Appalachian Storage Hub (ASH) Study

Regional Subsurface Geology

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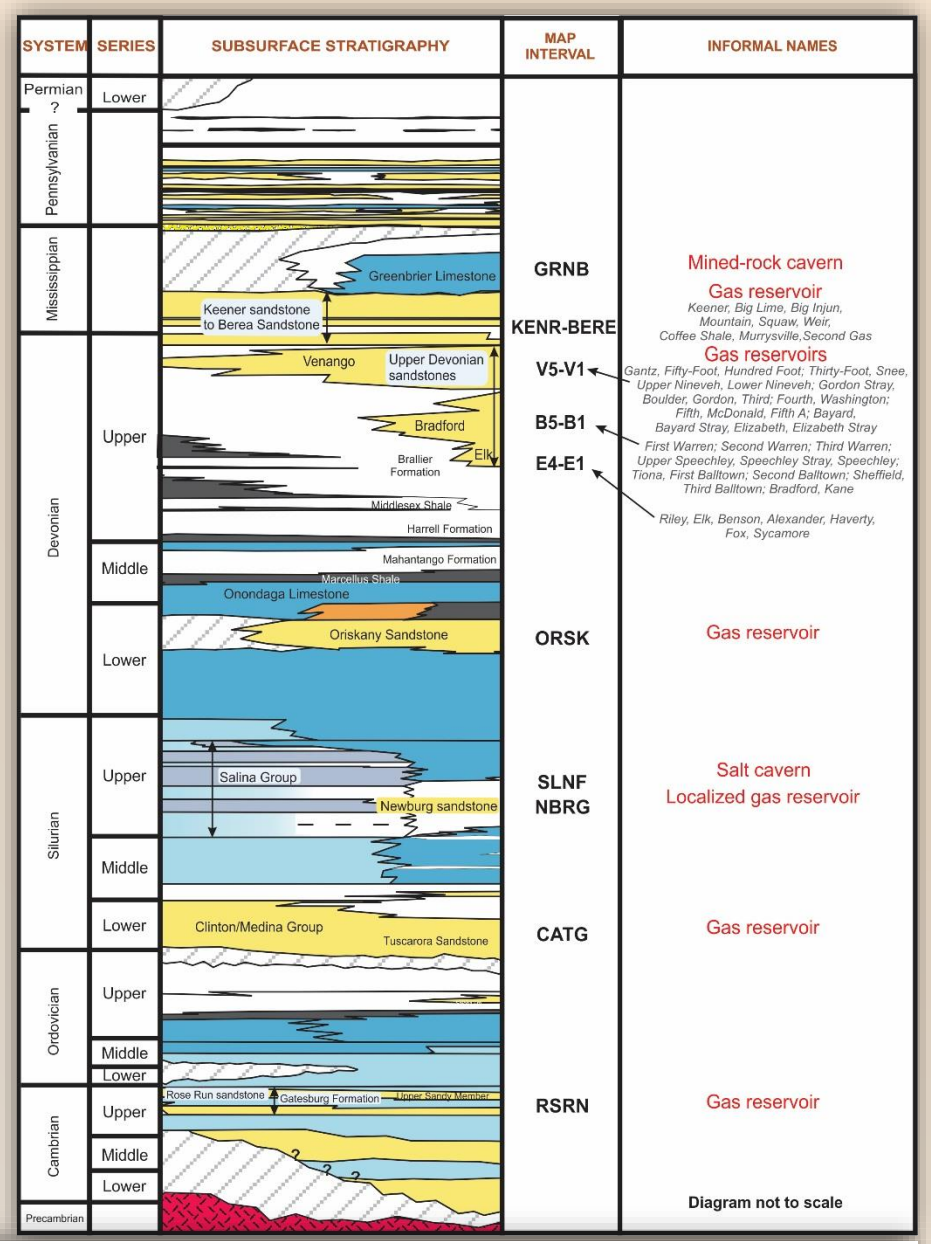
INTRODUCTION AND PURPOSE

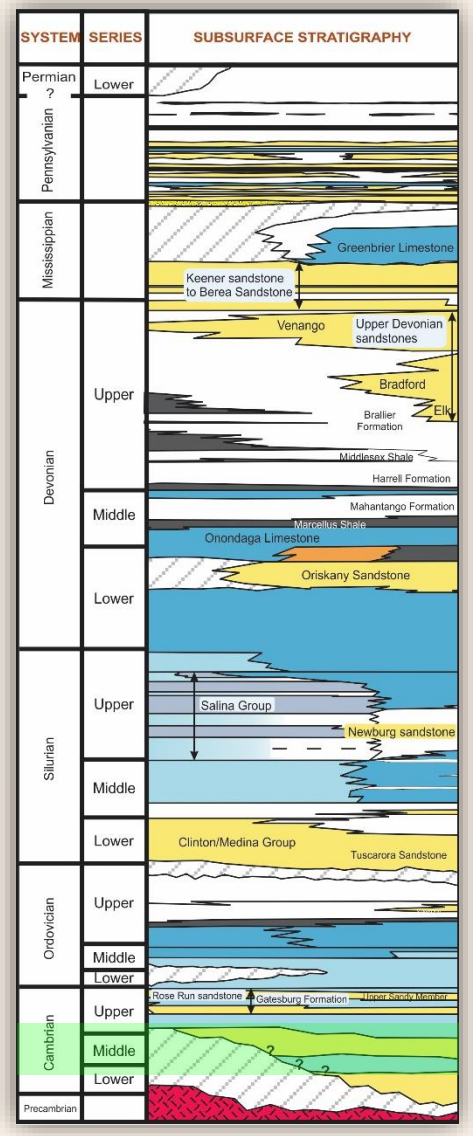
- Take a walk through geologic time, visiting geologic intervals of interest as we go
- Present the lithostratigraphic framework for subsurface geologic units in the AOI
- Discuss basic geological characteristics (depth, thickness and extent)of intervals included in the Study
- Present the concept of stacked opportunities

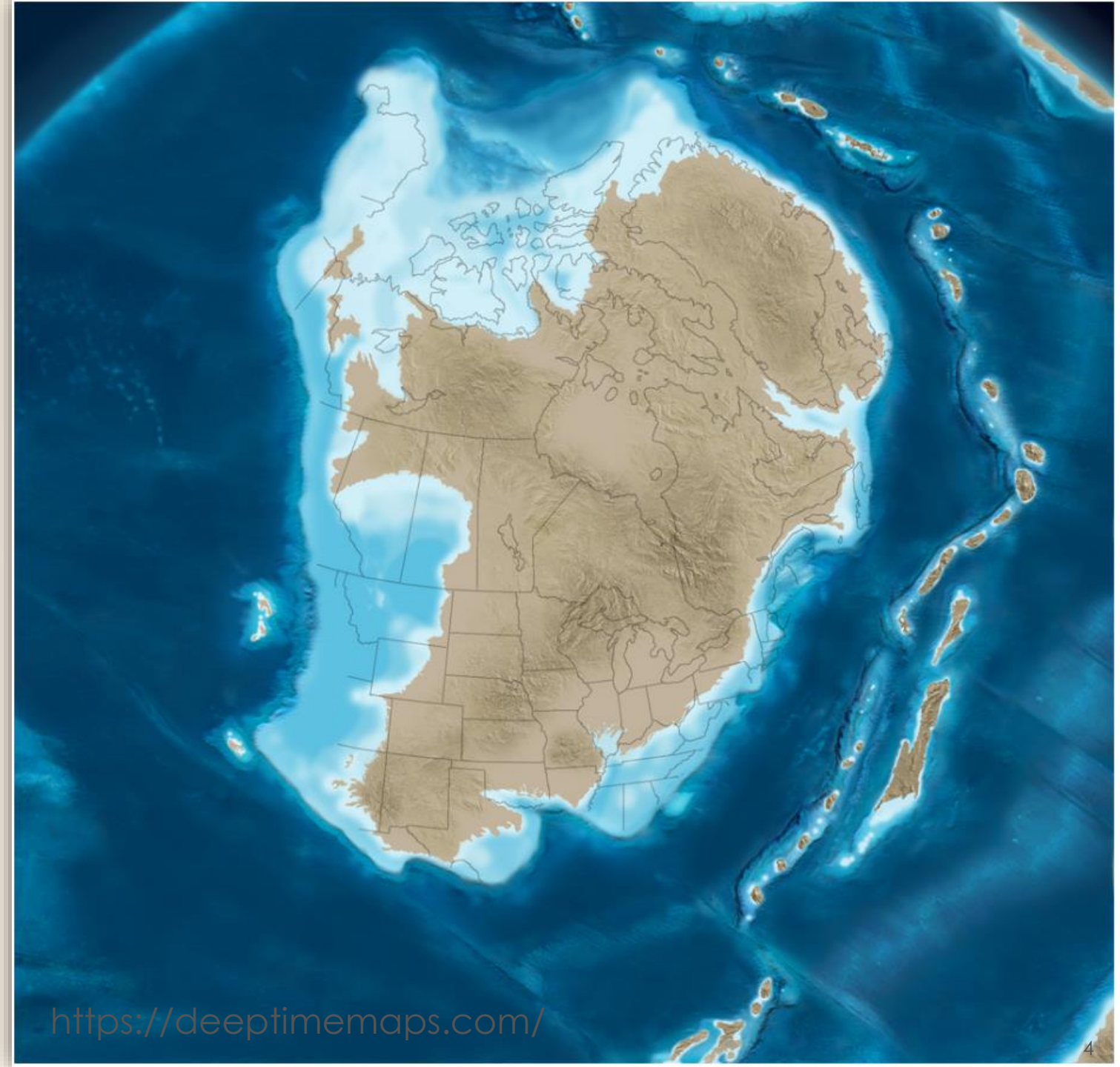
GENERALIZED SUBSURFACE STRATIGRAPHY

- 10 intervals of interest
- Cambrian- through Mississippian-age units
- Various lithologies (carbonate, siliciclastic and salt)
- Rock type affected by environments of deposition, as well as post-depositional processes

