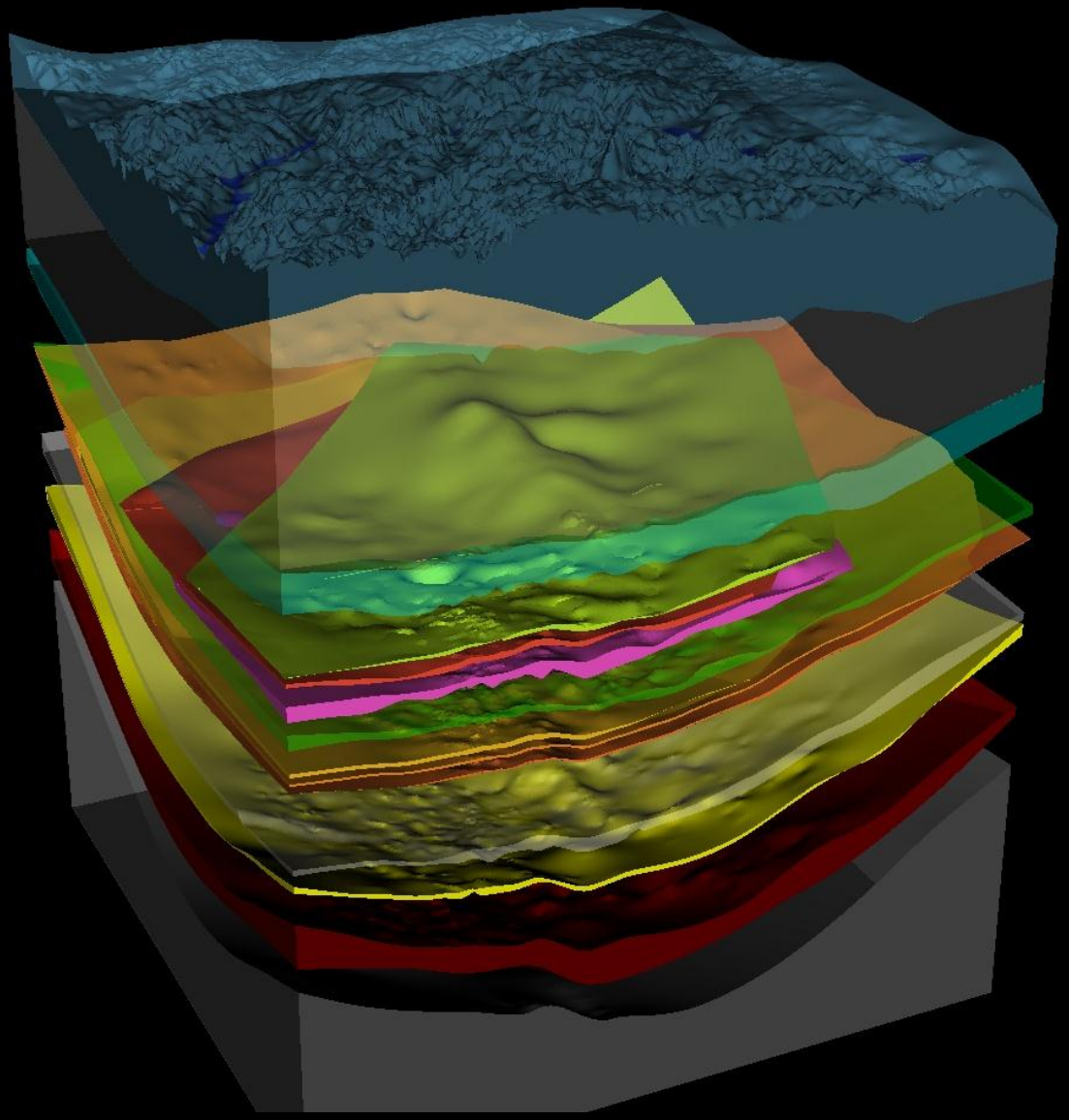

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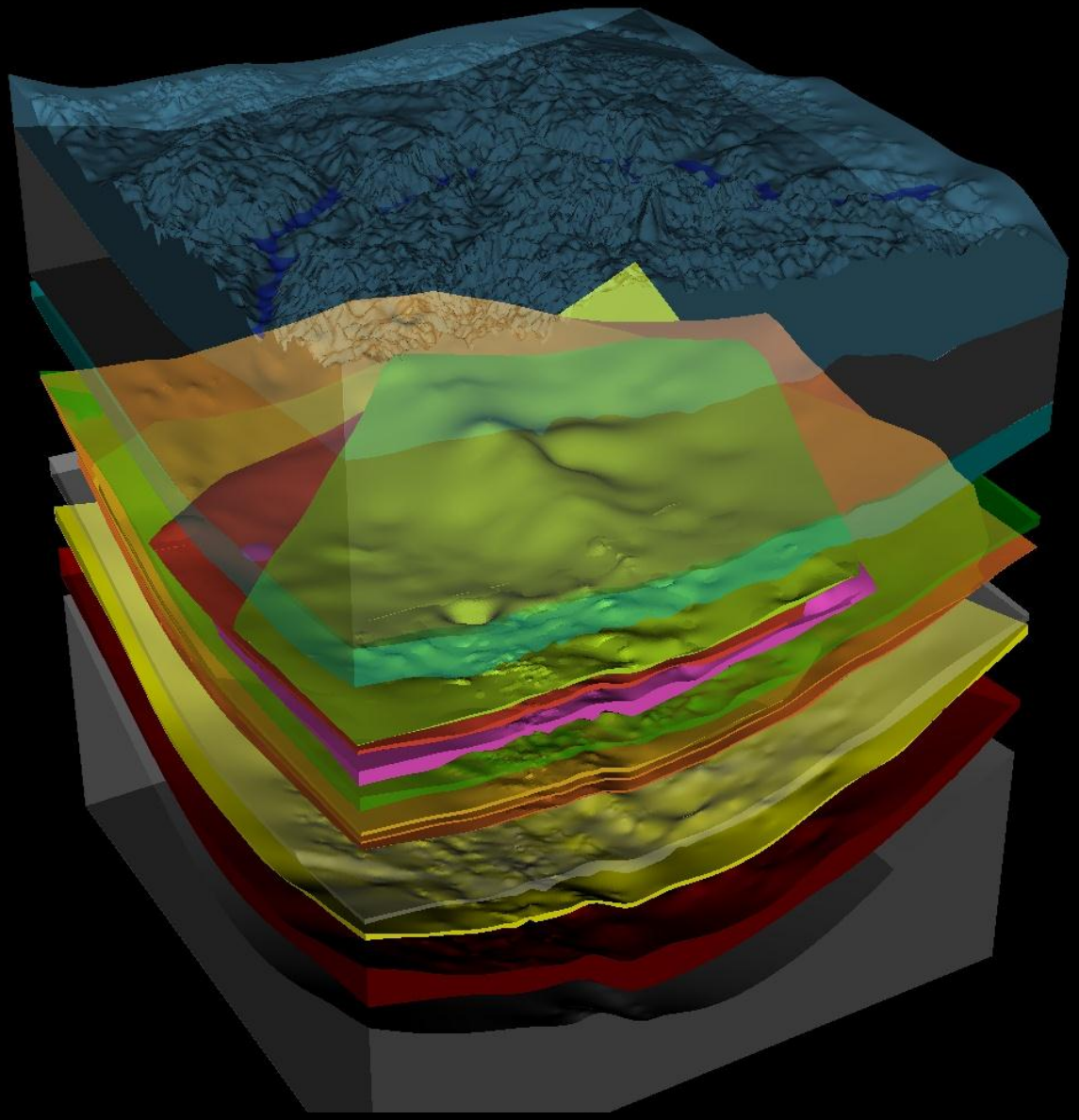

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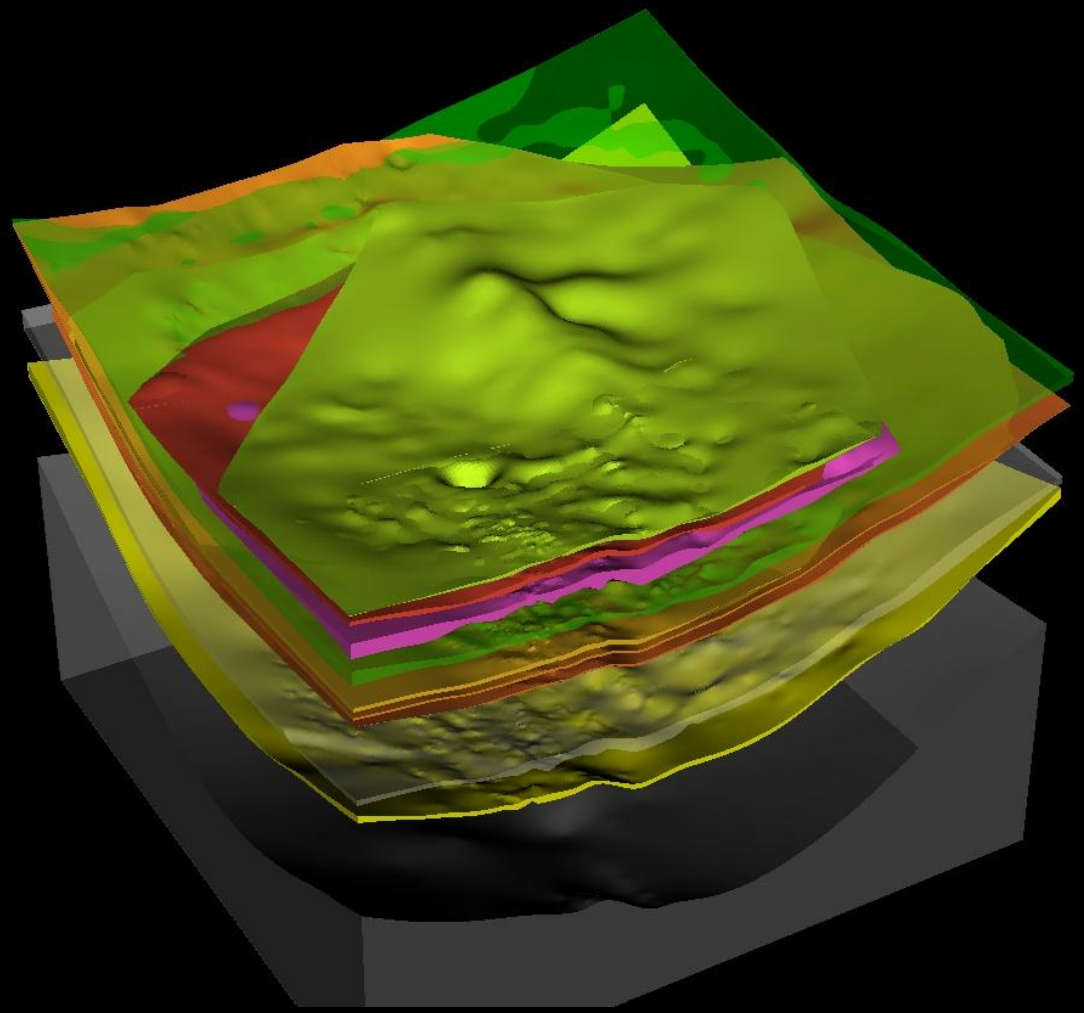
Piper Fm.

Dunham Salt



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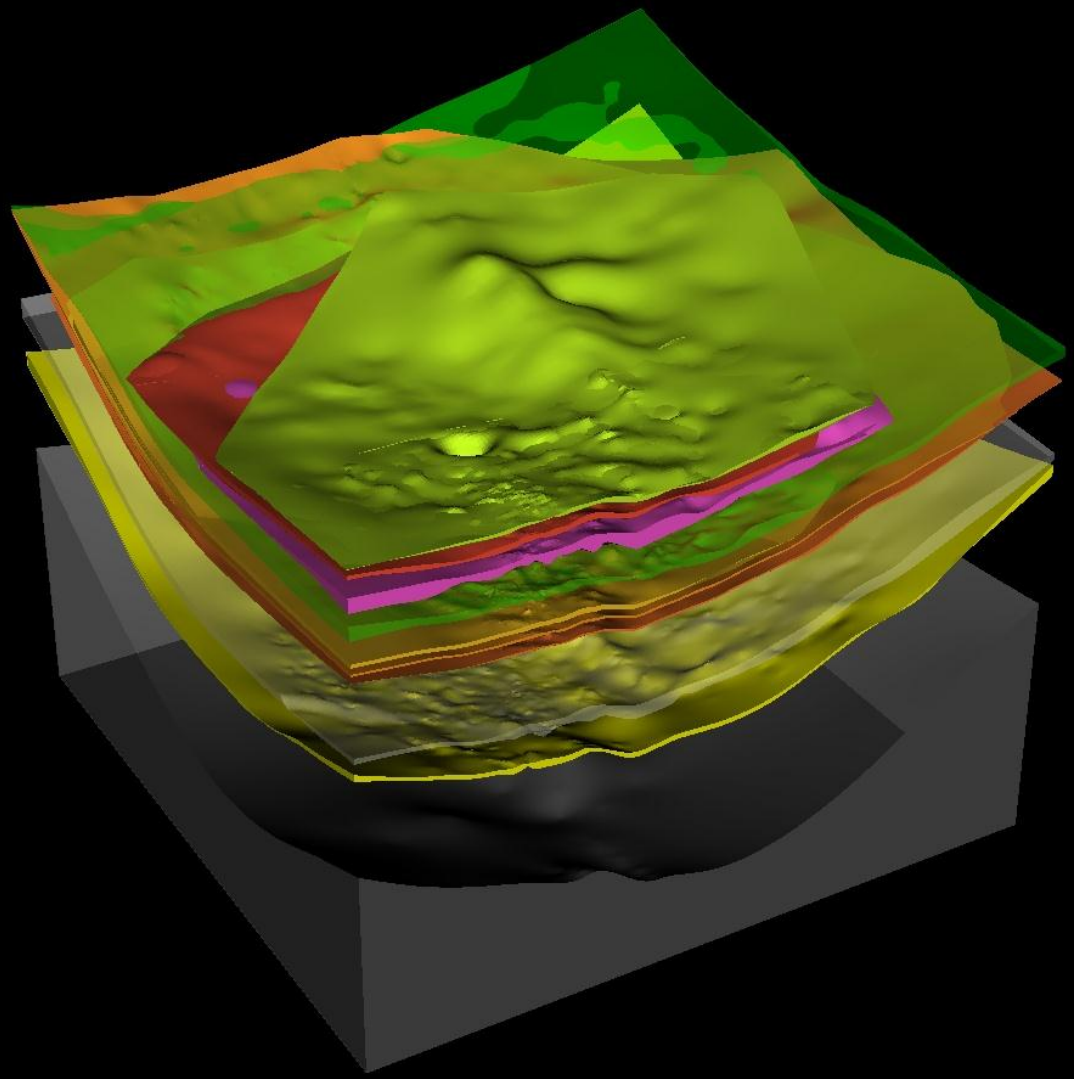
Piper Fm.