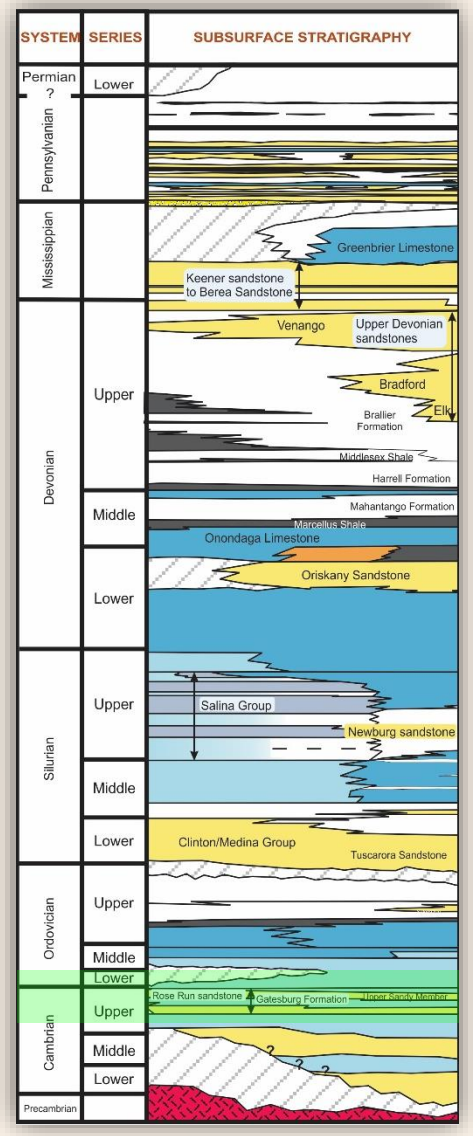


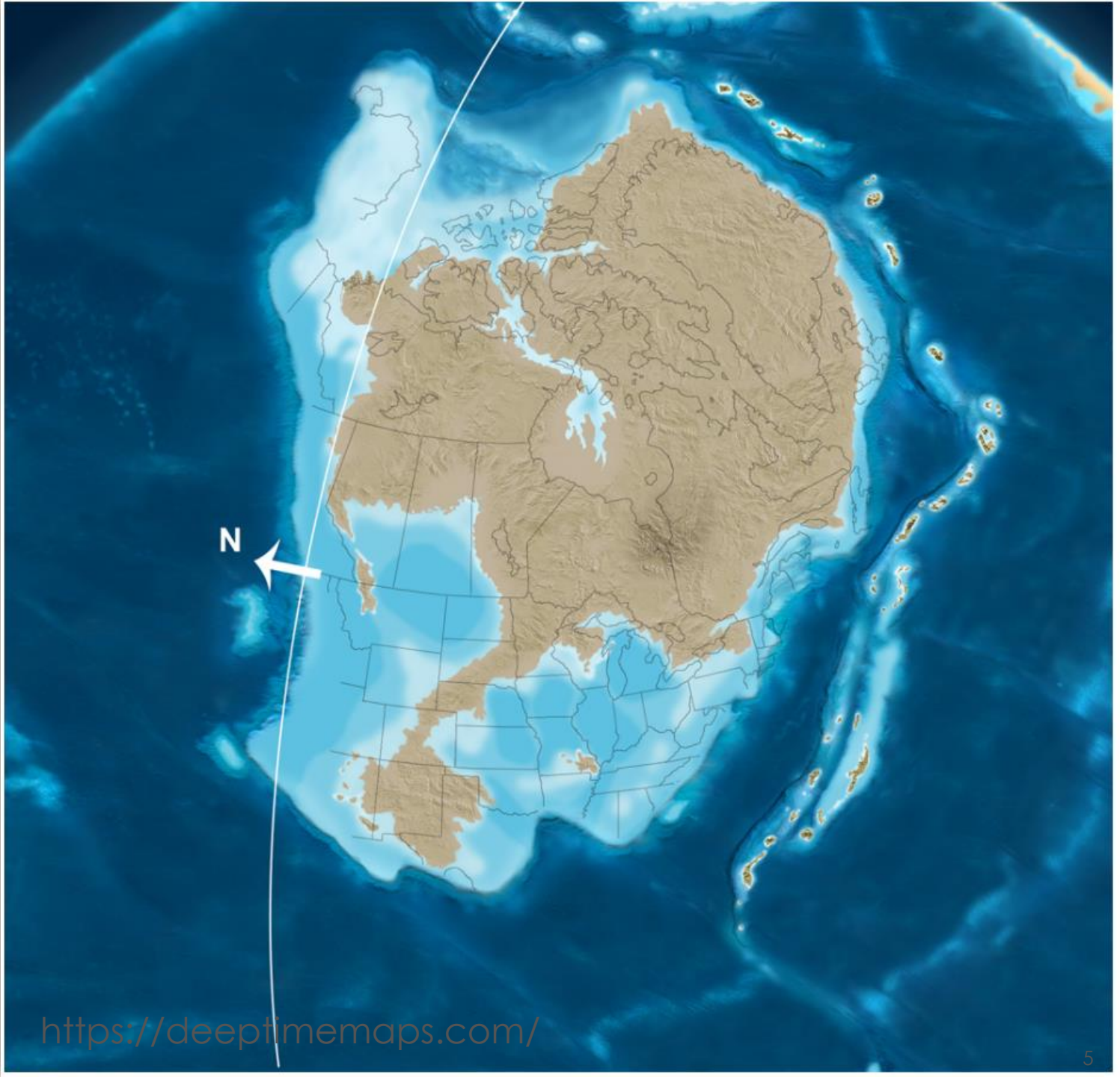
510 Ma
Middle Cambrian



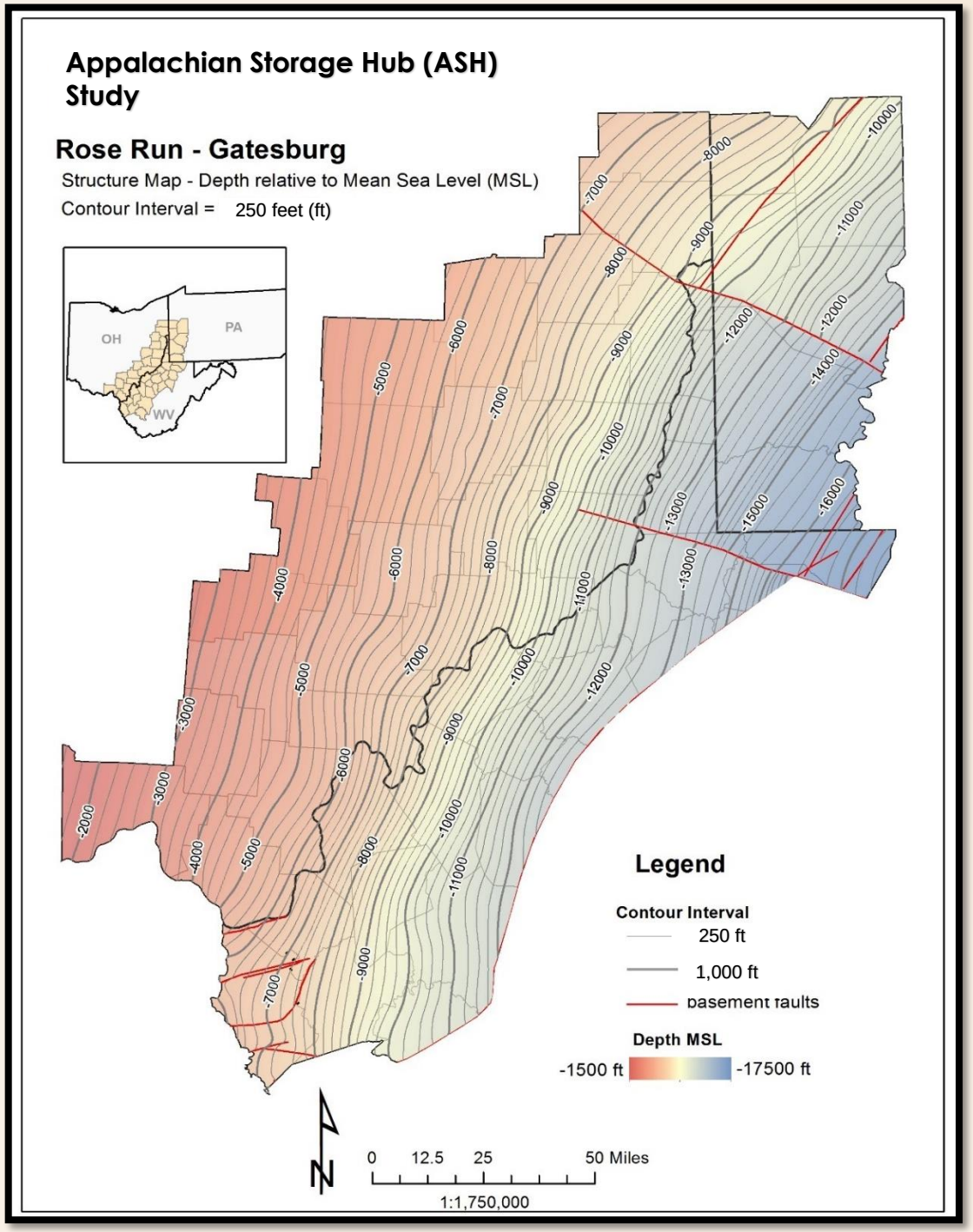


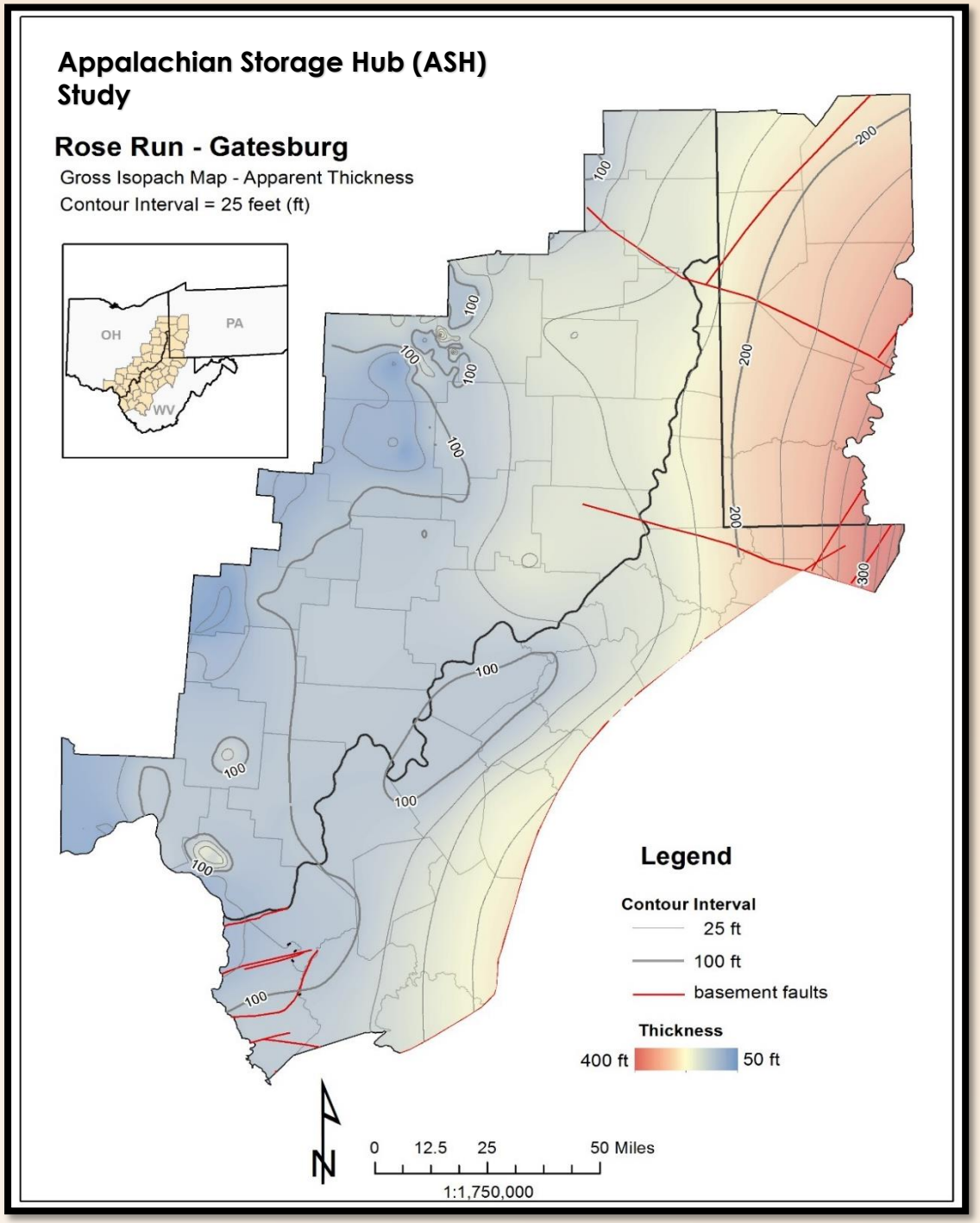
500 Ma
Late Cambrian



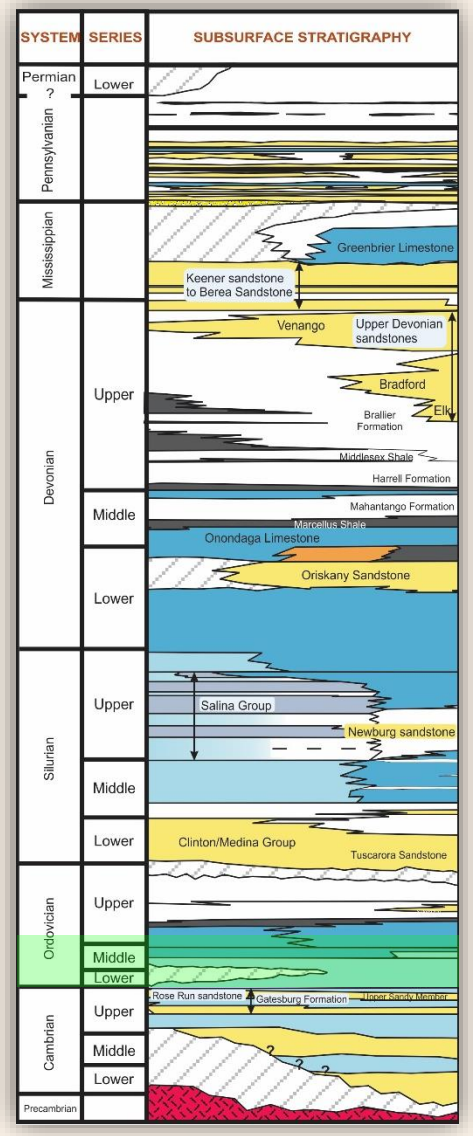


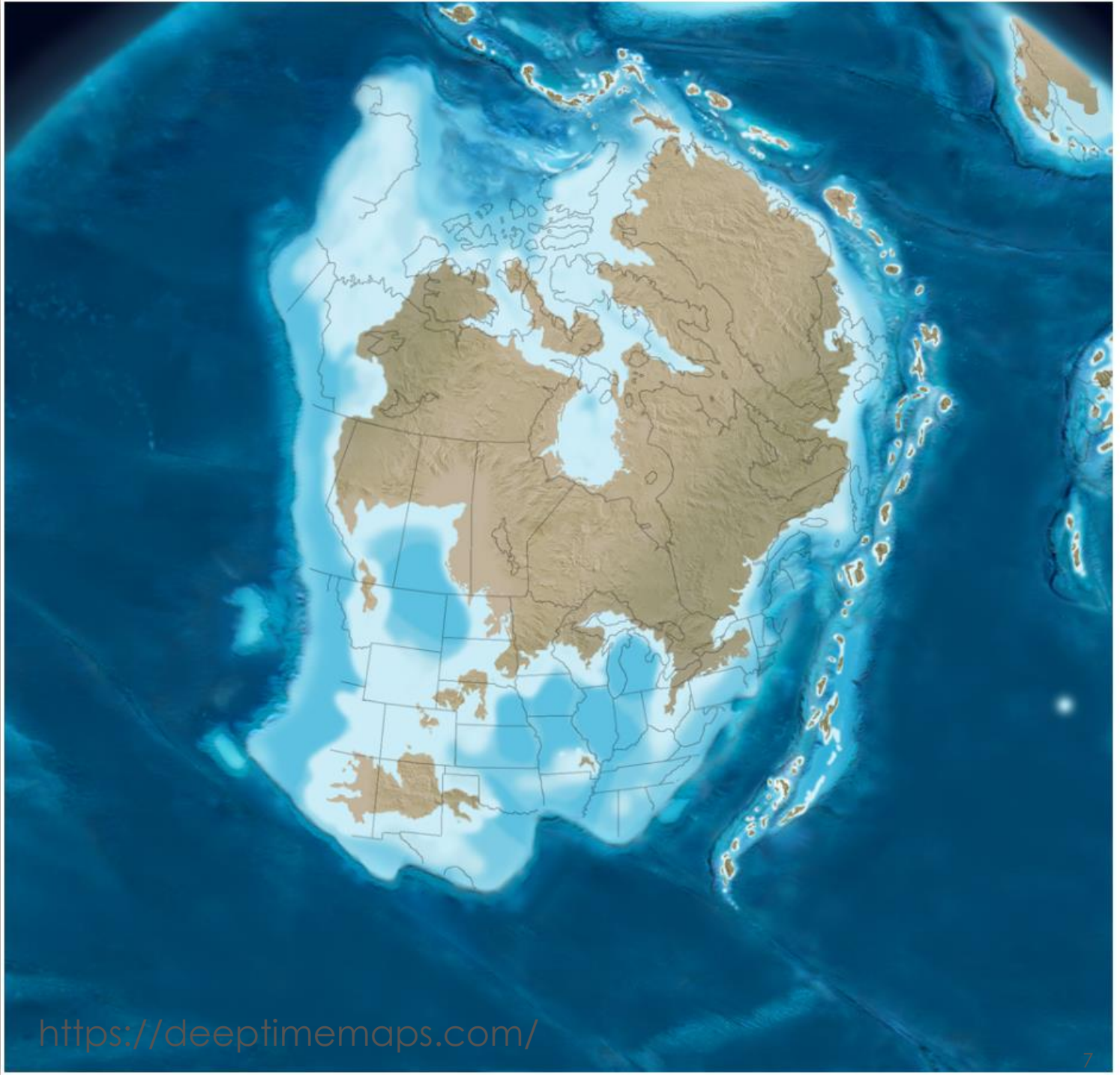
https://deeptimemaps.com/


Appalachian Storage Hub (ASH) Study
Rose Run - Gatesburg
Structure Map - Depth relative to Mean Sea Level (MSL)
Contour Interval = 250 feet (ft)
OH
PA
WV
Legend
Contour Interval
250 ft
1,000 ft
basement faults
Depth MSL
-1500 ft
-17500 ft
0 12.5 25 50 Miles
1:1,750,000

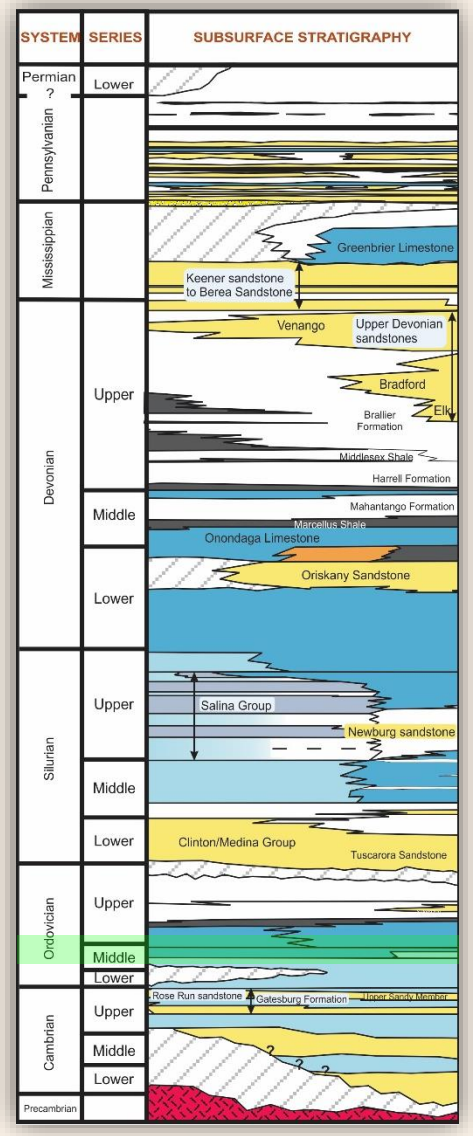

Appalachian Storage Hub (ASH) Study
Rose Run - Gatesburg
Gross Isopach Map - Apparent Thickness
Contour Interval = 25 feet (ft)
OH
PA
WV
Legend
Contour Interval
25 ft
100 ft
basement faults
Thickness
400 ft
50 ft
0 12.5 25 50 Miles
1:1,750,000