Dunham Salt



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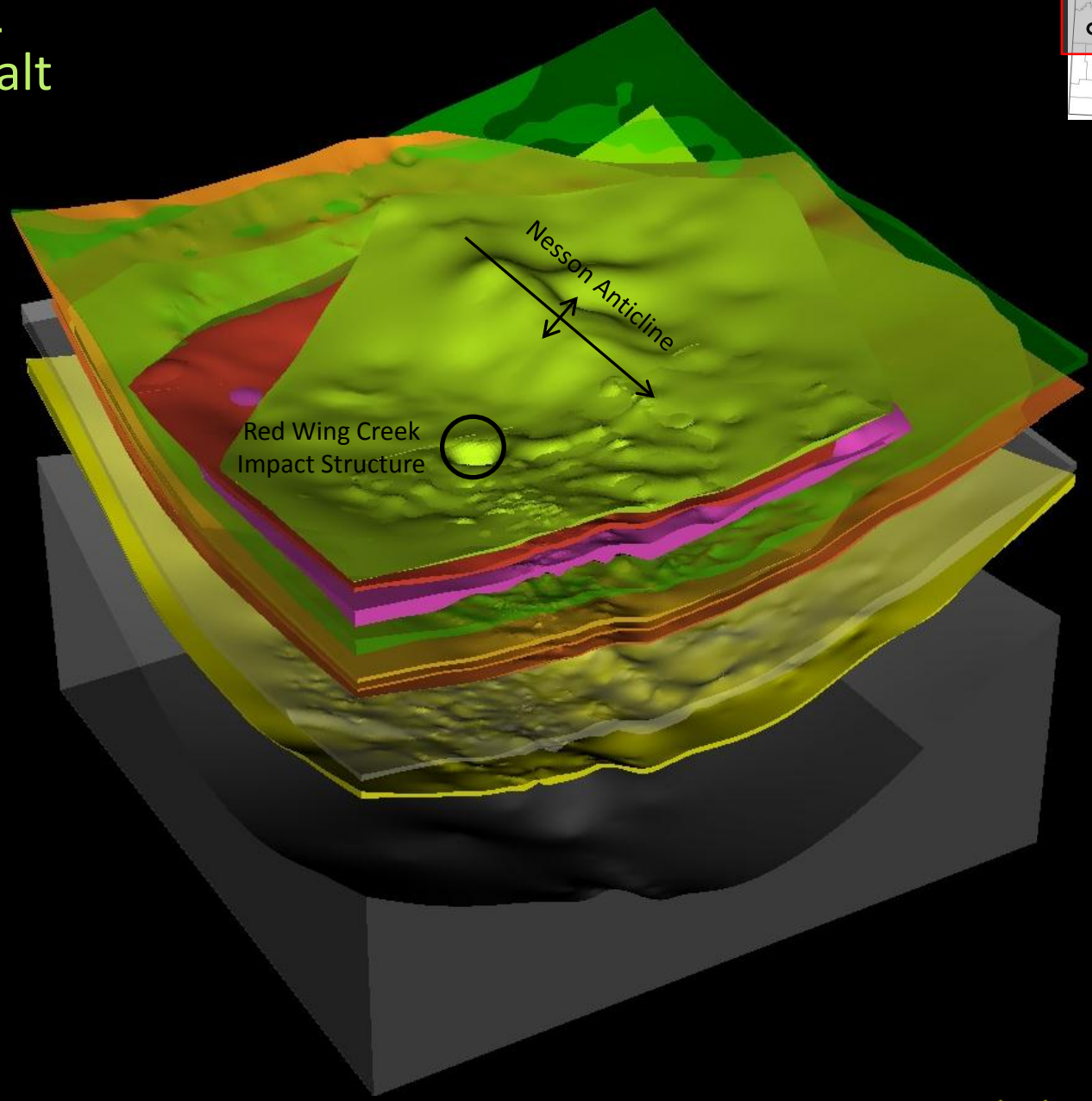
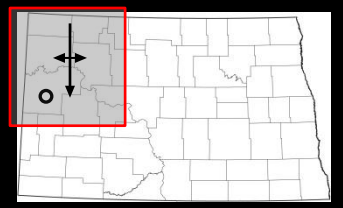
Dunham Salt





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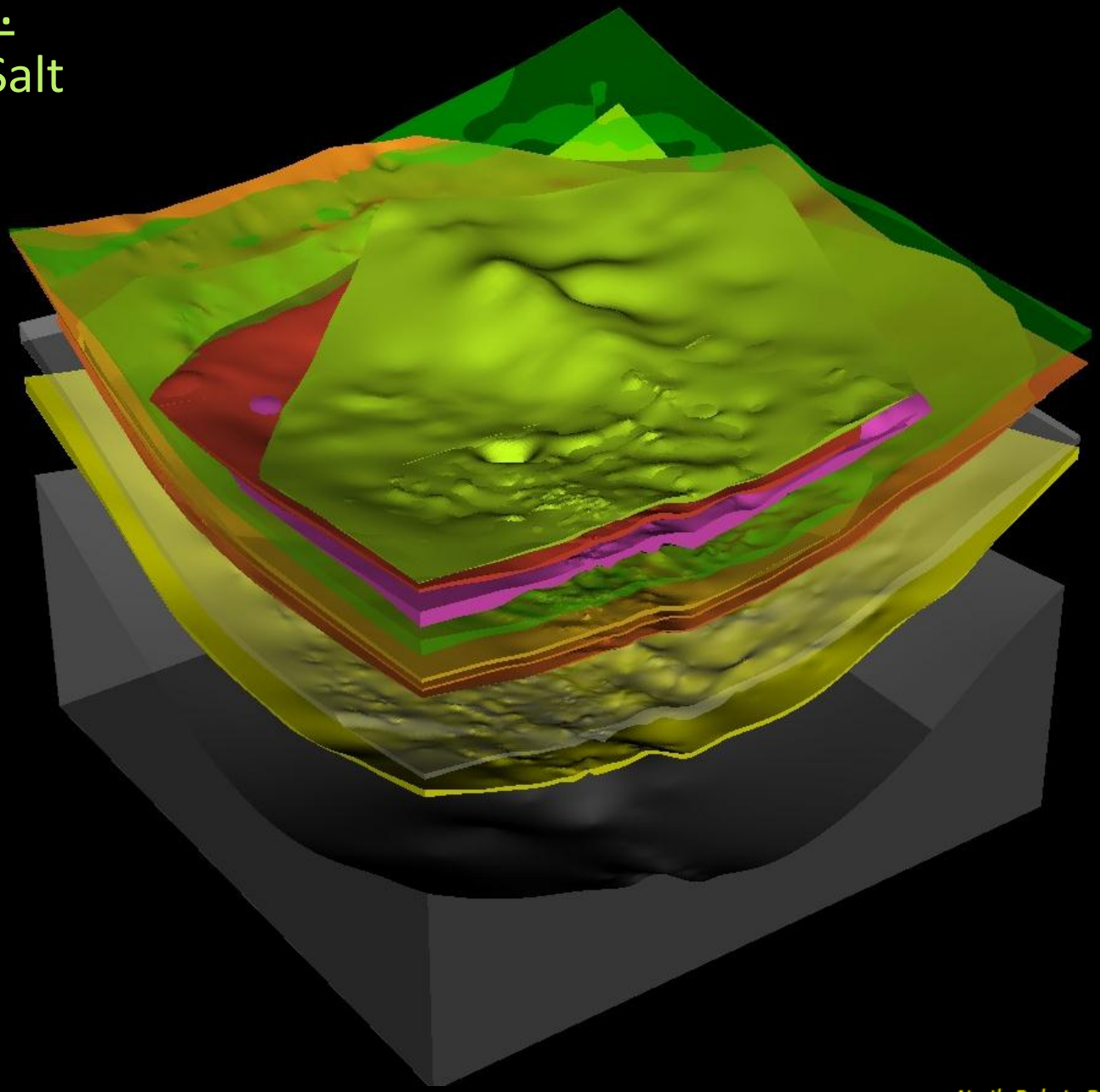
Dunham Salt



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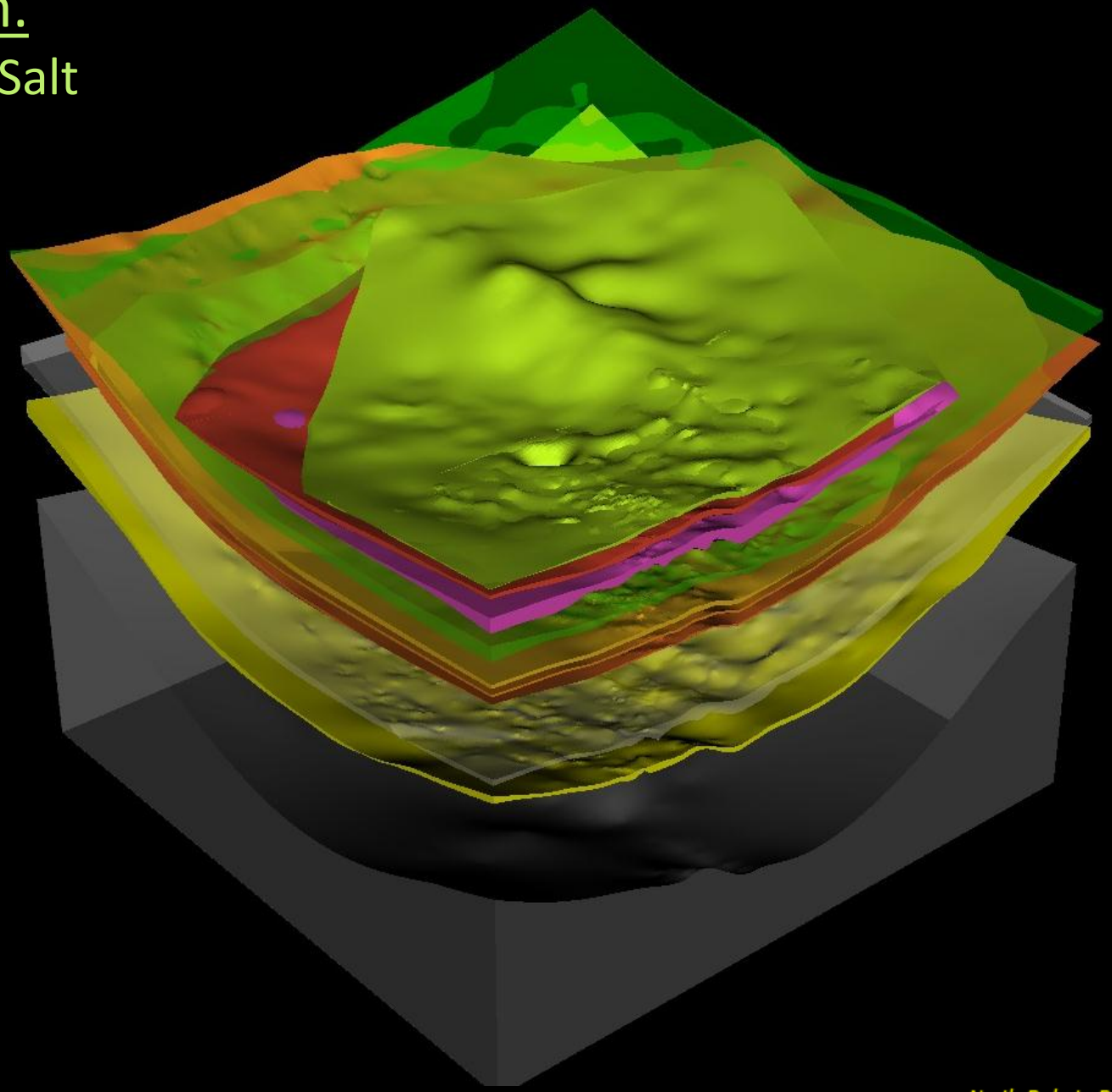

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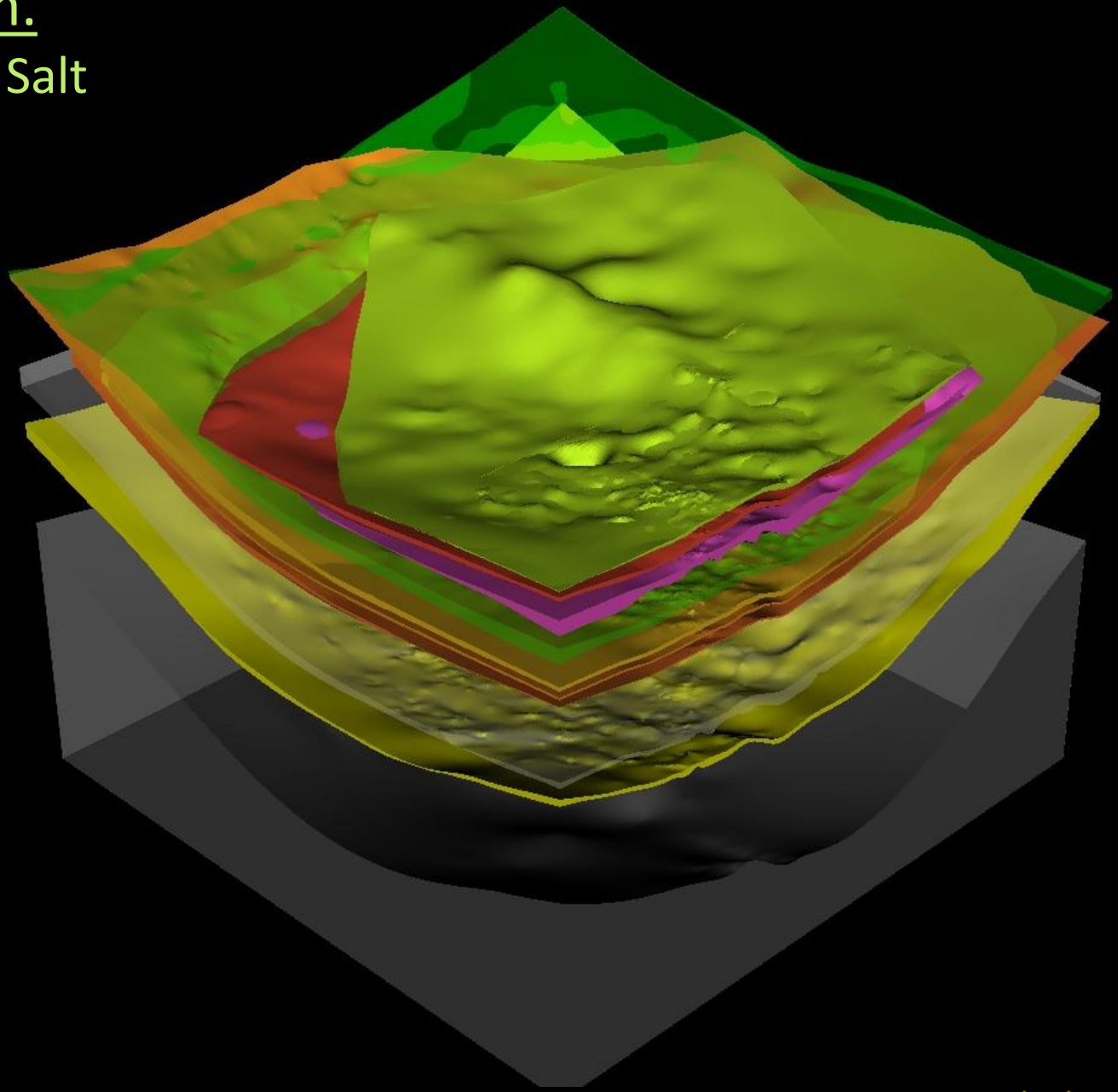
Dunham Salt



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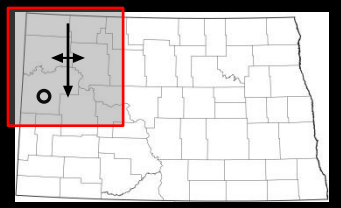
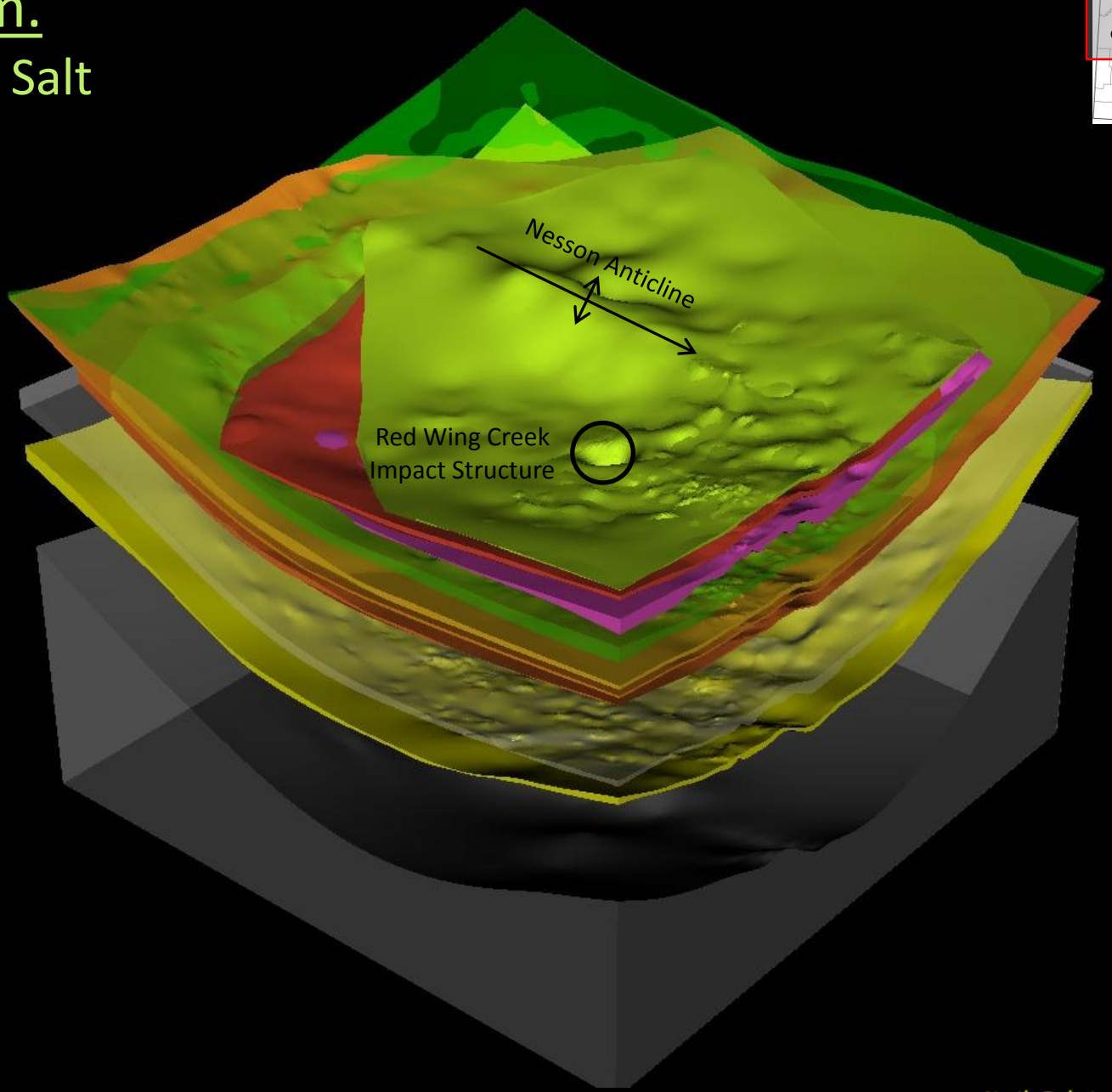
Piper Fm.