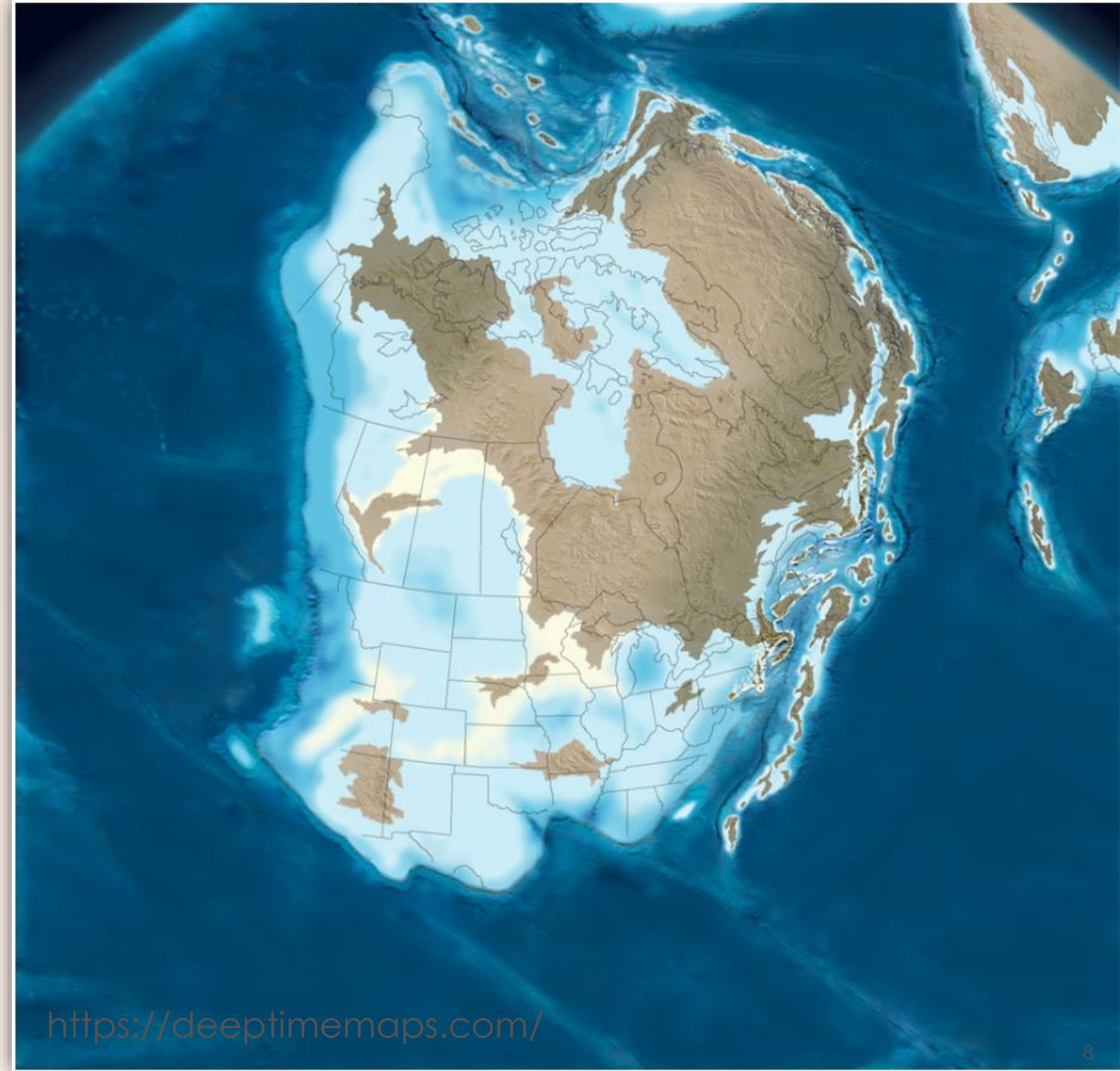
485 Ma
Early Ordovician



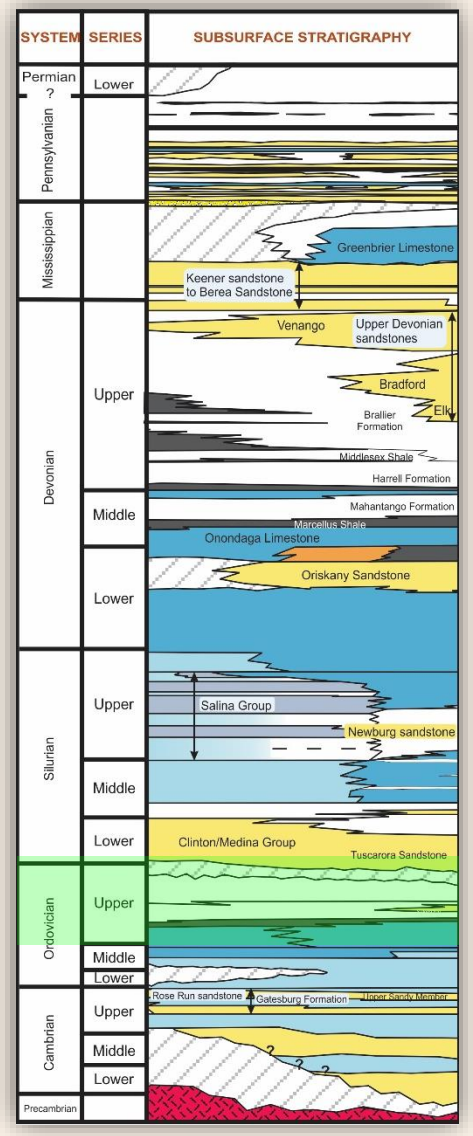


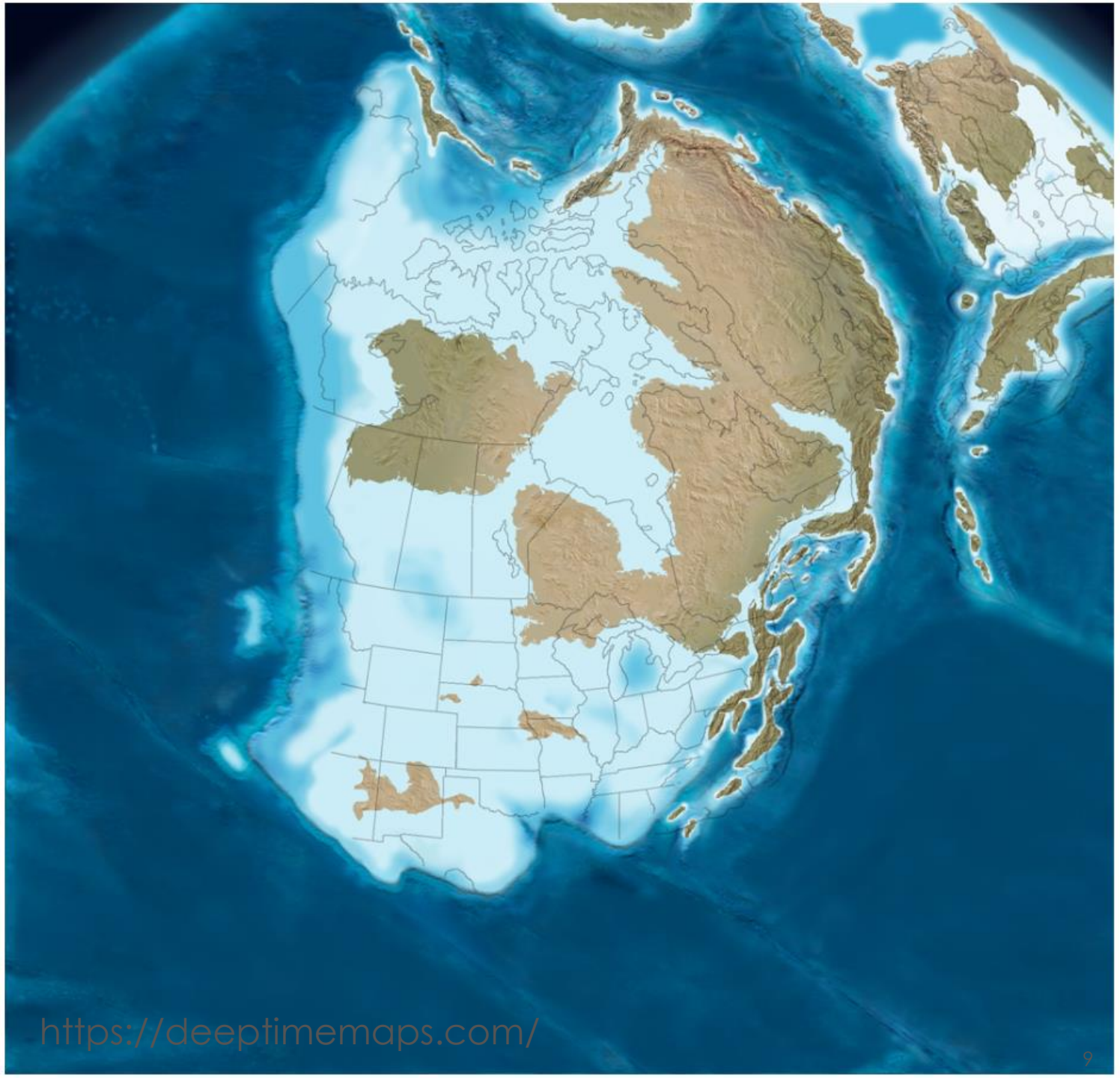
470 Ma
Middle Ordovician



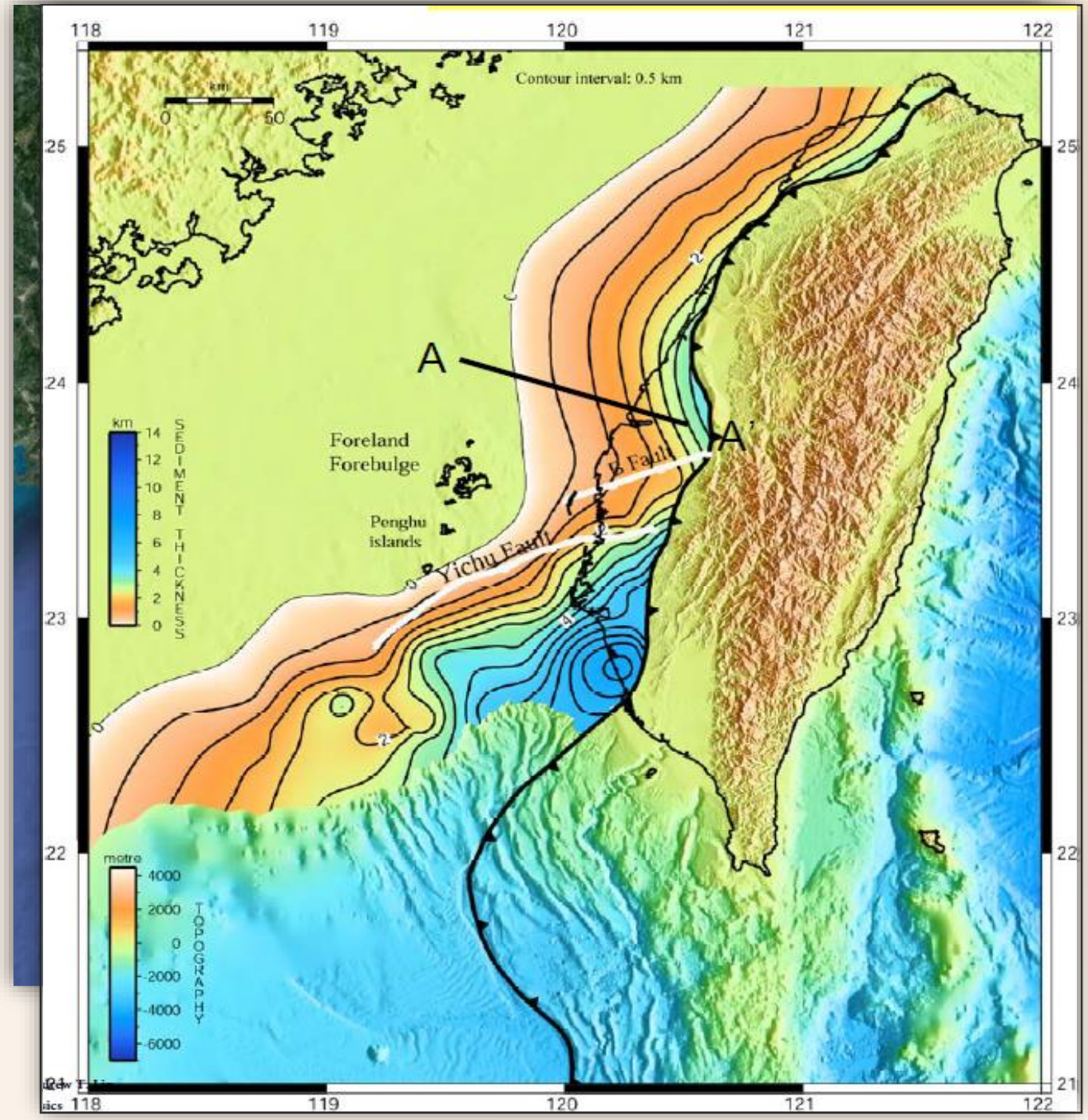


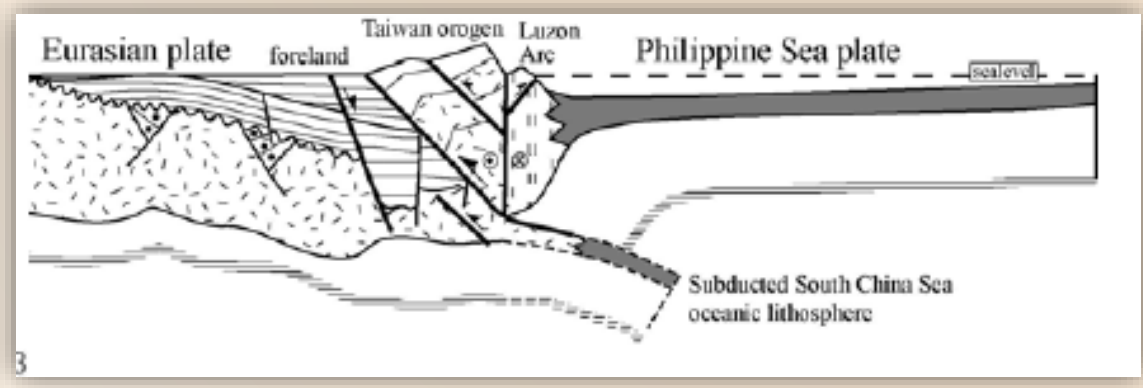
450 Ma
Late Ordovician



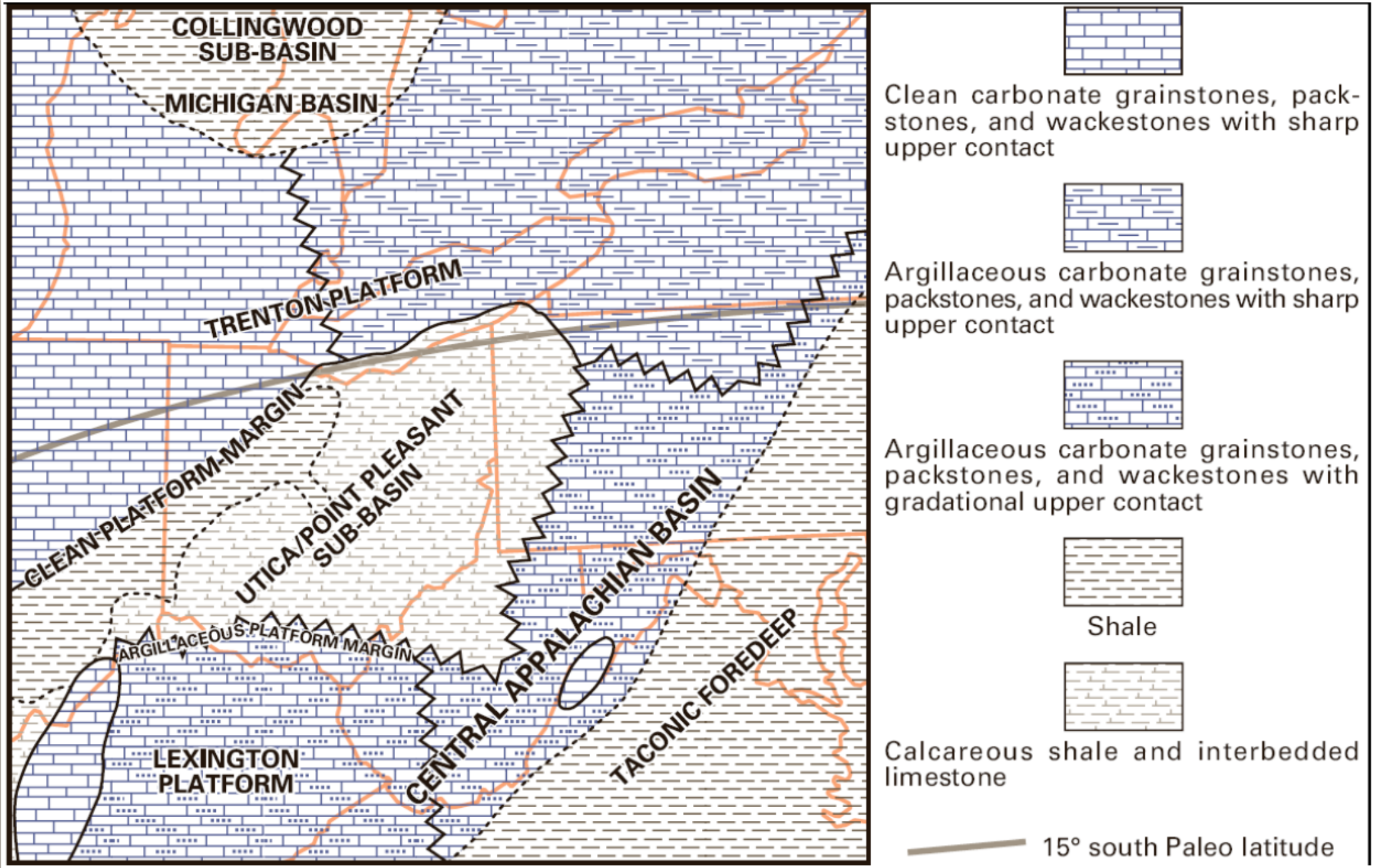


Modern Analog: Taiwan Foreland Basin



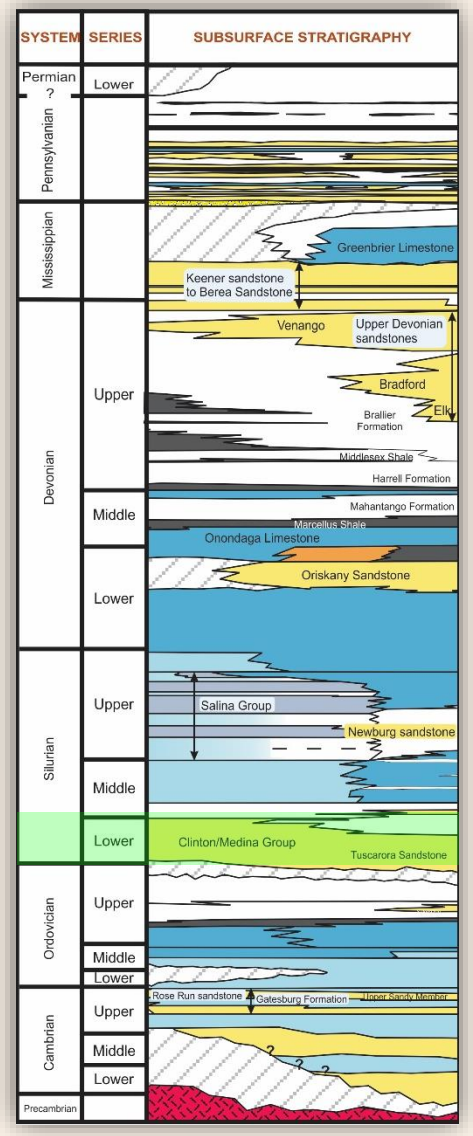


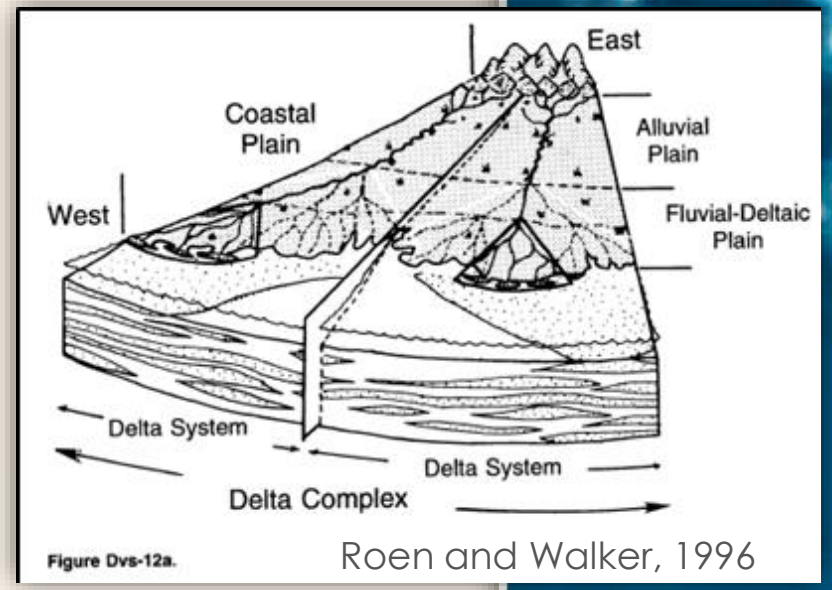
http://basin.earth.ncu.edu.tw/download/courses/basin_analysis/4_flexure.pdf