Dunham Salt





Maximum Thickness: >100 ft.

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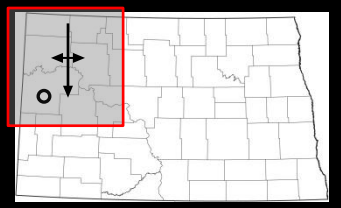
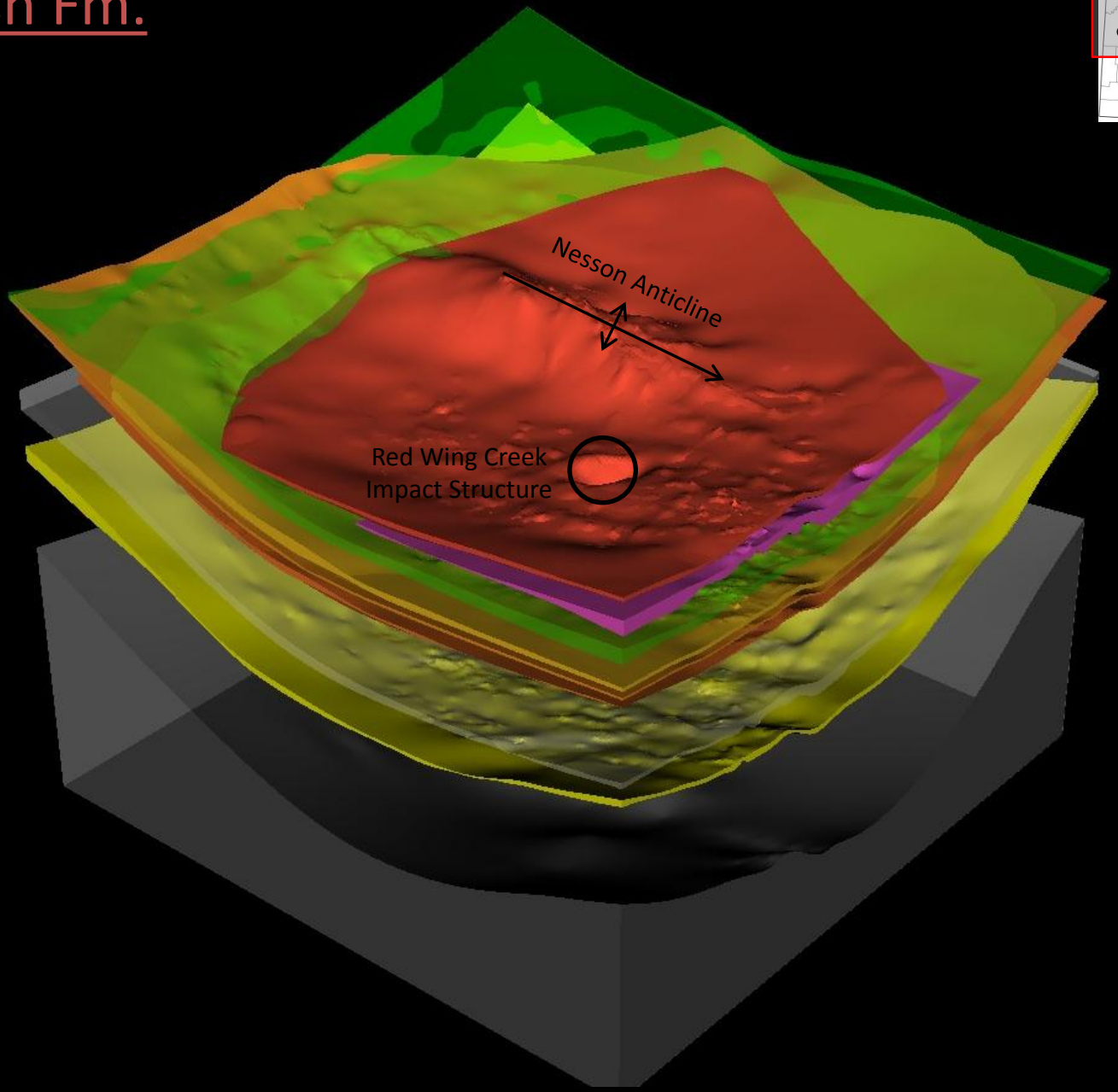
Spearfish Fm.

Pine Salt





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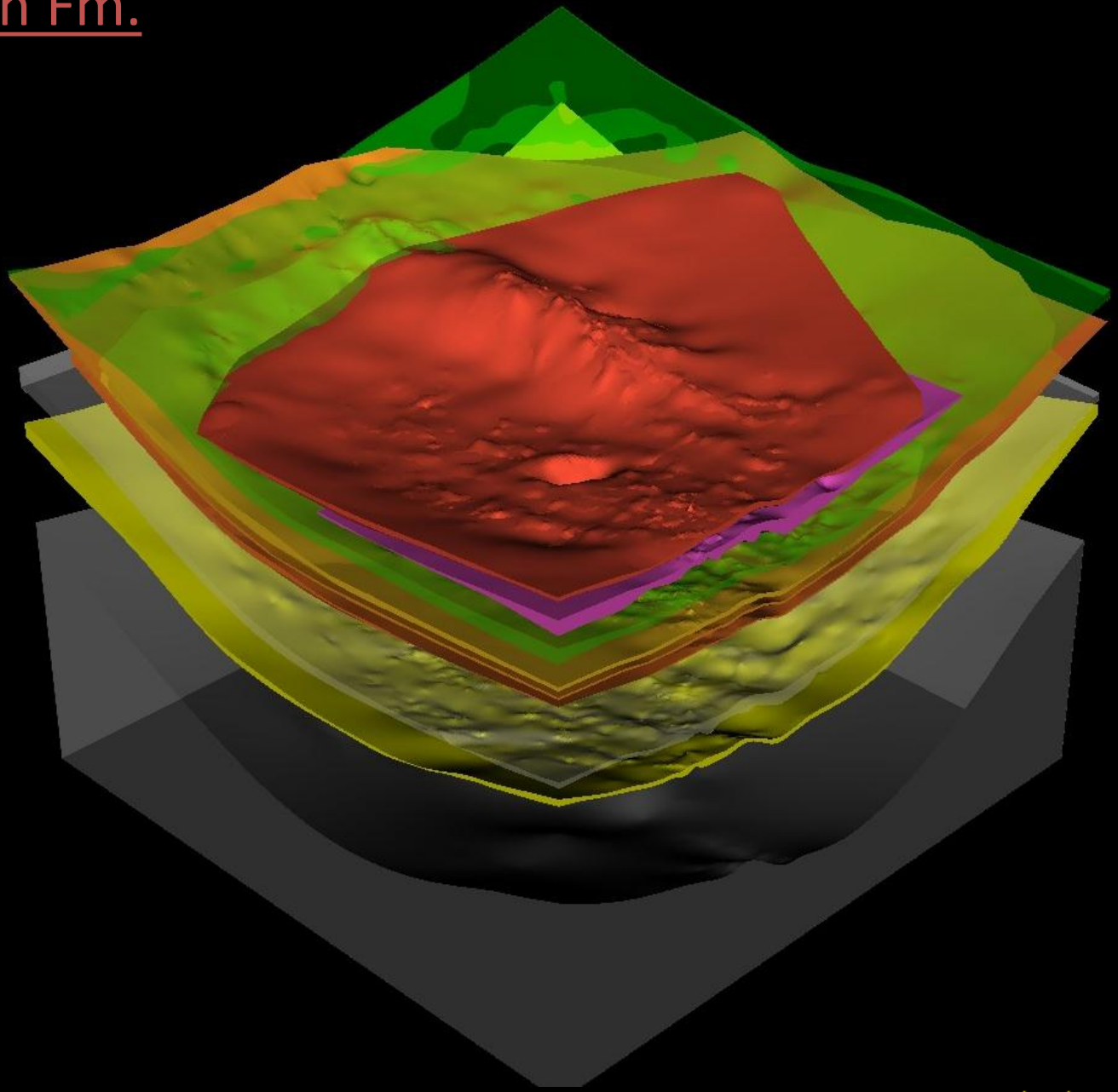
Spearfish Fm.

Pine Salt

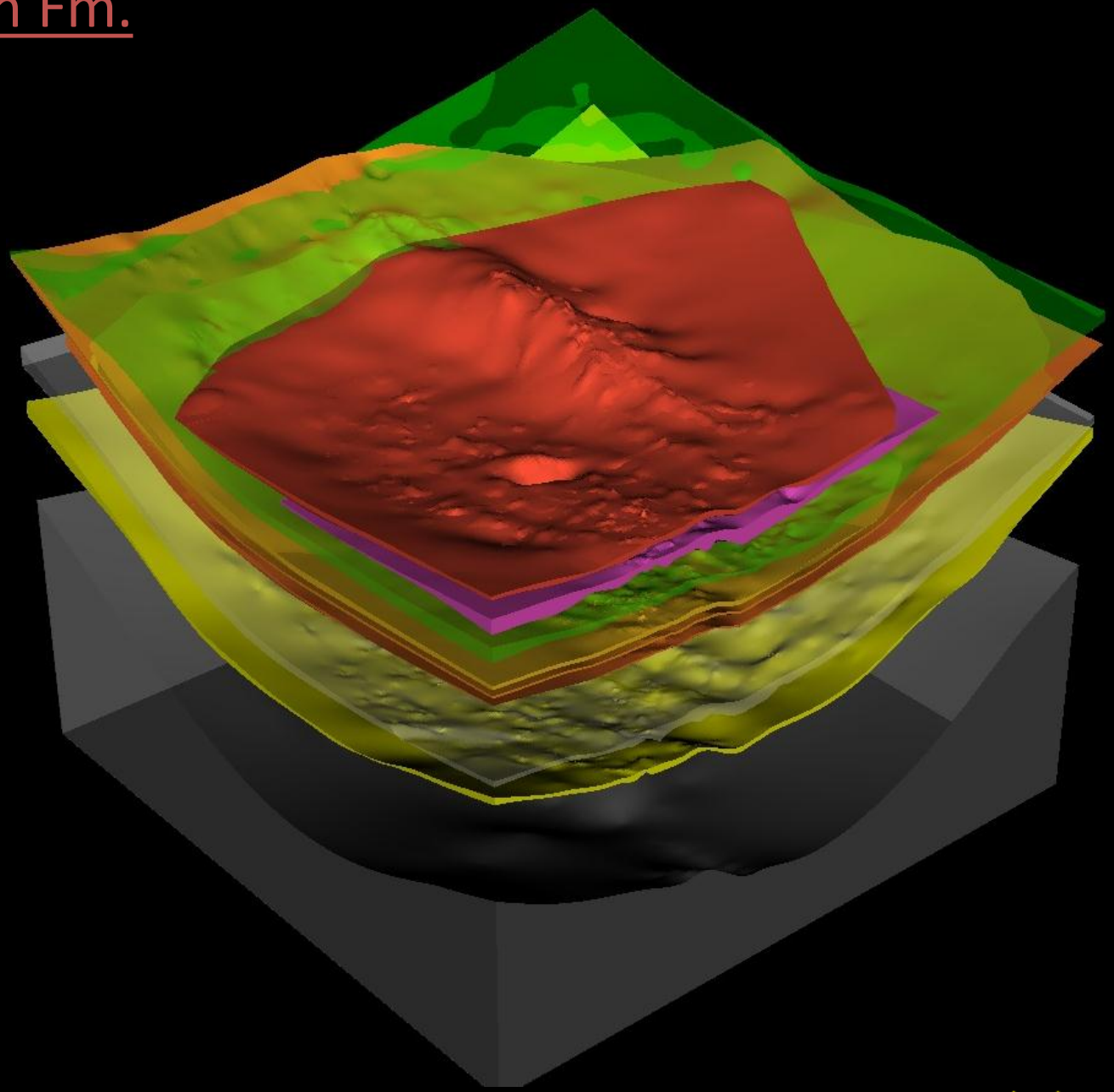


North Dakota Geological Survey

North Dakota Department of Mineral Resources

Spearfish Fm.

Pine Salt

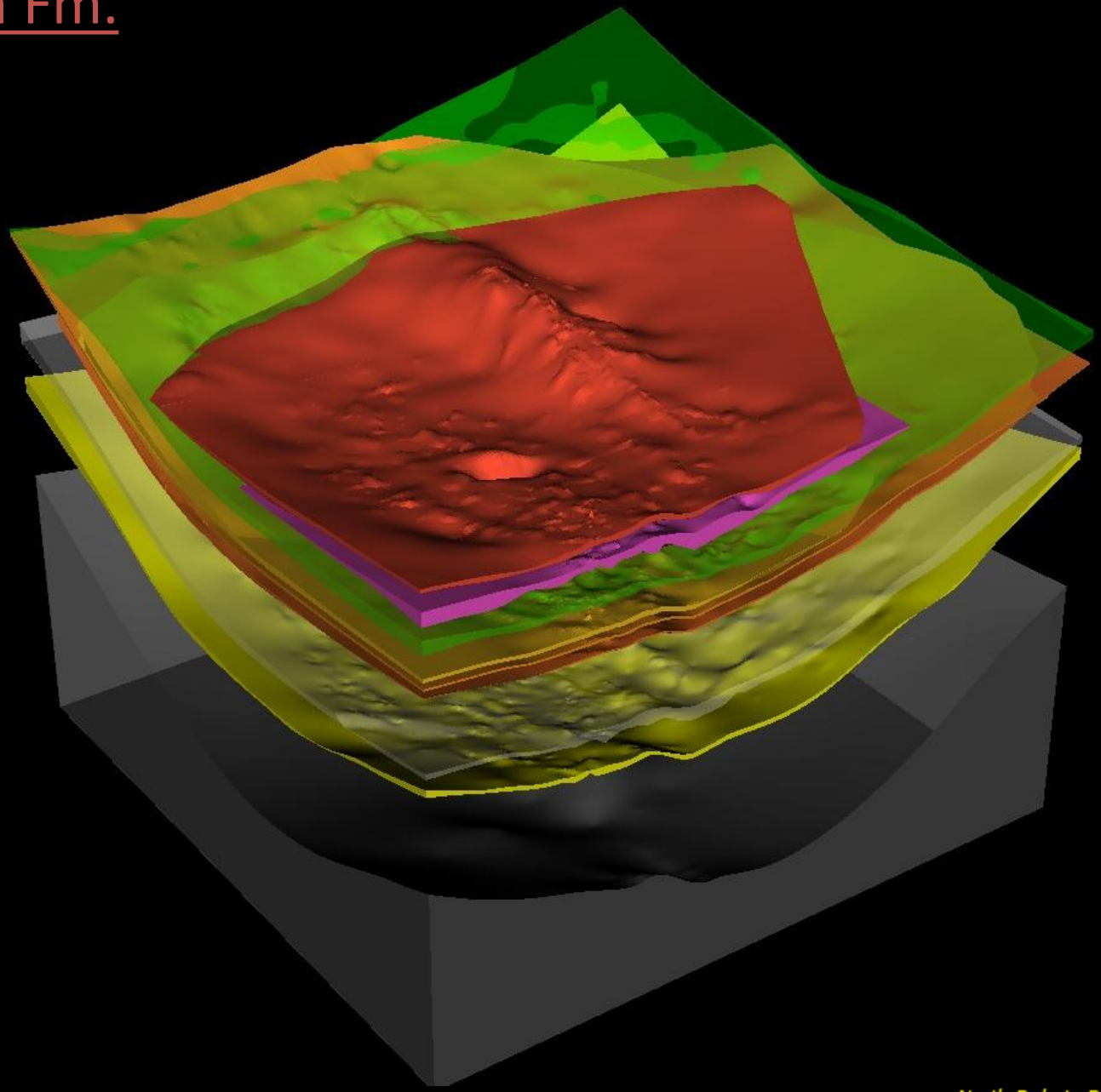


North Dakota Geological Survey

North Dakota Department of Mineral Resources

Spearfish Fm.