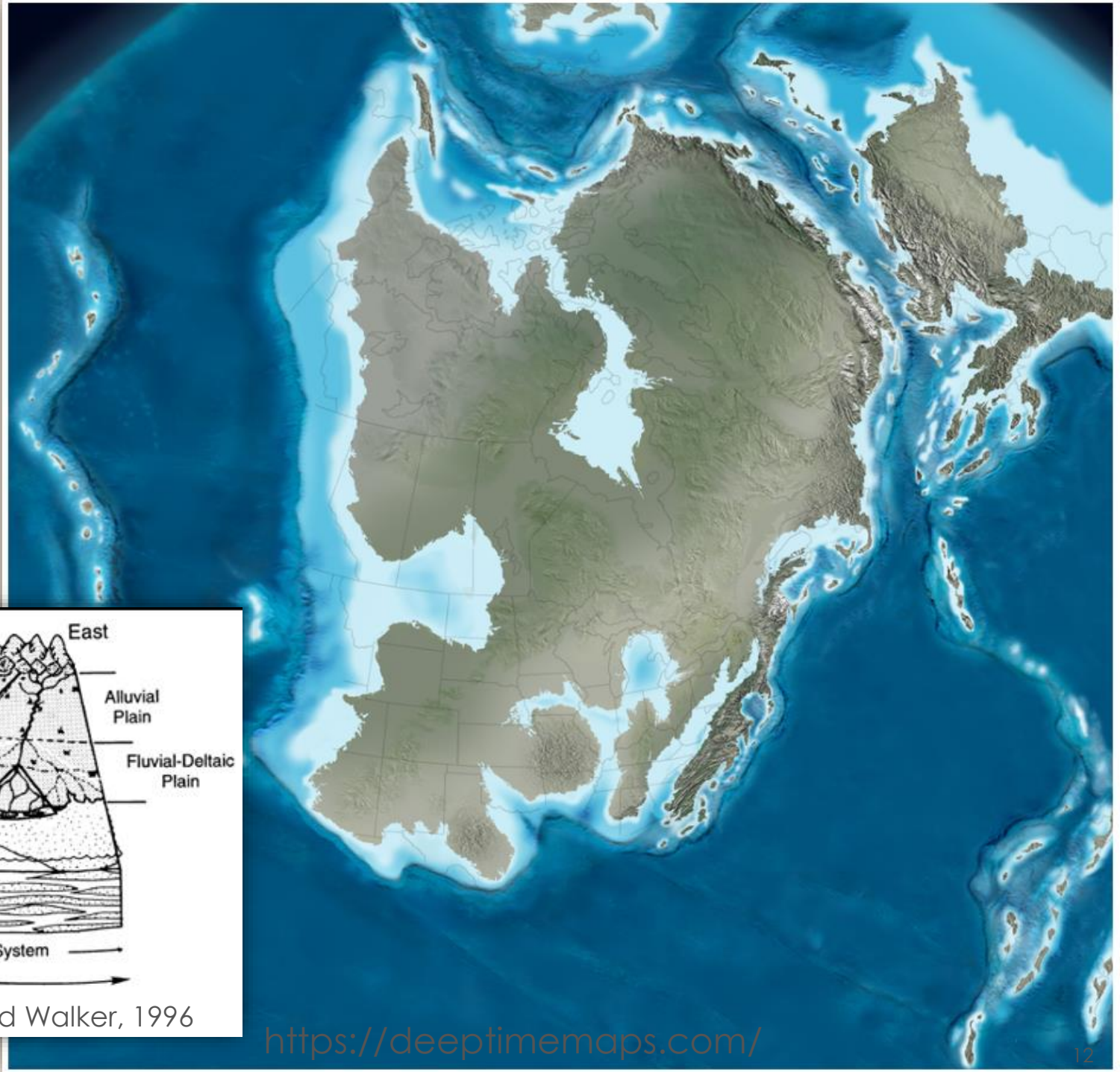
Patchen and others, 2006

430 Ma
Early Silurian





Roen and Walker, 1996



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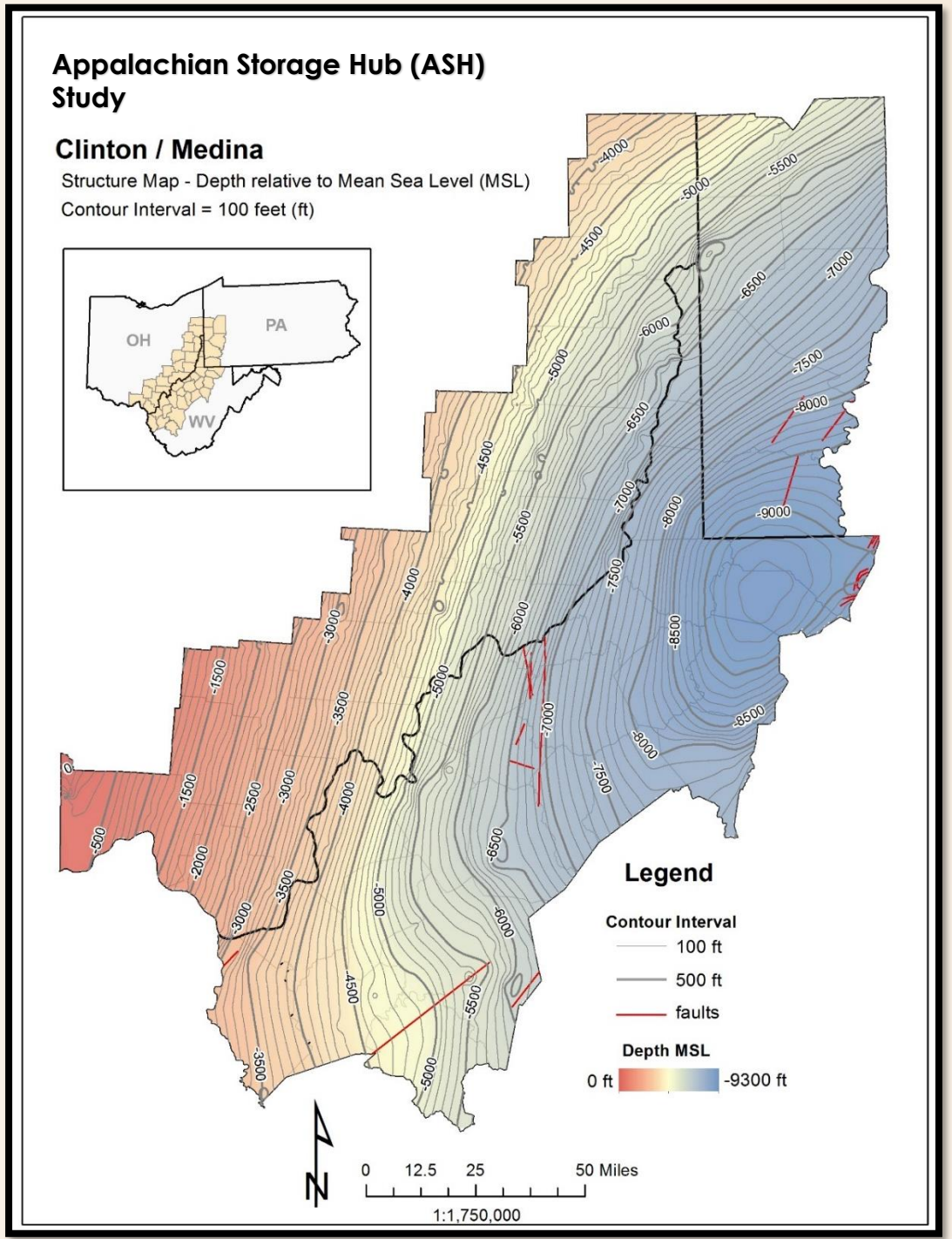
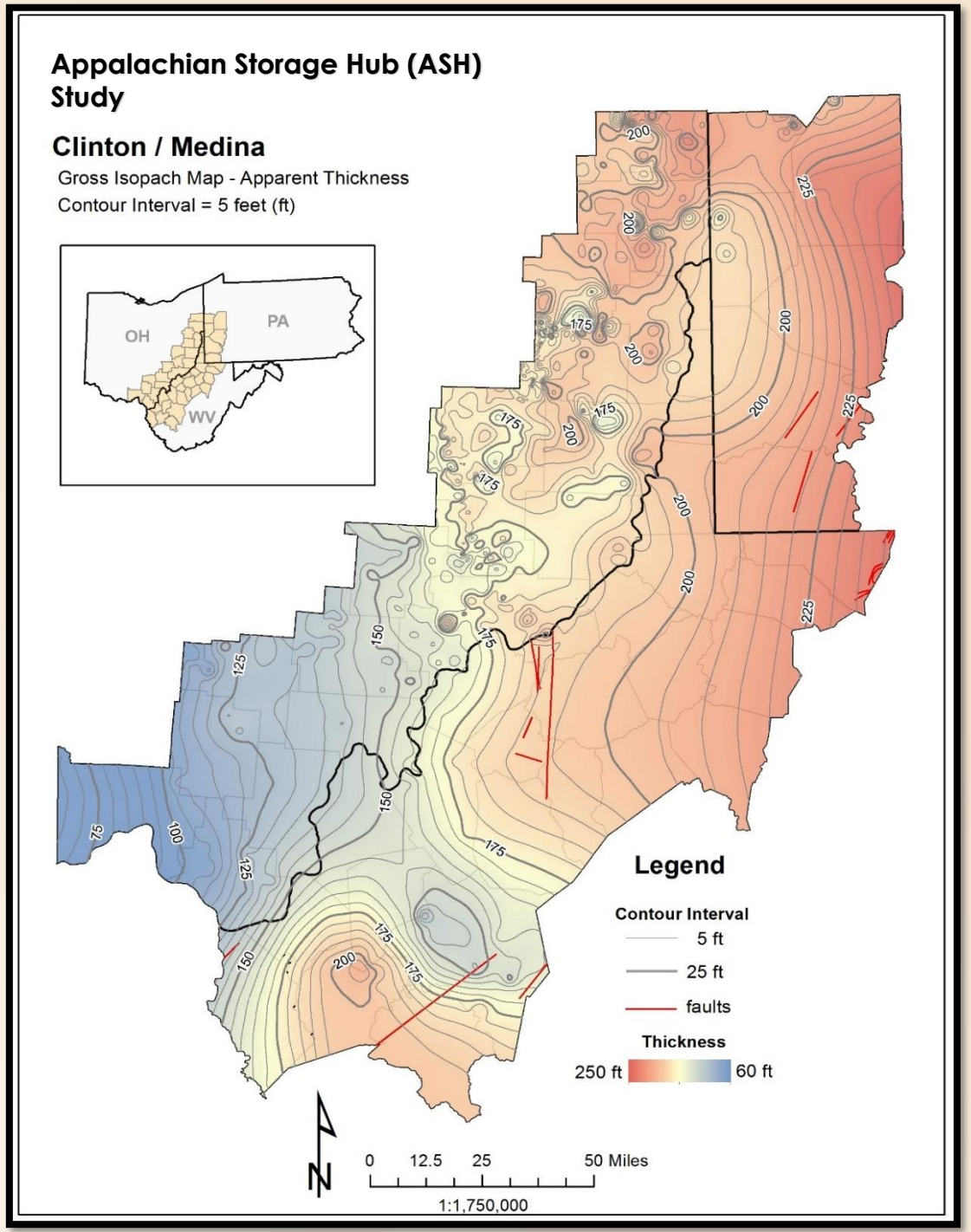
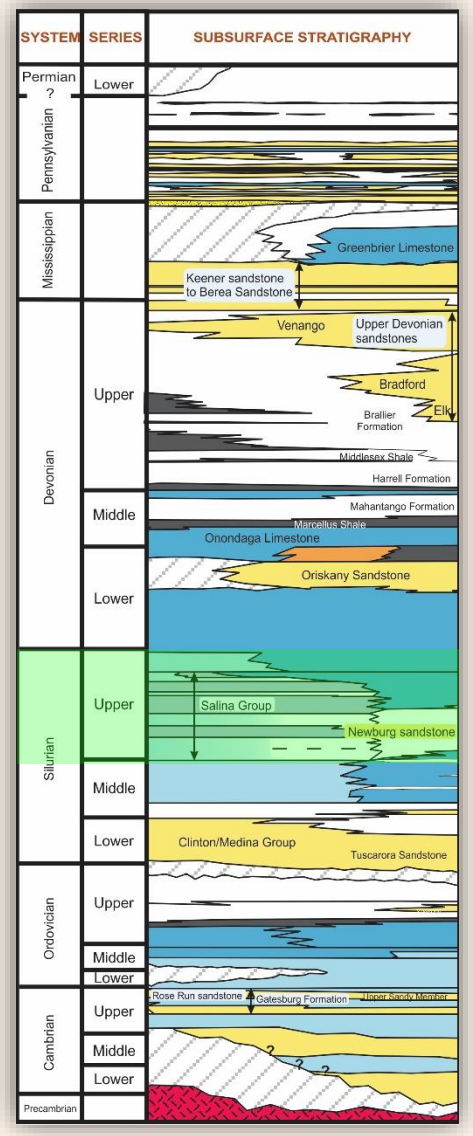
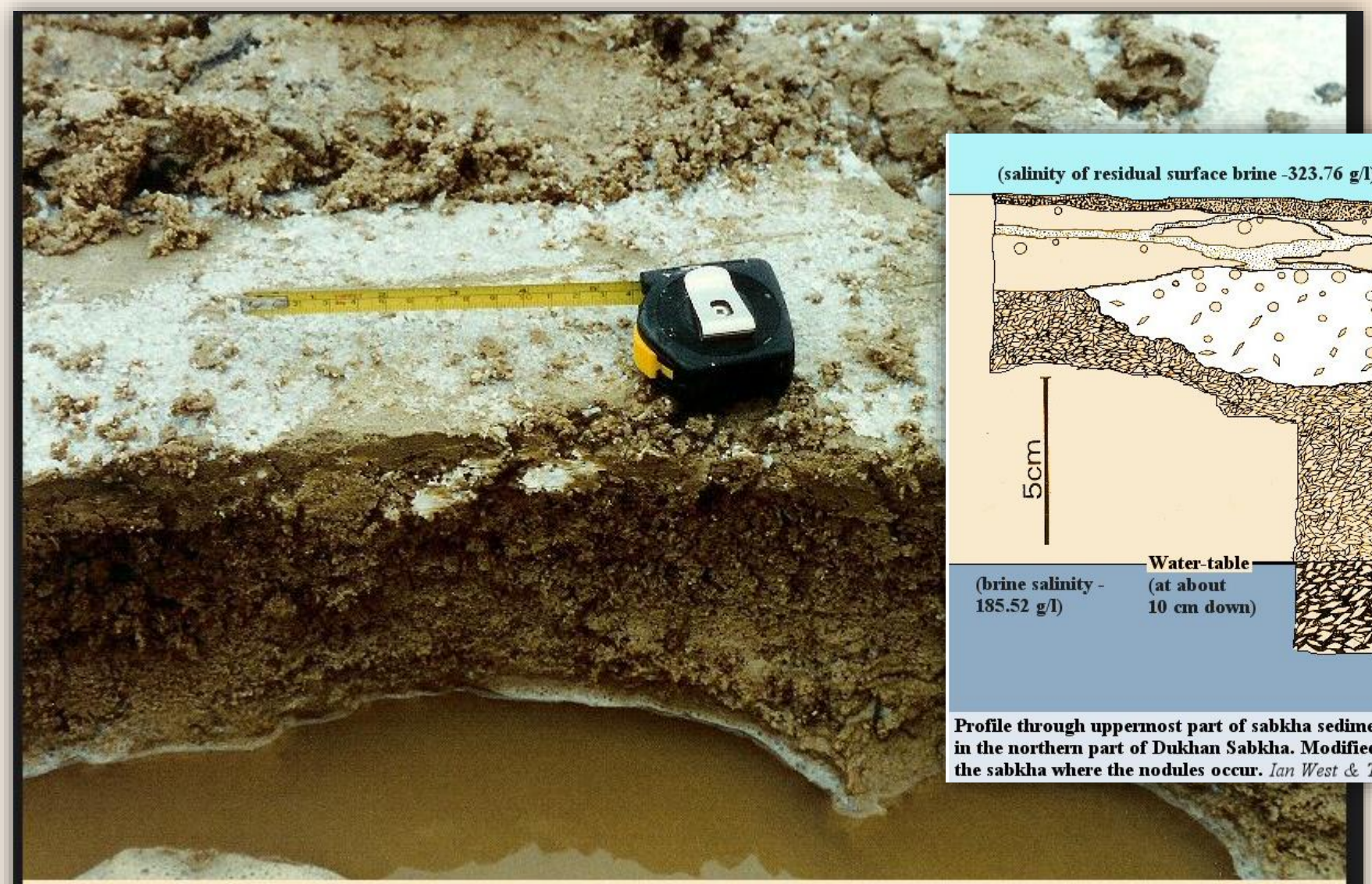