Pine Salt

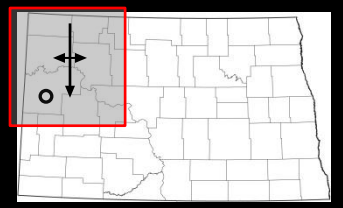


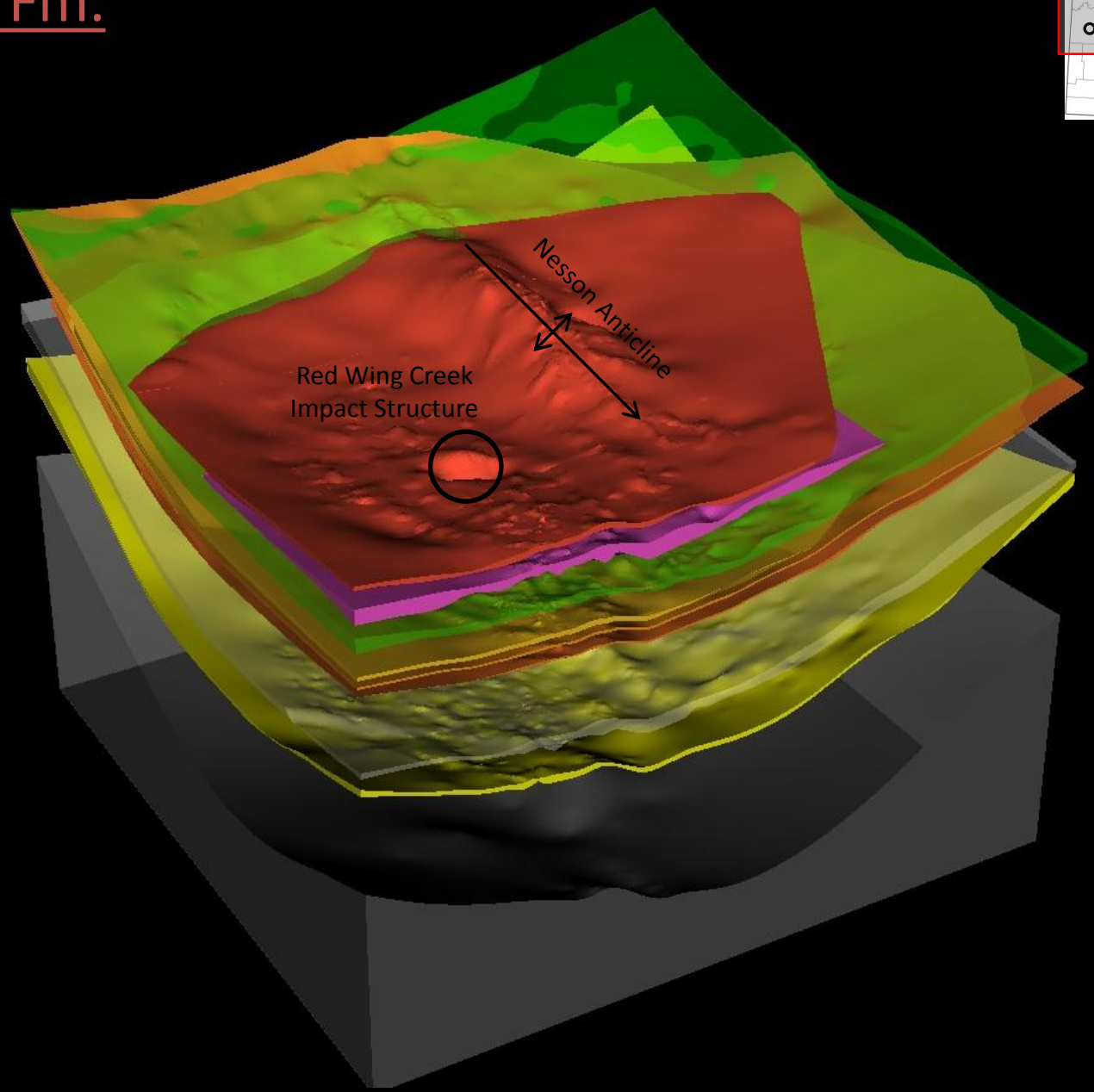
North Dakota Geological Survey

North Dakota Department of Mineral Resources

Spearfish Fm.

Pine Salt





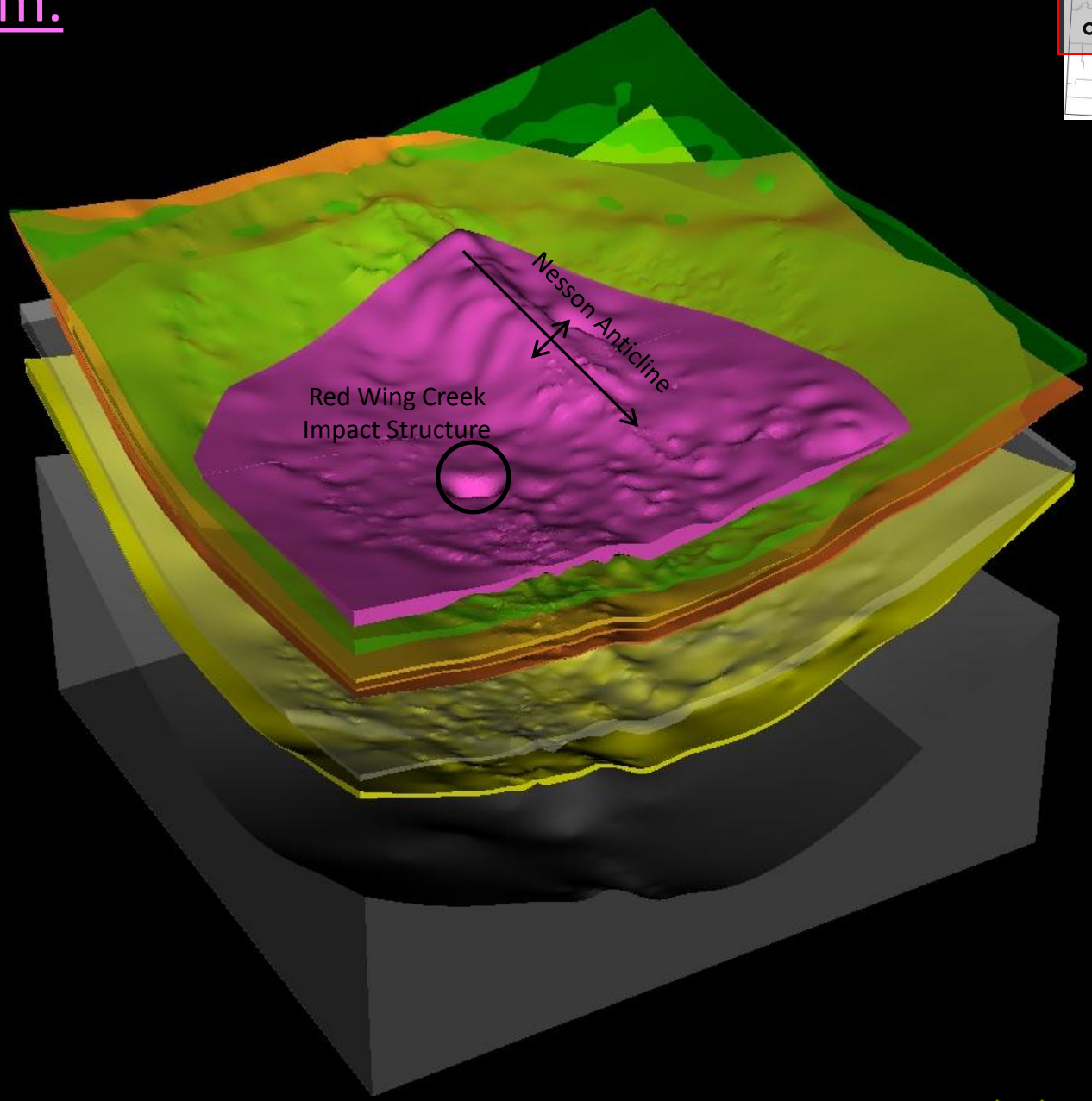
Maximum Thickness: >200 ft.

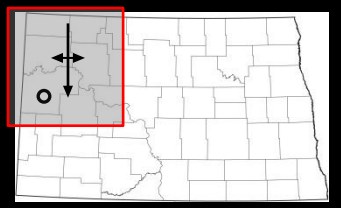
North Dakota Geological Survey

North Dakota Department of Mineral Resources

Opeche Fm.

Salt A



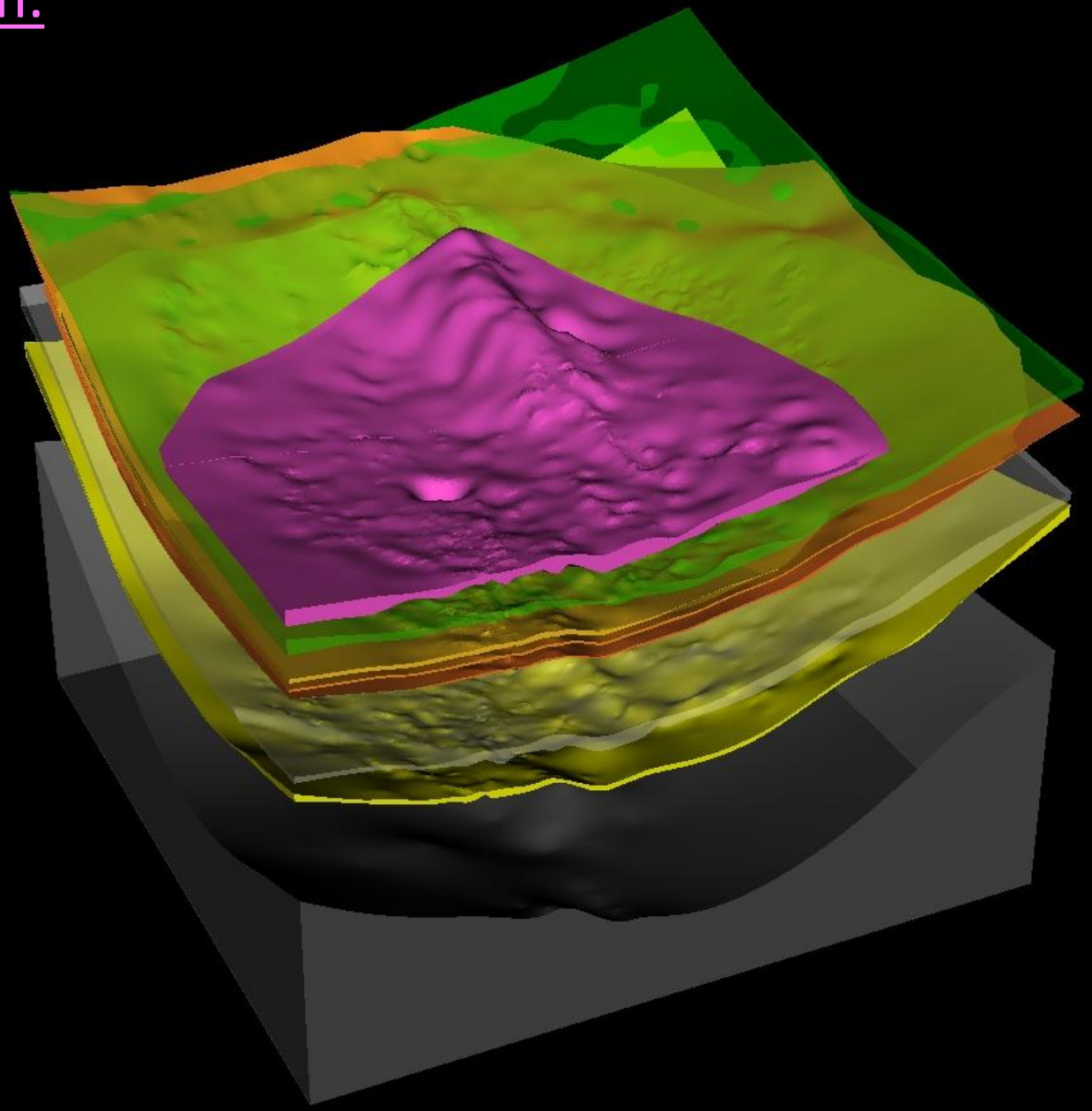


North Dakota
Geological Survey

North Dakota Department
of Mineral Resources

Opeche Fm.

Salt A

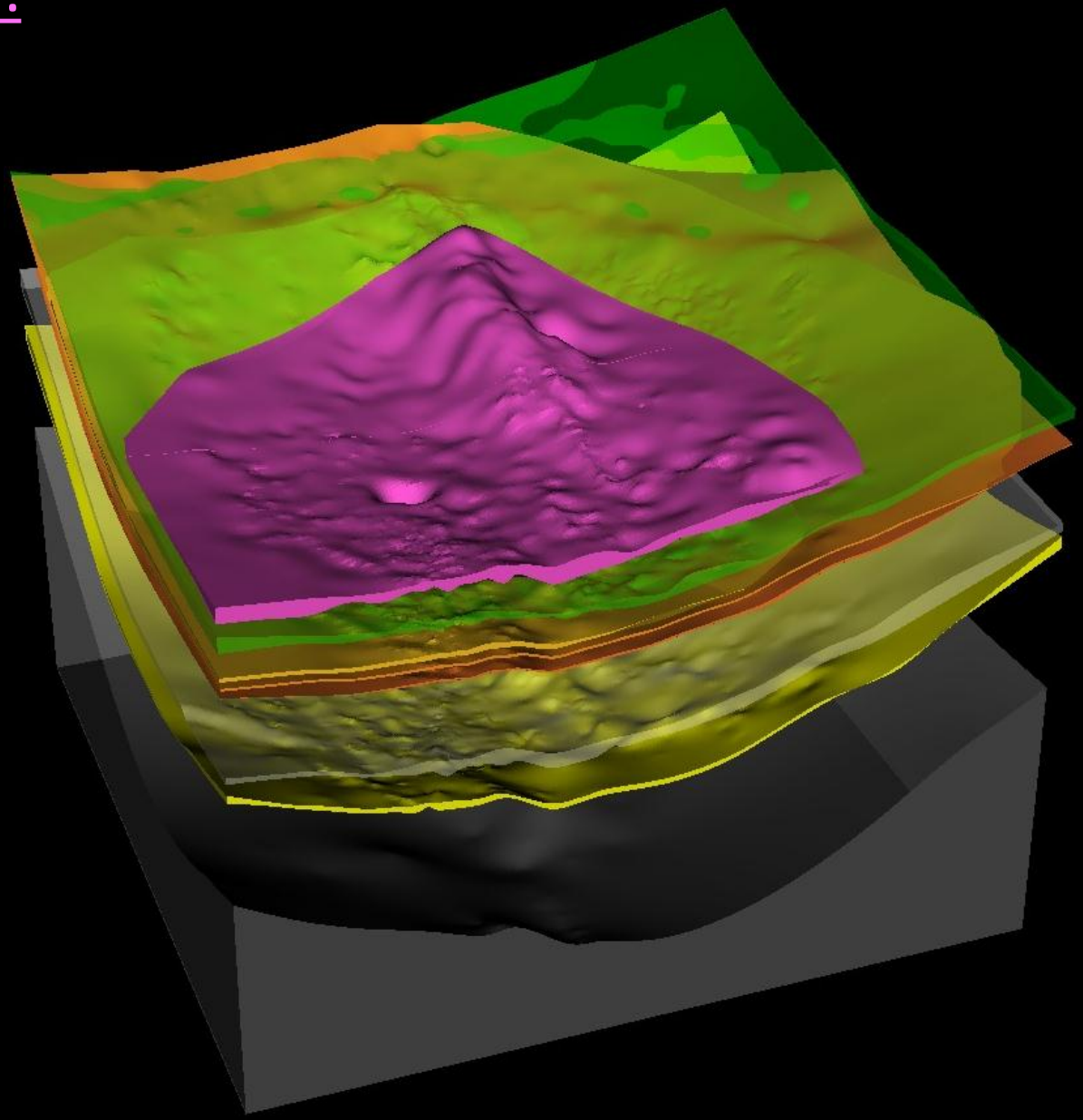


North Dakota Geological Survey

North Dakota Department of Mineral Resources

Opeche Fm.