Appalachian Storage Hub (ASH) Study
Clinton / Medina
Structure Map - Depth relative to Mean Sea Level (MSL)
Contour Interval = 100 feet (ft)
OH
PA
WV
Legend
Contour Interval
100 ft
500 ft
faults
Depth MSL
0 ft
-9300 ft
0 12.5 25 50 Miles
1:1,750,000


Appalachian Storage Hub (ASH) Study
Clinton / Medina
Gross Isopach Map - Apparent Thickness
Contour Interval = 5 feet (ft)
OH
PA
WV
Legend
Contour Interval
5 ft
25 ft
faults
Thickness
250 ft
60 ft
0 12.5 25 50 Miles
1:1,750,000

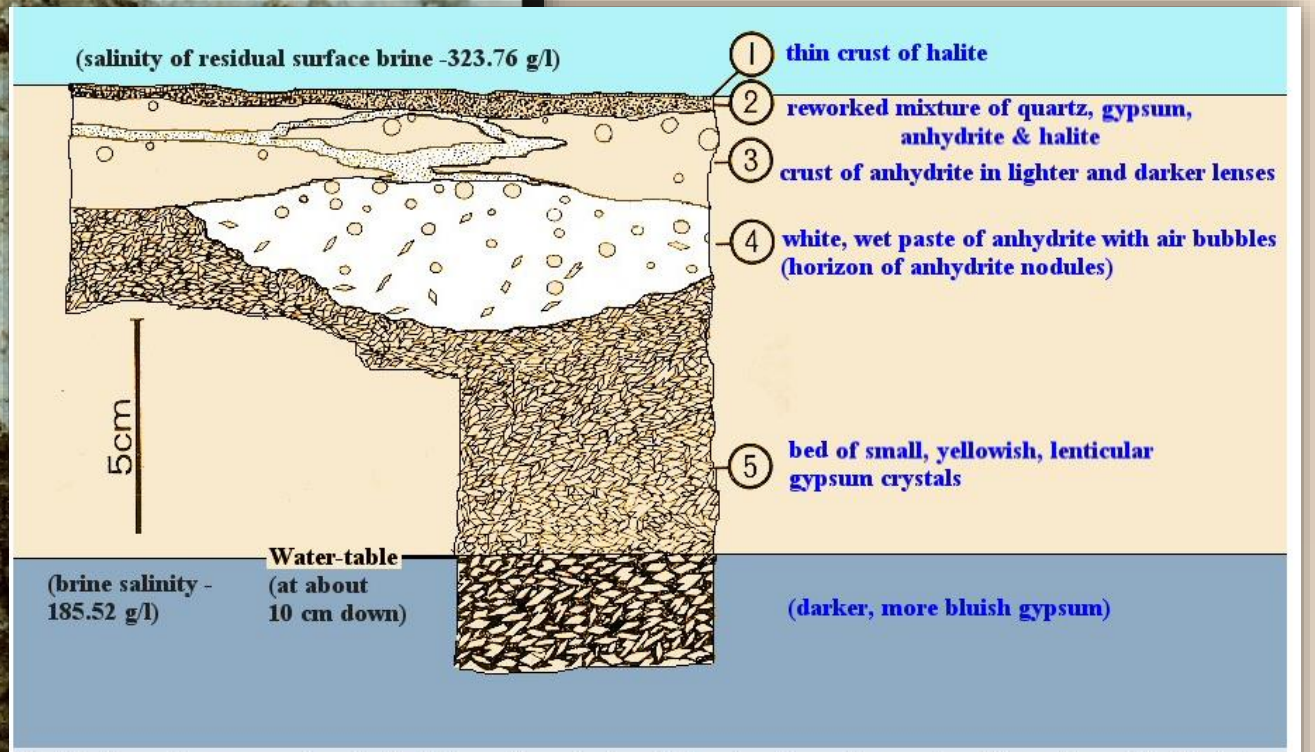
420 Ma
Late Silurian



Modern Analog: Persian Gulf Sabkha



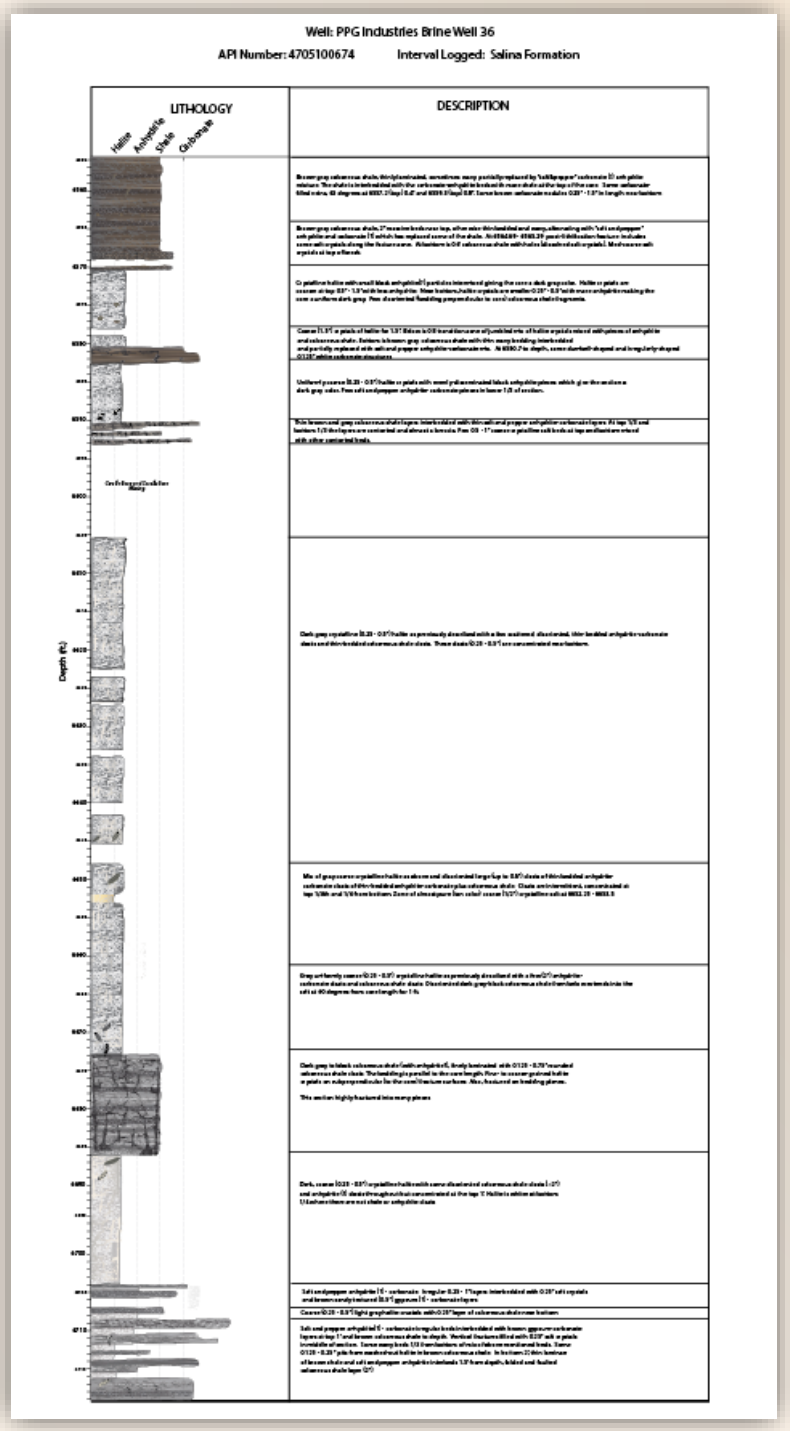
Pit through a marginal part of Dukhan Sabkha near the salt lake. White anhydrite occurs a few cm beneath the surface. The level of the gypsum-saturated brine is about 10 or 15 cm beneath the halite encrusted surface. Compare with profile of Perthuisot (1977). *Ian West & Tonya West (c) 2006.*