Salt A

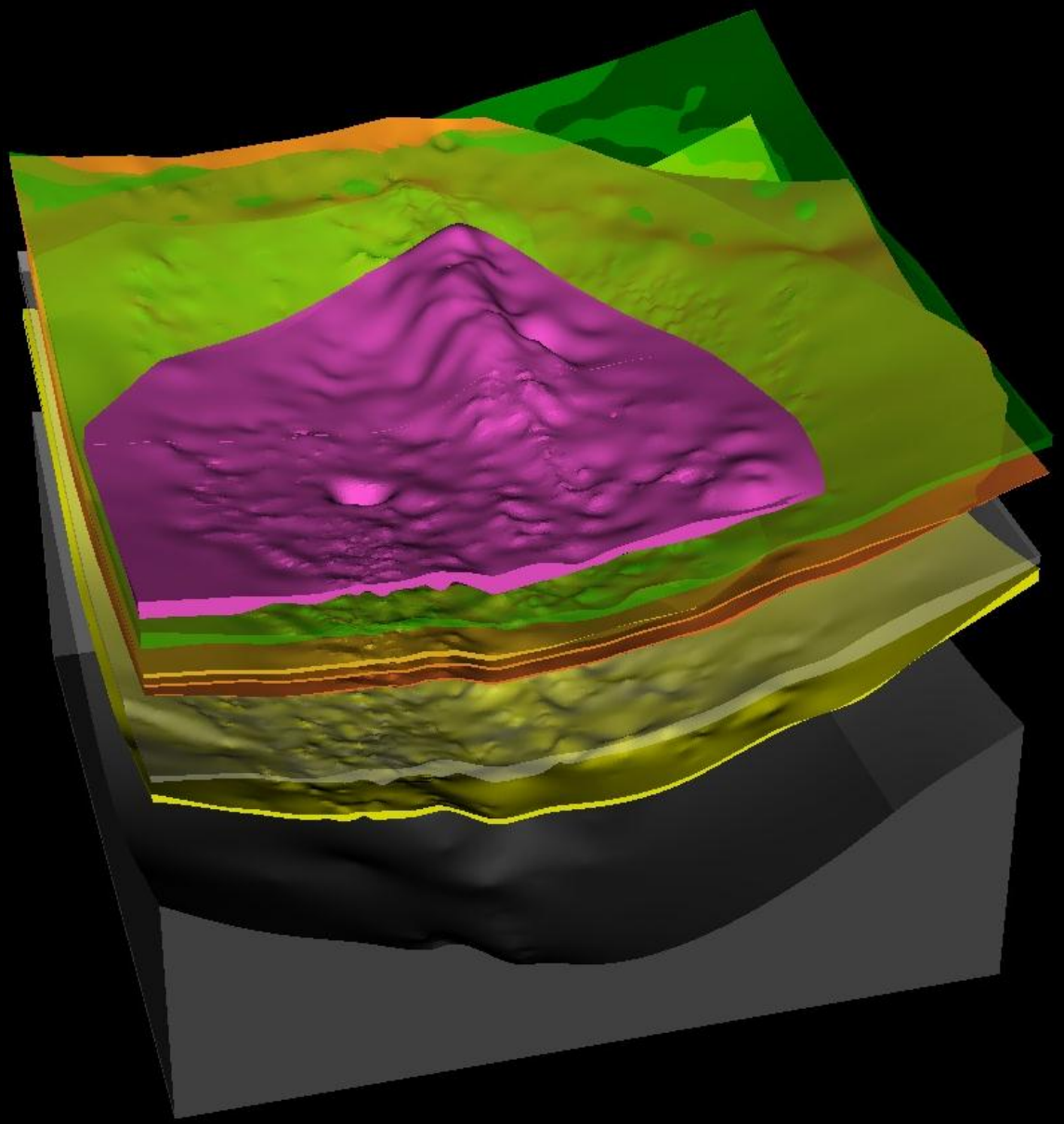


North Dakota Geological Survey

North Dakota Department of Mineral Resources

Opeche Fm.

Salt A

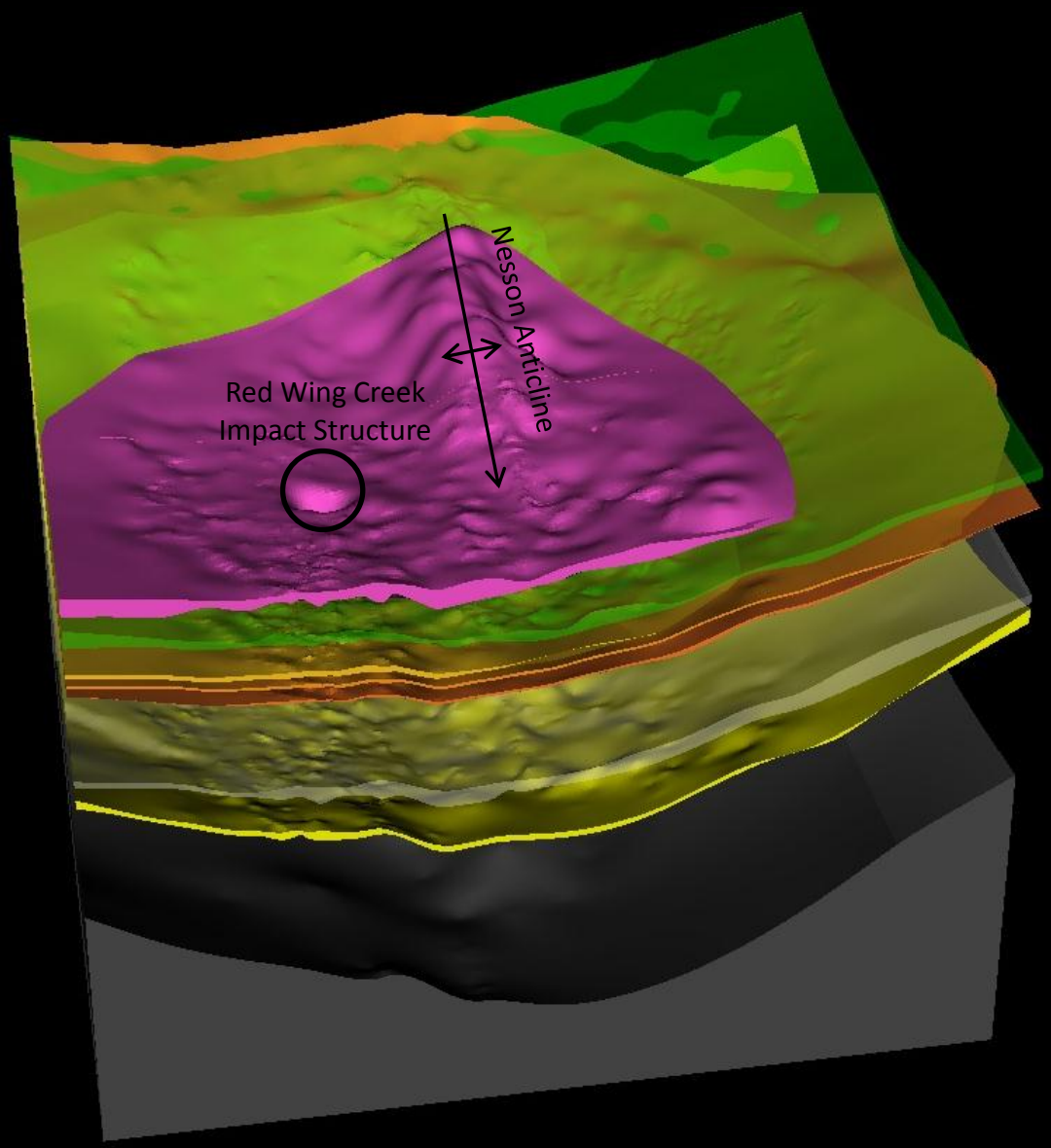


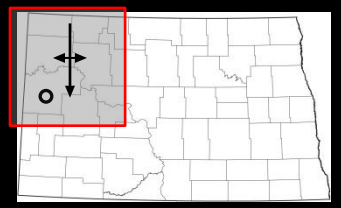
North Dakota Geological Survey

North Dakota Department of Mineral Resources

Opeche Fm.

Salt A





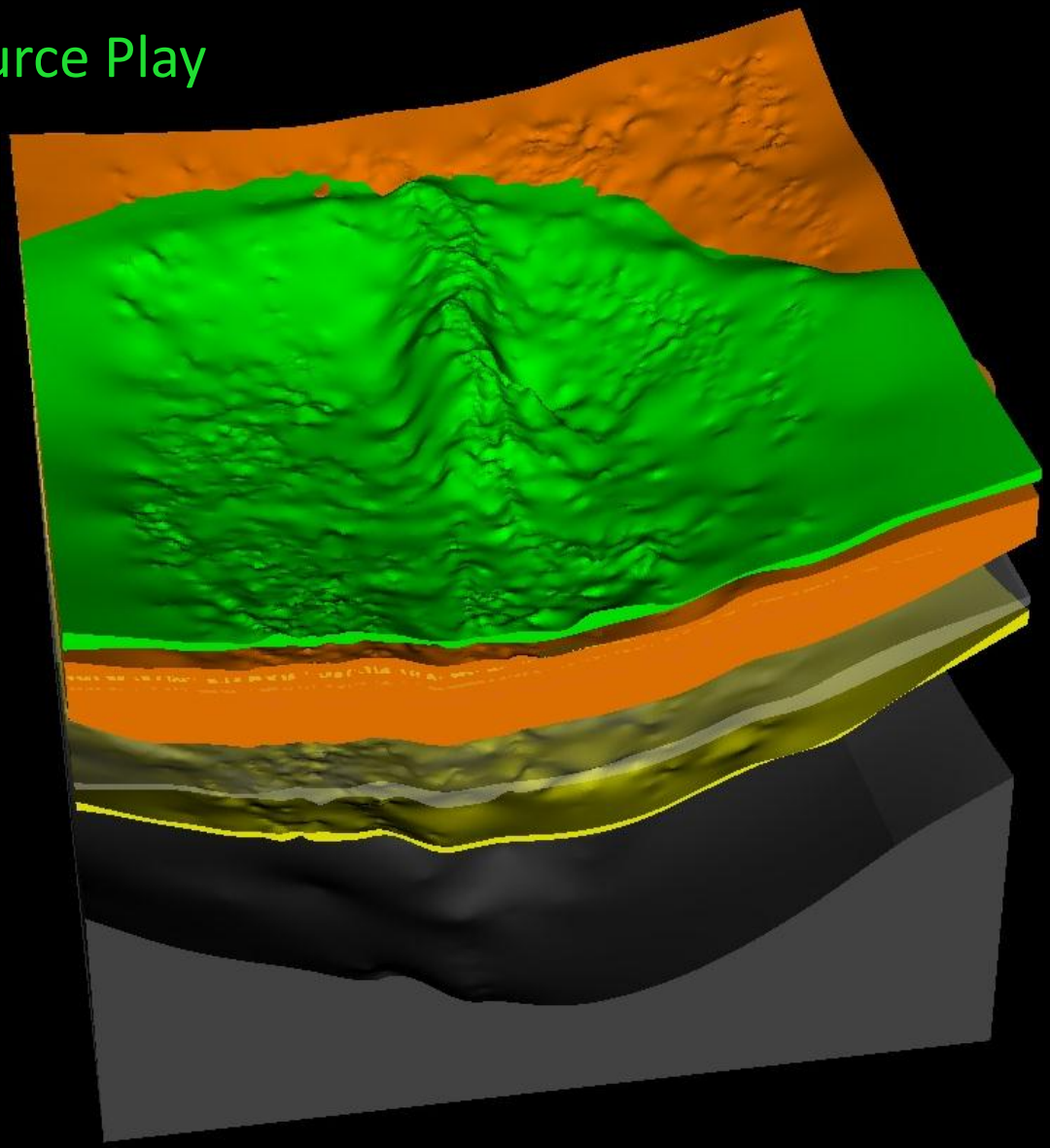
Maximum Thickness: >100 ft.

North Dakota Geological Survey

North Dakota Department of Mineral Resources

Tyler Fm.

Potential Resource Play



North Dakota Geological Survey

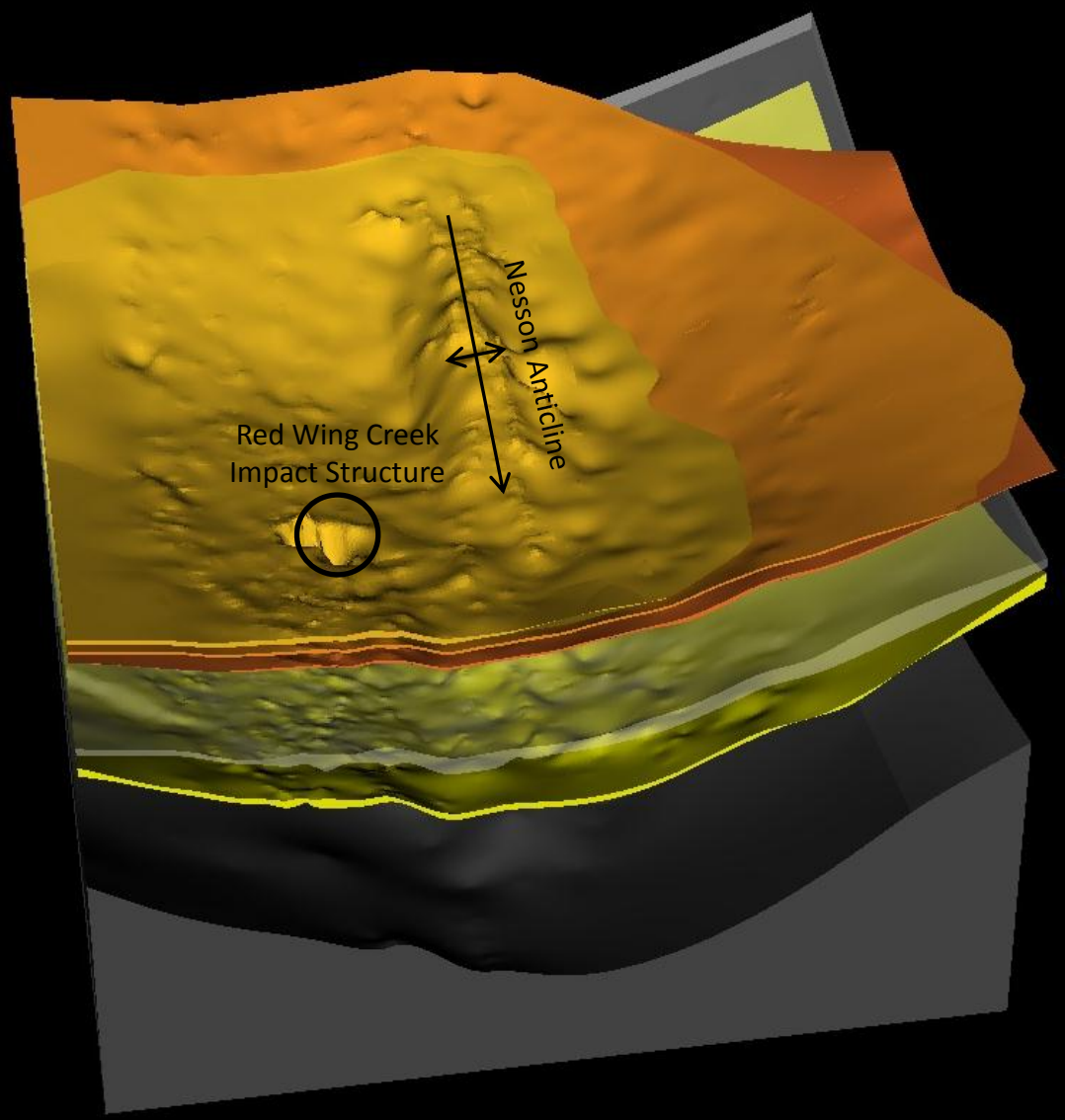
North Dakota Department of Mineral Resources

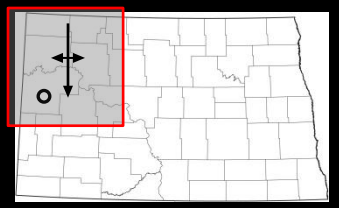
Charles Fm. (Madison)

A Salt

D Salt

F Salt





North Dakota
Geological Survey

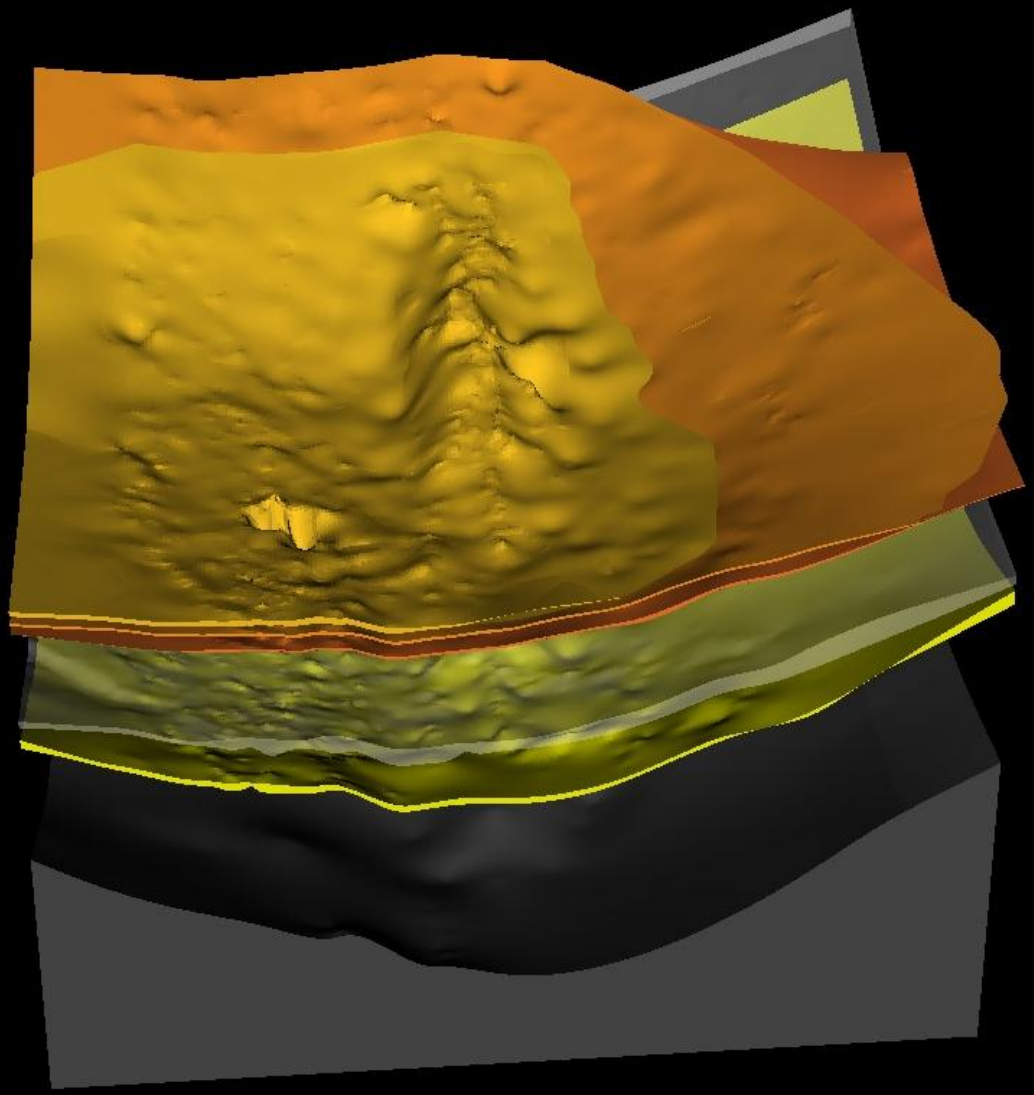
North Dakota Department
of Mineral Resources

Charles Fm. (Madison)

A Salt

D Salt

F Salt

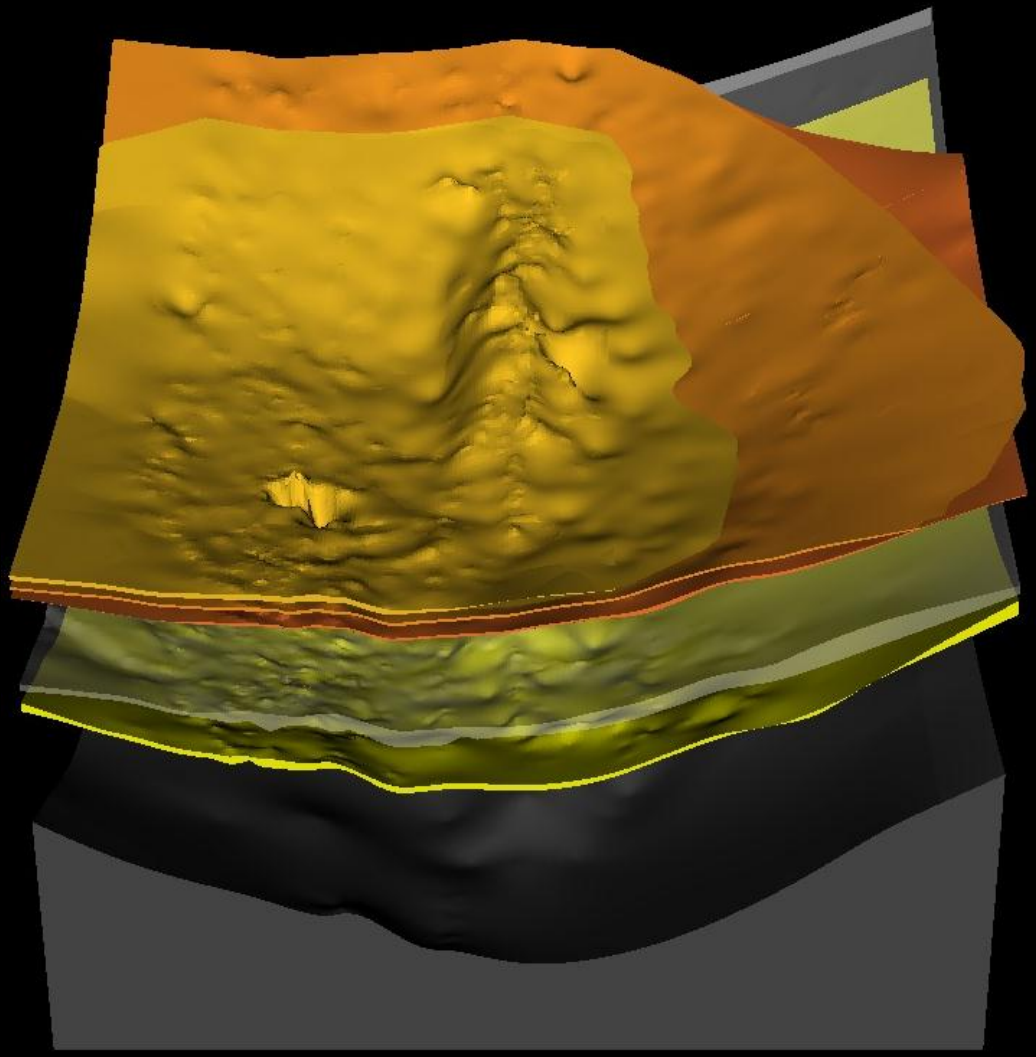


Charles Fm. (Madison)

A Salt

D Salt

F Salt

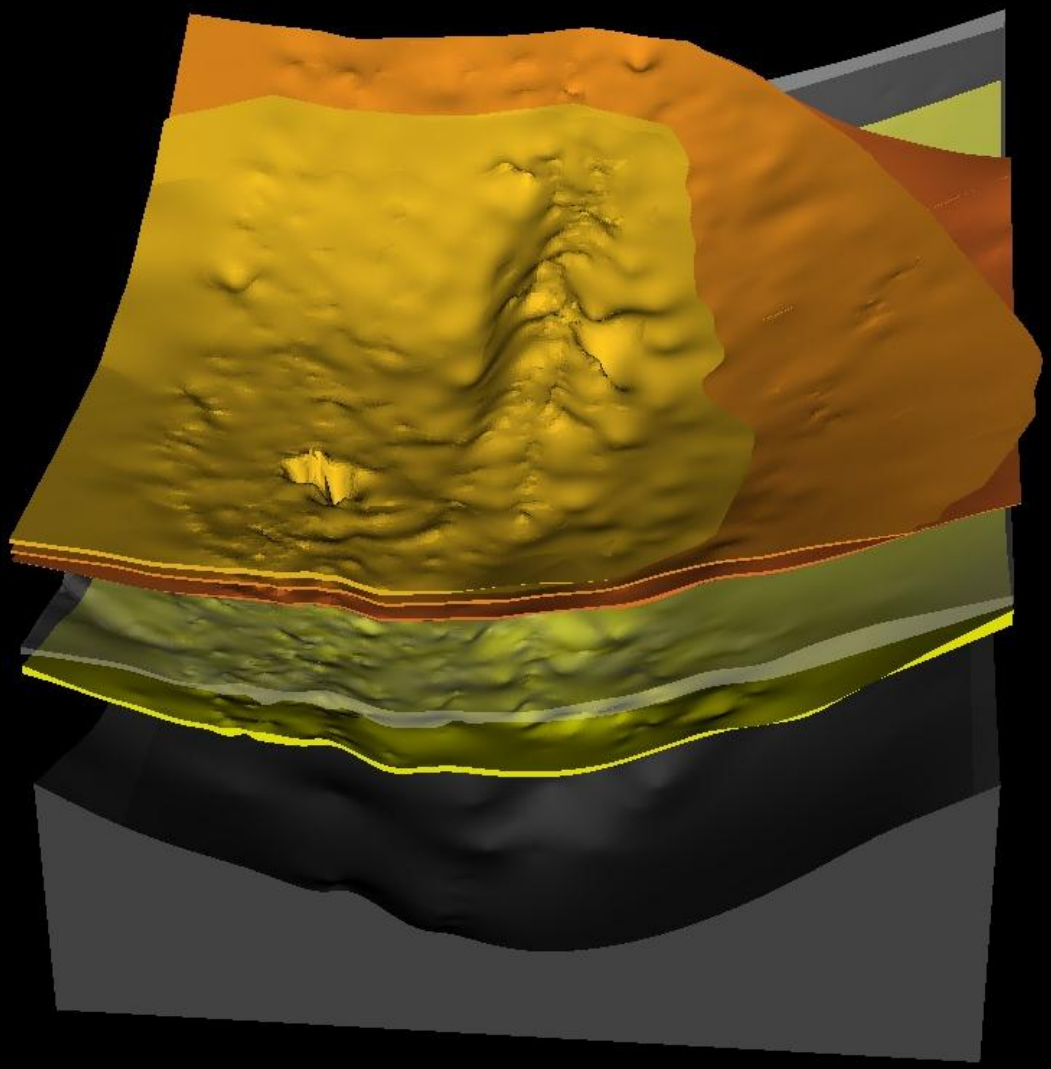


Charles Fm. (Madison)

A Salt

D Salt

F Salt



North Dakota Geological Survey

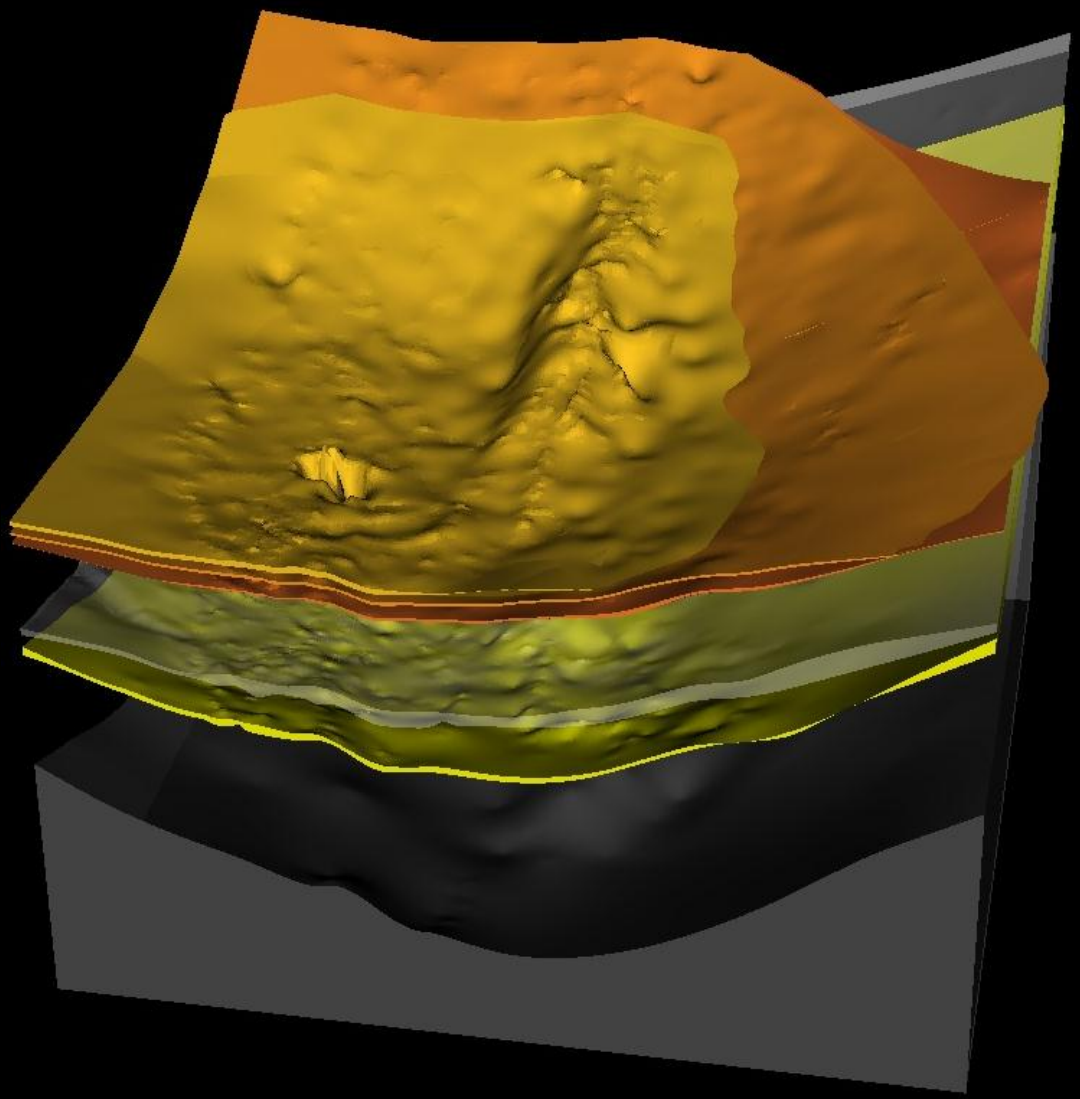
North Dakota Department of Mineral Resources

Charles Fm. (Madison)

A Salt

D Salt

F Salt



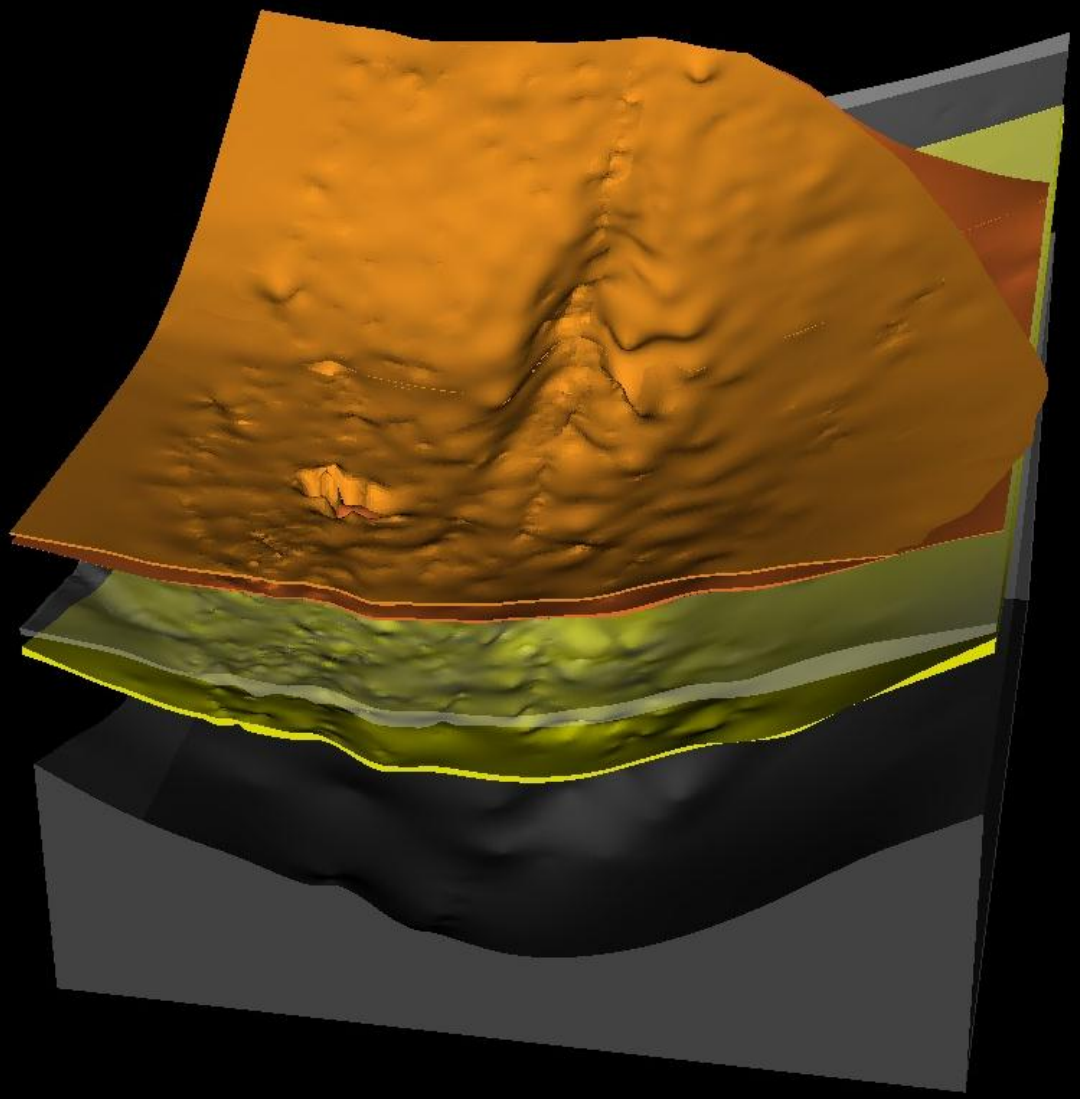
North Dakota Geological Survey

A Salt Maximum Thickness: >200 ft.

North Dakota Department of Mineral Resources

Charles Fm. (Madison)

D Salt
F Salt



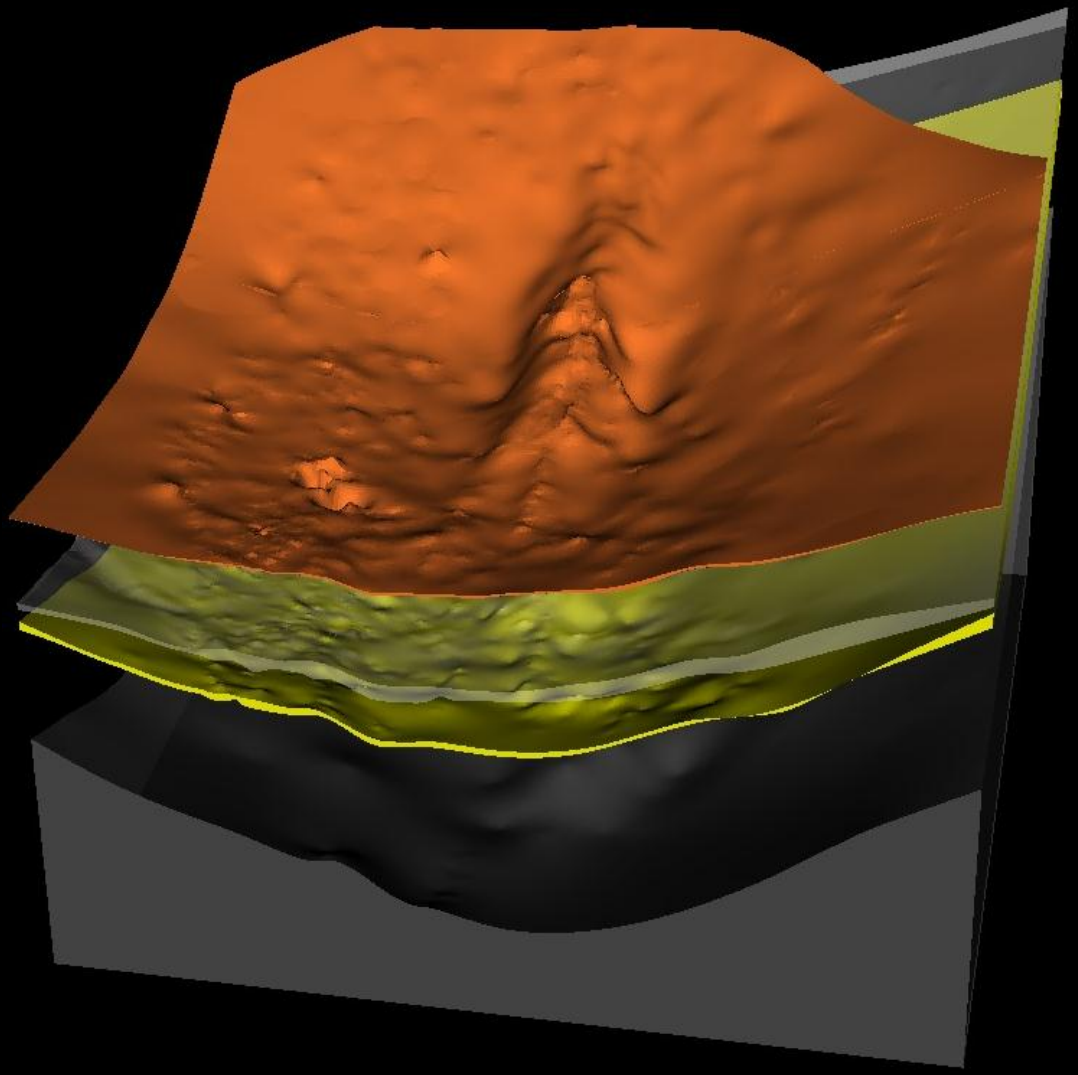
B Salt Maximum Thickness: >70 ft.

North Dakota Geological Survey

North Dakota Department of Mineral Resources

Charles Fm. (Madison)

F Salt

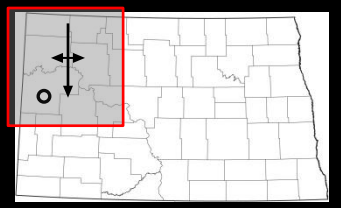


North Dakota Geological Survey

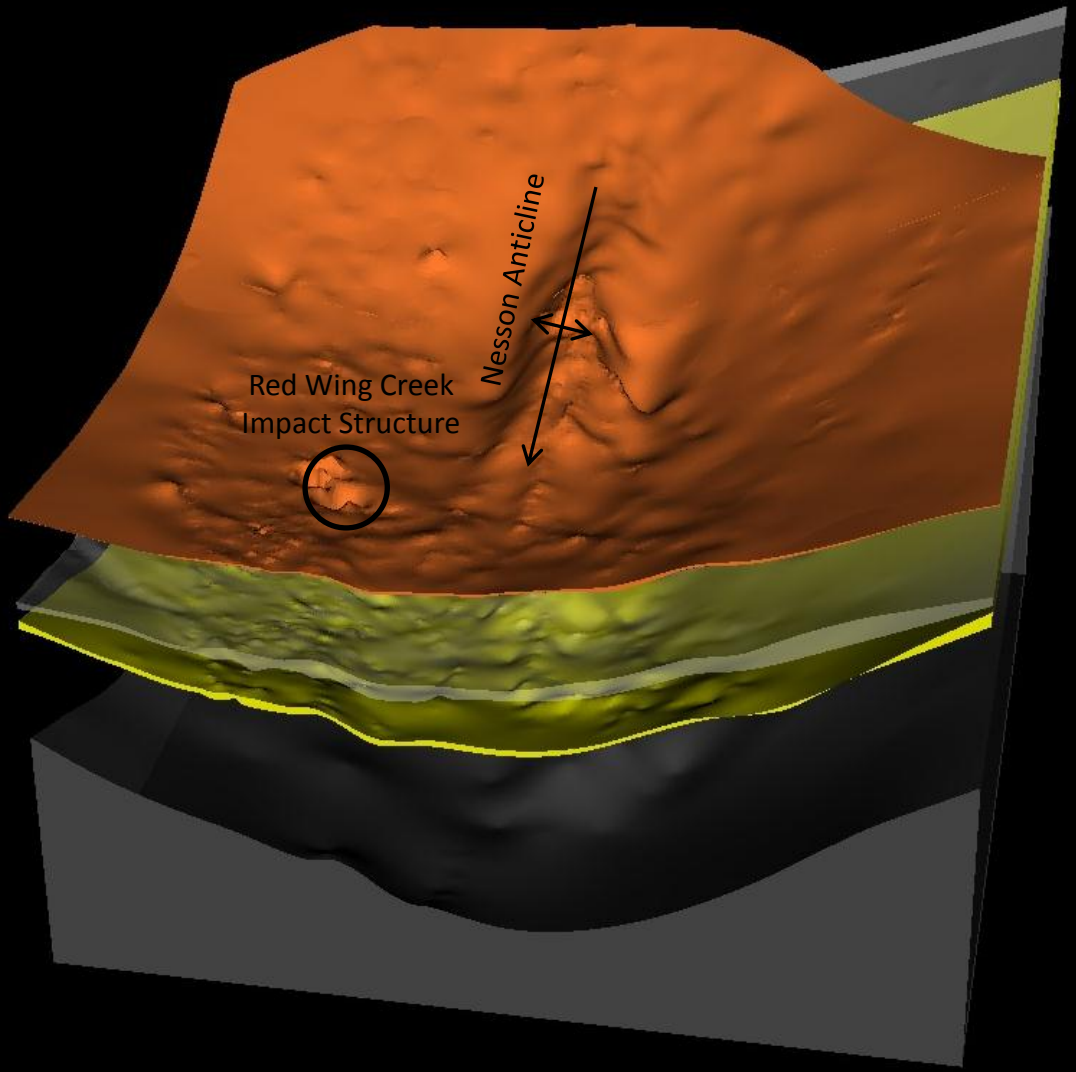
F Salt Maximum Thickness: >70 ft.

North Dakota Department of Mineral Resources

Charles Fm. (Madison)



F Salt

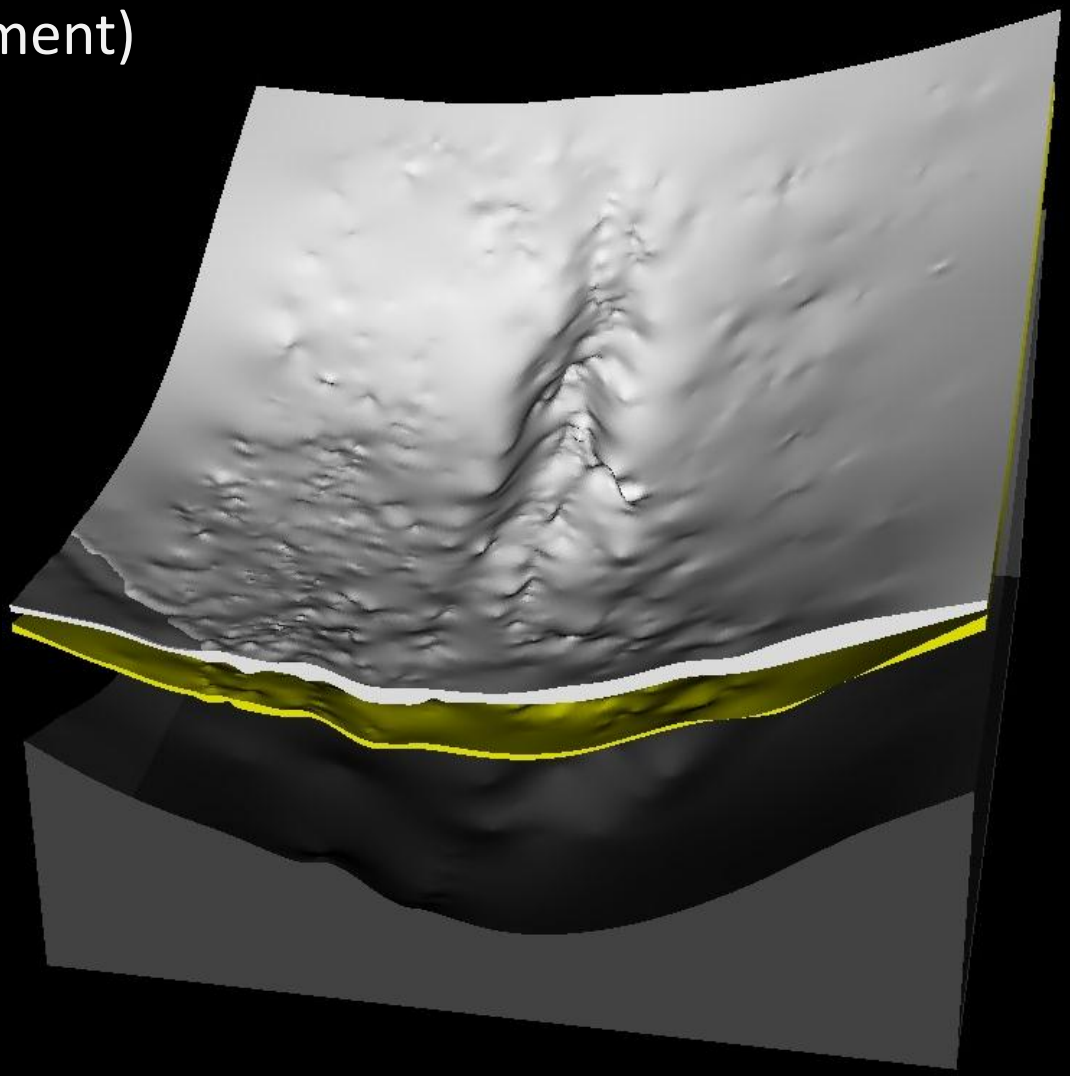


North Dakota
Geological Survey

North Dakota Department
of Mineral Resources

Bakken Fm.

Current Resource Play
(in development)

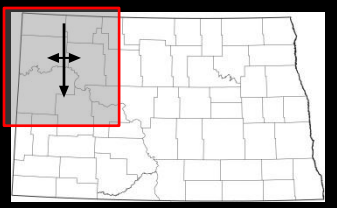


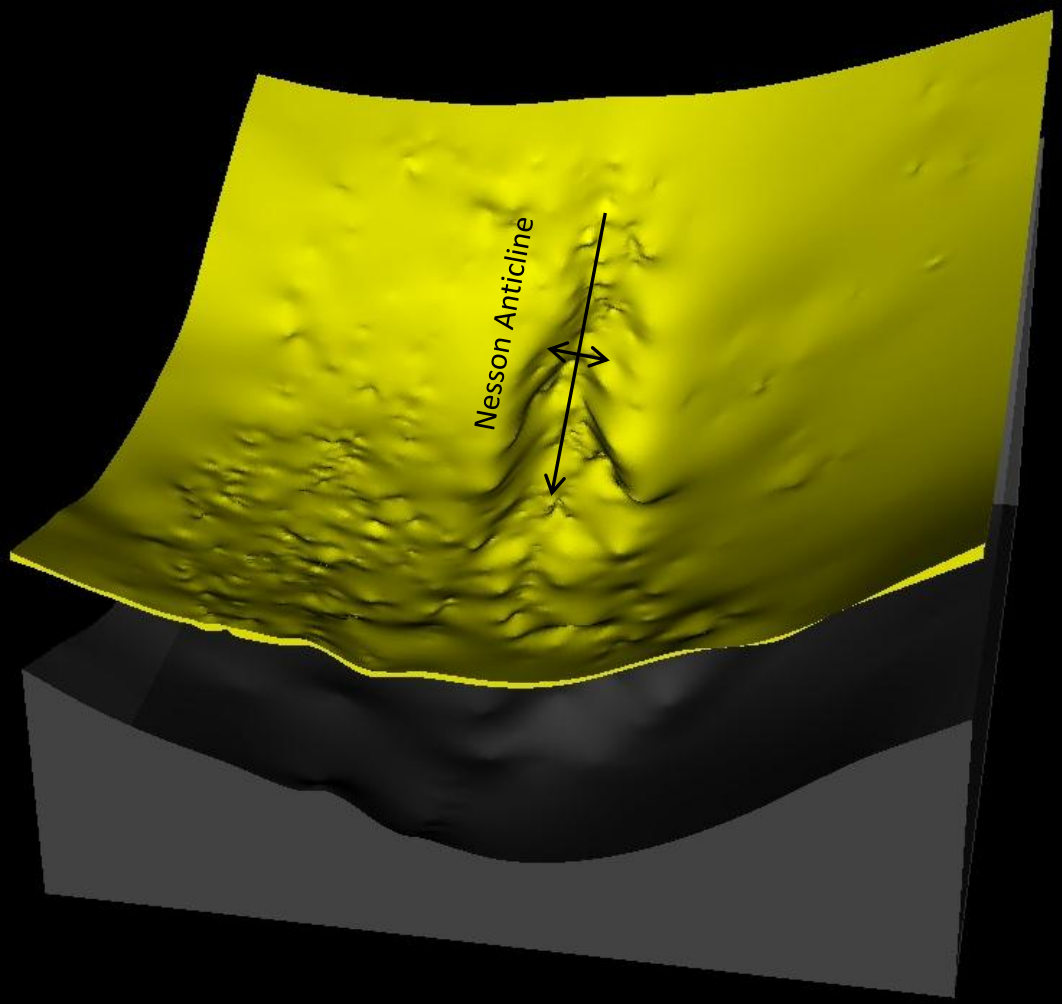
North Dakota
Geological Survey

North Dakota Department
of Mineral Resources

Prairie Fm.

Prairie Salt



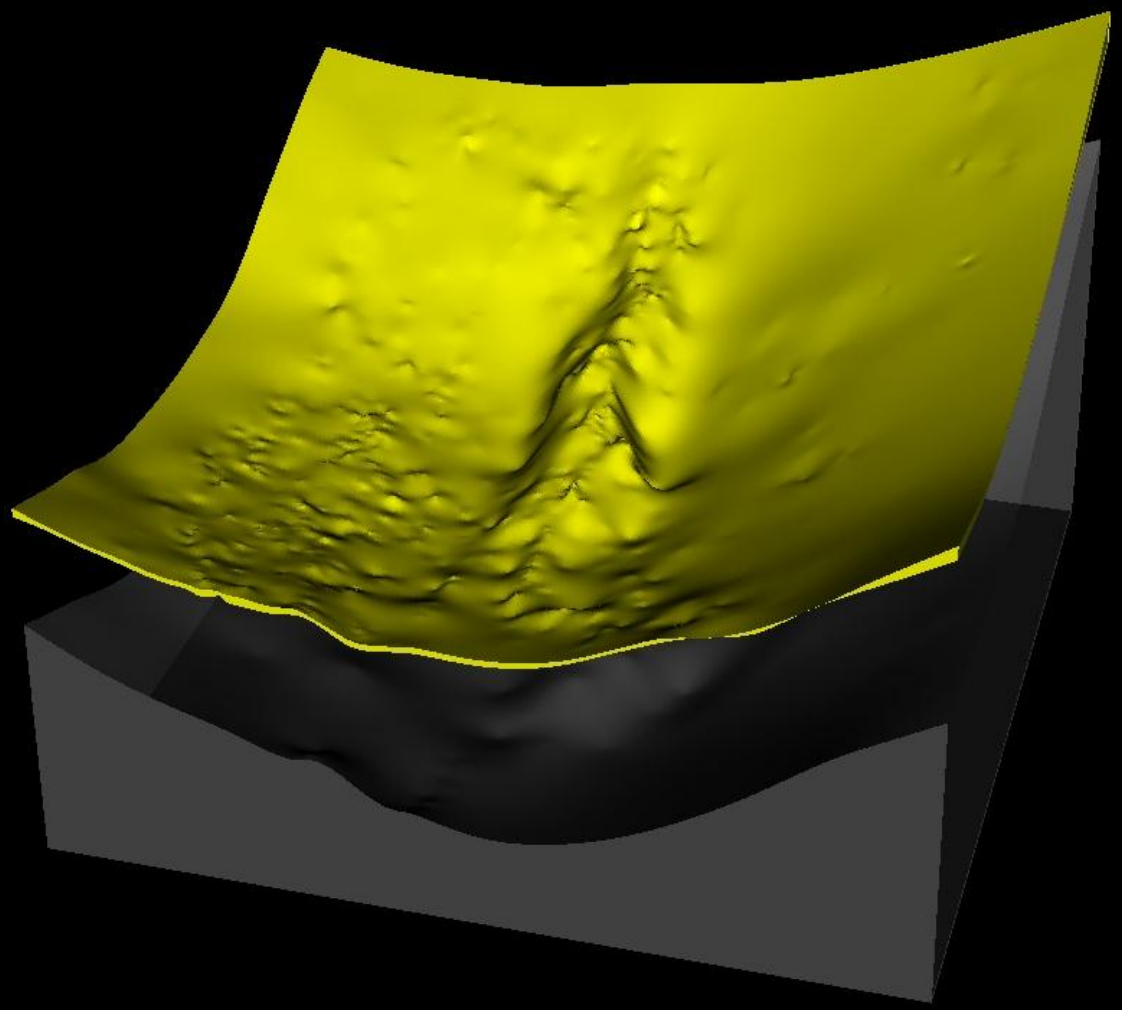


North Dakota Geological Survey

North Dakota Department of Mineral Resources

Prairie Fm.

Prairie Salt

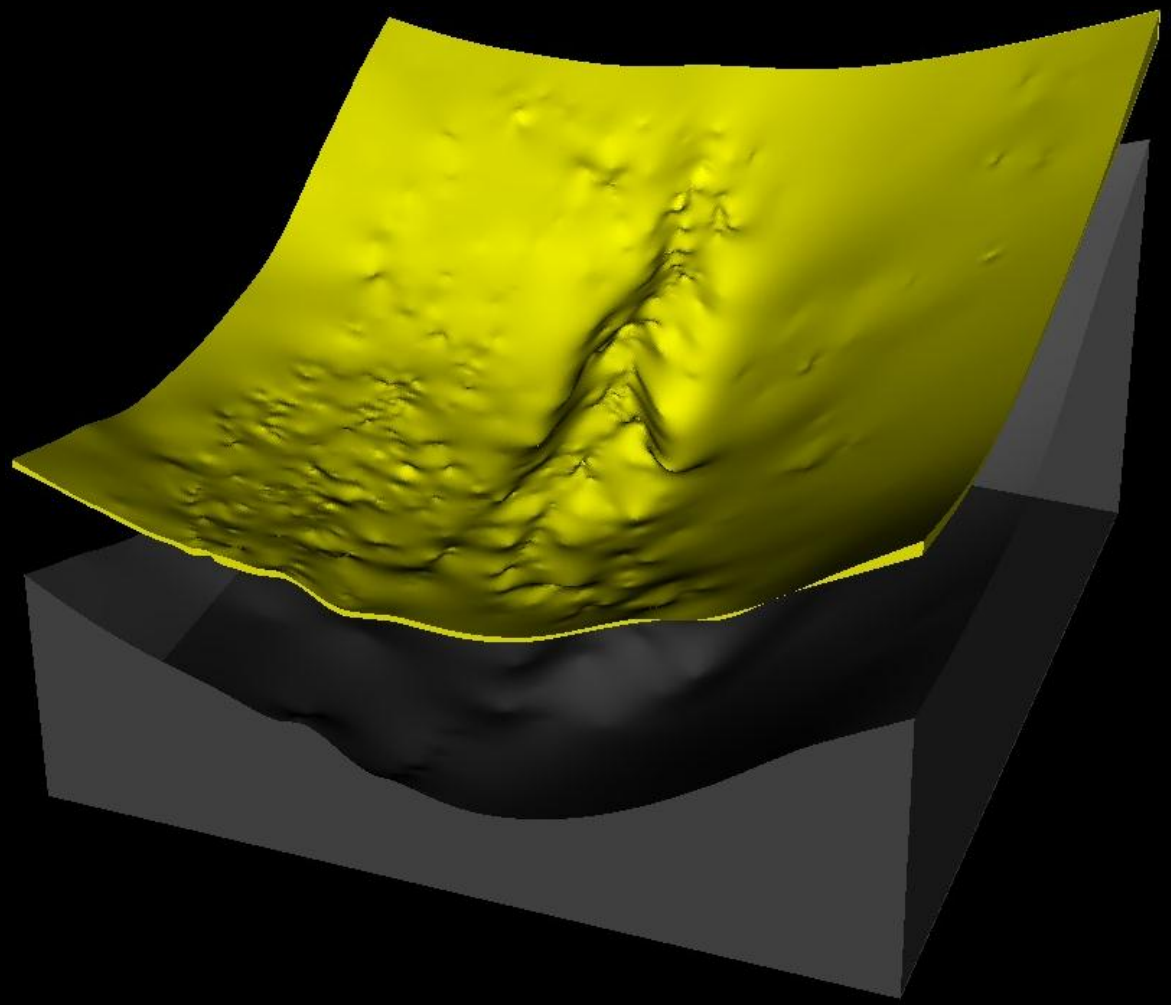


North Dakota Geological Survey

North Dakota Department of Mineral Resources

Prairie Fm.

Prairie Salt

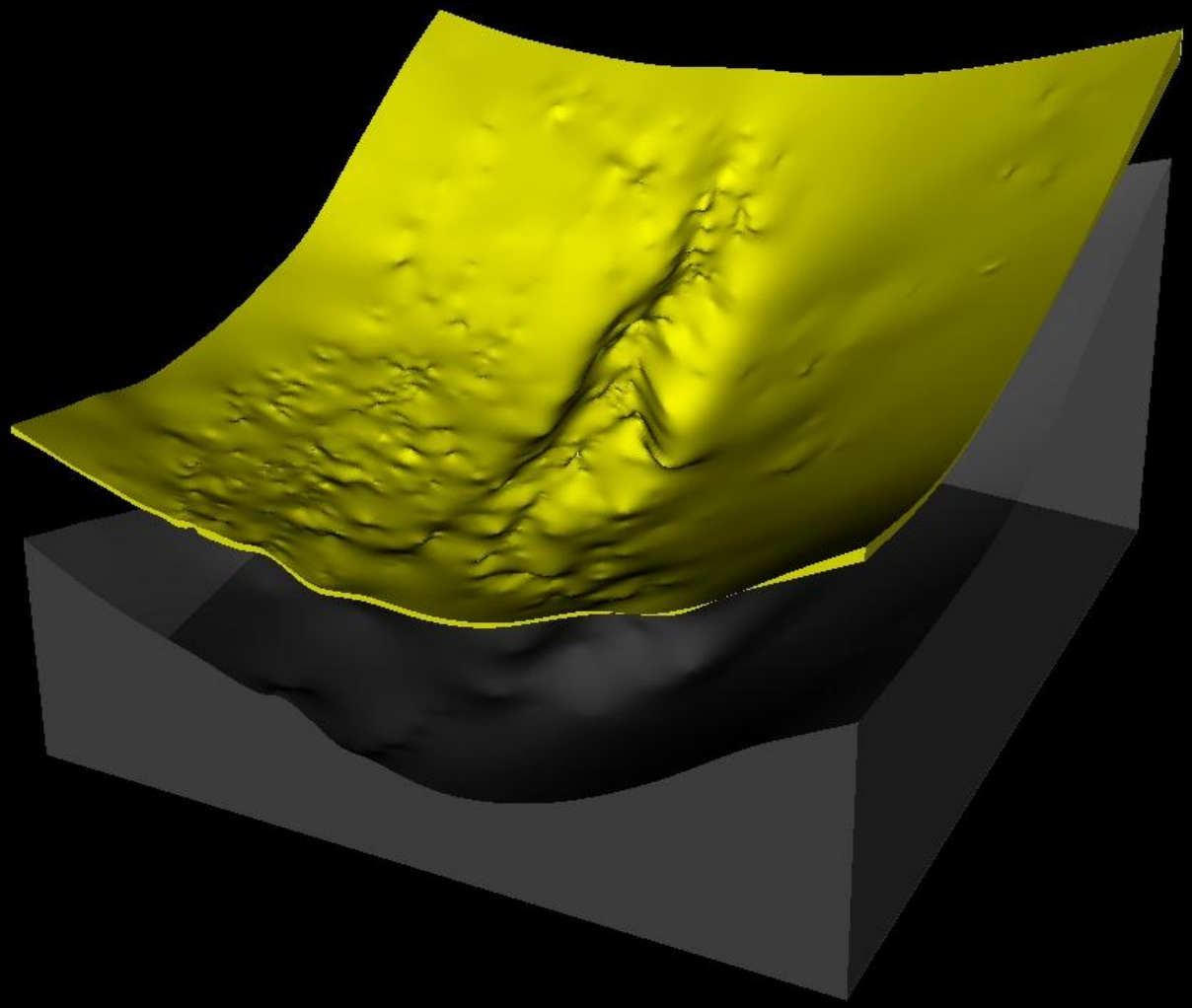


North Dakota Geological Survey

North Dakota Department of Mineral Resources

Prairie Fm.

Prairie Salt

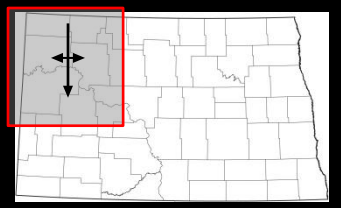


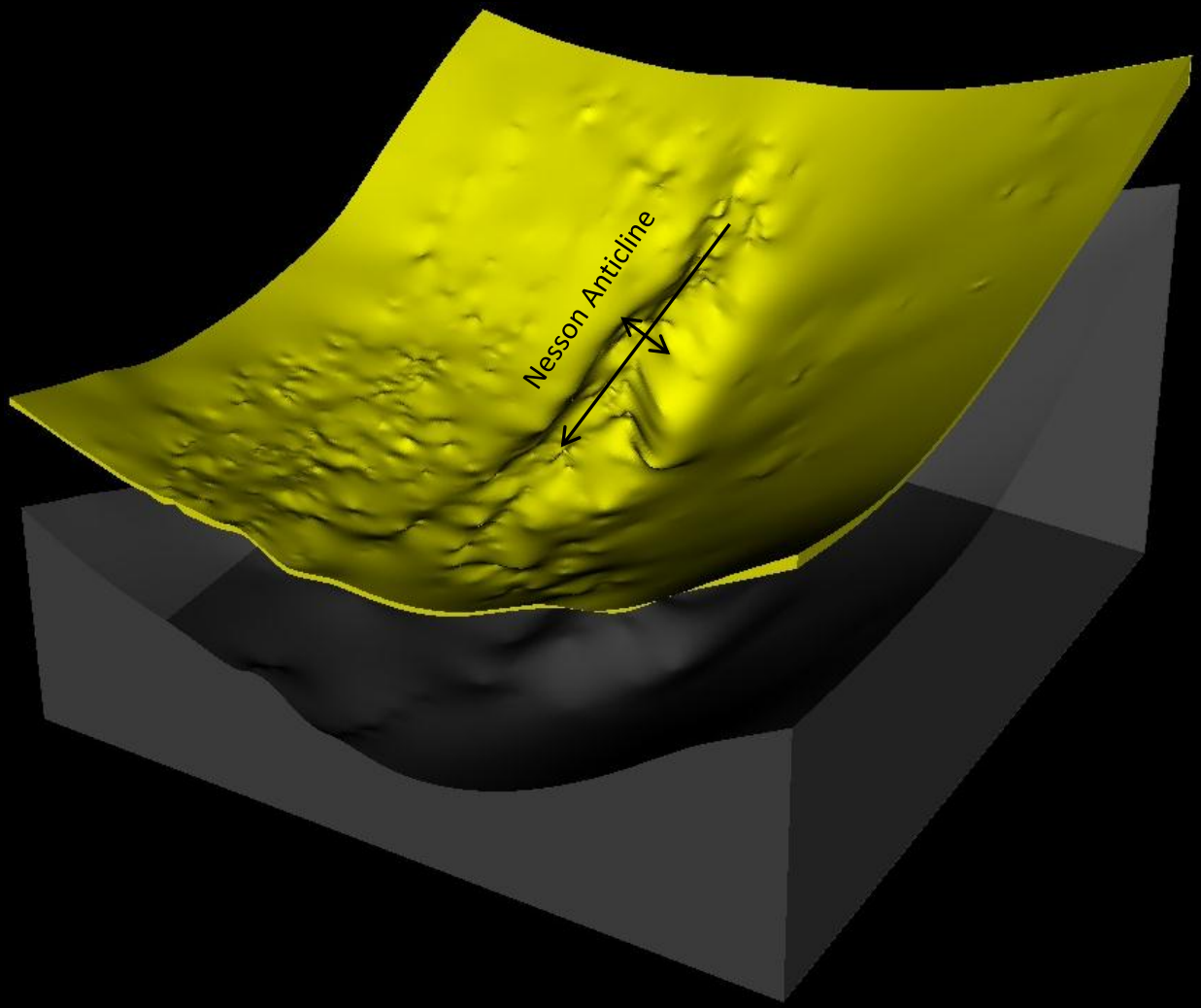
North Dakota Geological Survey

North Dakota Department of Mineral Resources

Prairie Fm.

Prairie Salt





Maximum Thickness: >600 ft.

North Dakota Geological Survey

North Dakota Department of Mineral Resources