Profile through uppermost part of sabkha sediments about 50 metres from the margin of the salt crust (salt lake) in the northern part of Dukhan Sabkha. Modified after Perthuisot (1977). Compare with later photograph of pit in the sabkha where the nodules occur. *Ian West & Tonya West (c) 2006.*

http://www.southampton.ac.uk/~imw/Sabkhas-Bibliography.htm

The Salina is a bedded salt


Well: PPG Industries Brine Well 36

API Number: 4705100674 Interval Logged: Salina Formation

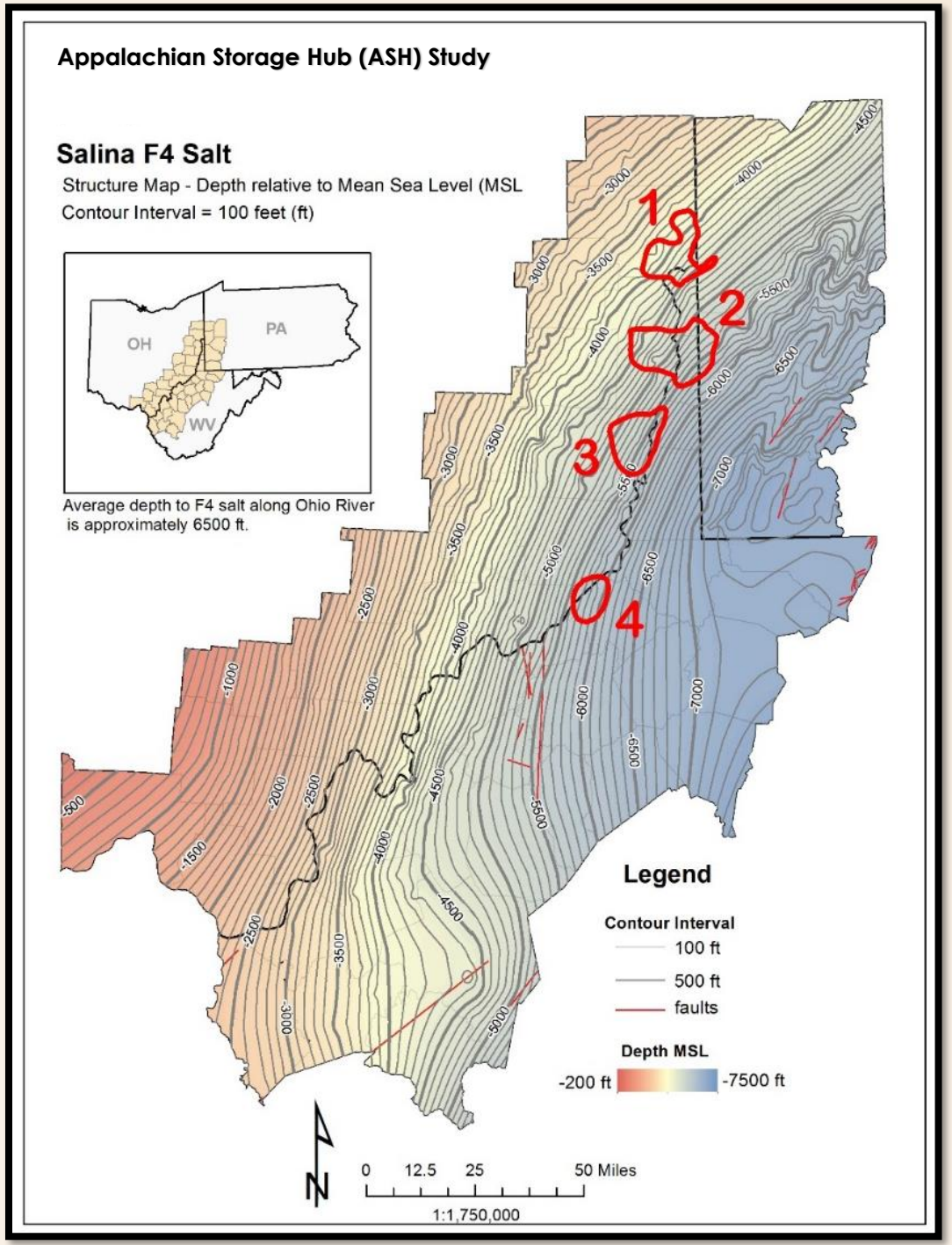
LITHOLOGY

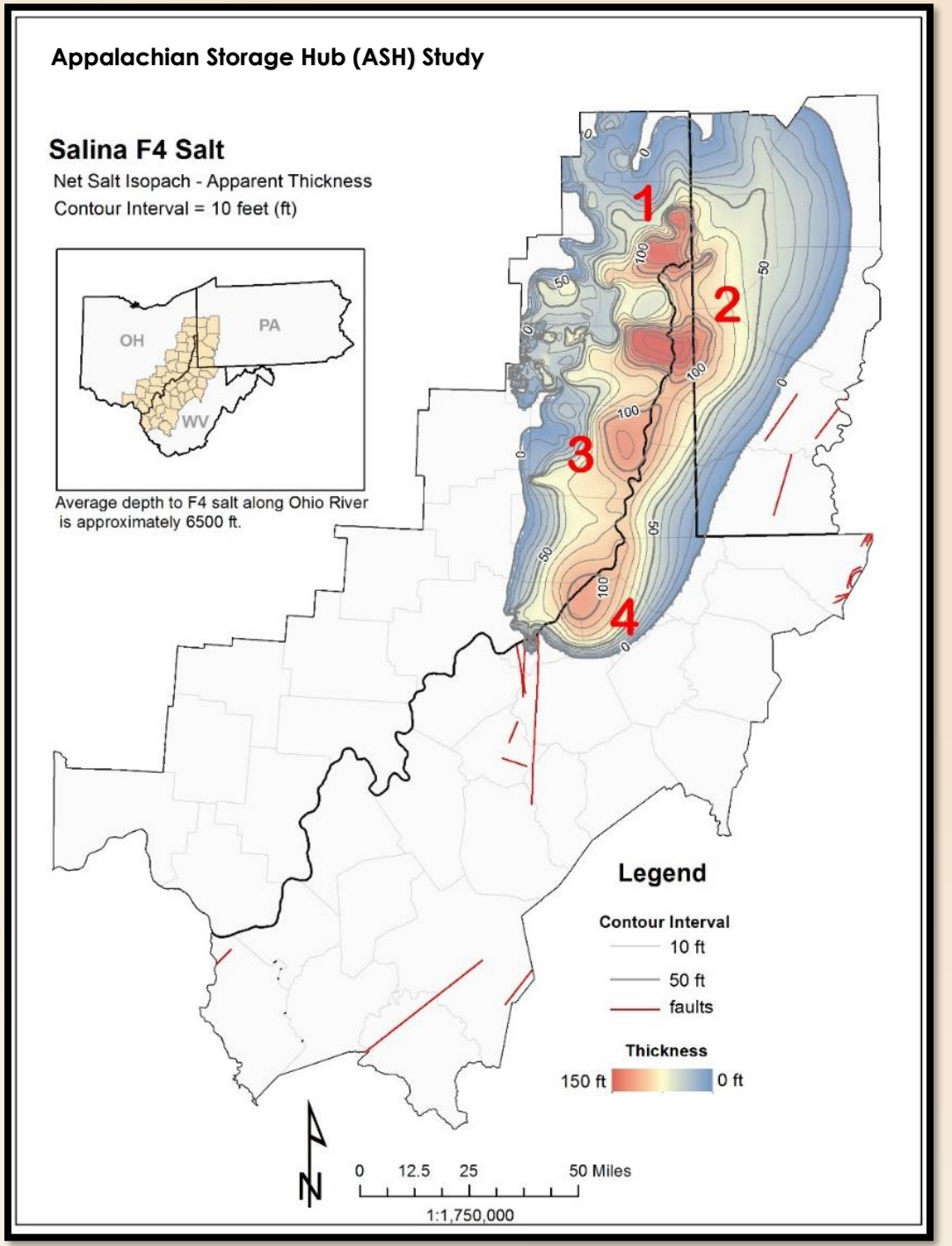
Halite Anhydrite Shale Carbonate

DESCRIPTION

Depth (ft)

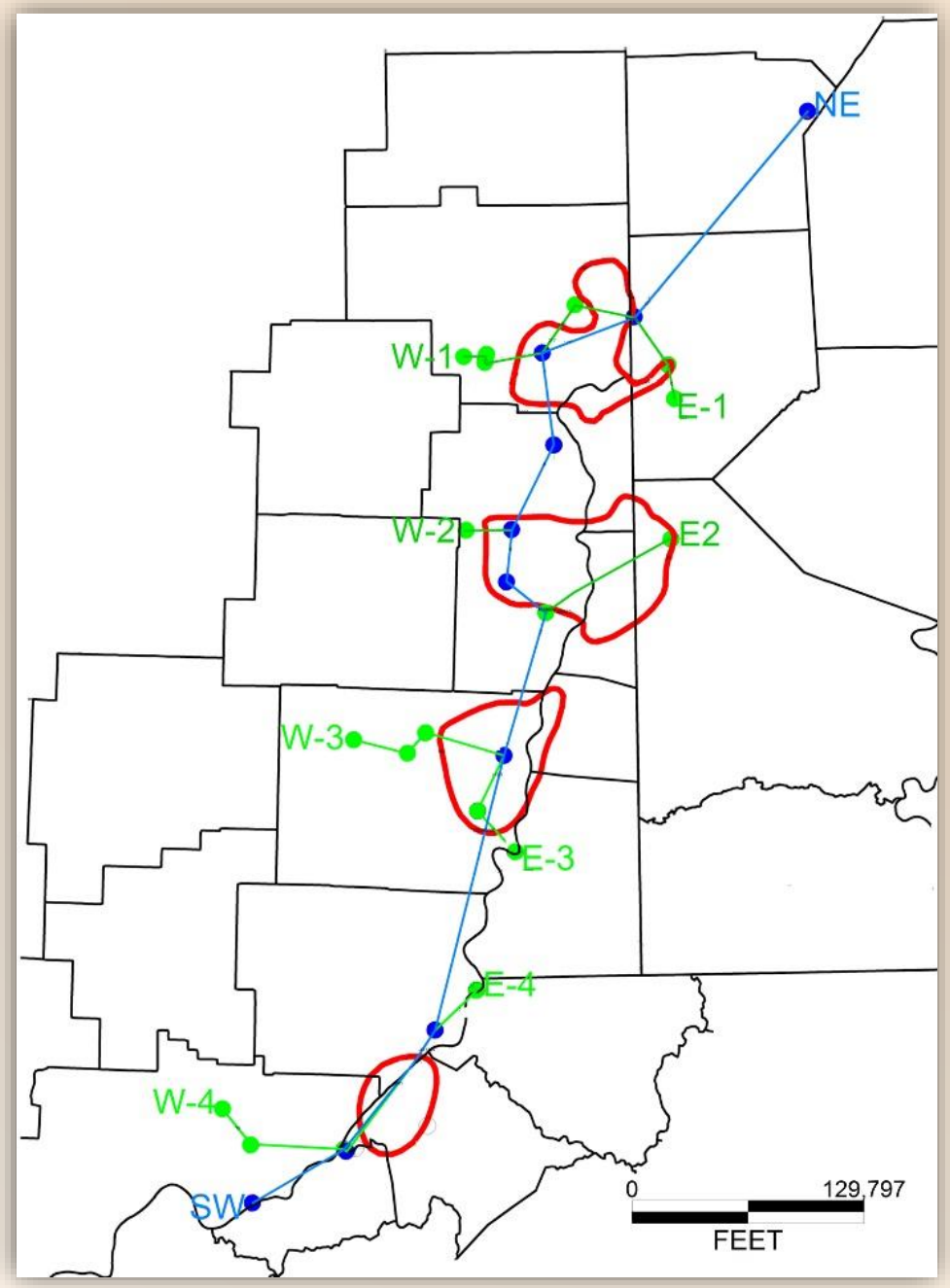
PPG Industries Brine Well 36, Marshall County, WV


Appalachian Storage Hub (ASH) Study
Salina F4 Salt
Structure Map - Depth relative to Mean Sea Level (MSL
Contour Interval = 100 feet (ft)
OH
PA
WV
Average depth to F4 salt along Ohio River is approximately 6500 ft.
1
2
3
4
Legend
Contour Interval
100 ft
500 ft
faults
Depth MSL
-200 ft
-7500 ft
N
0 12.5 25 50 Miles
1:1,750,000

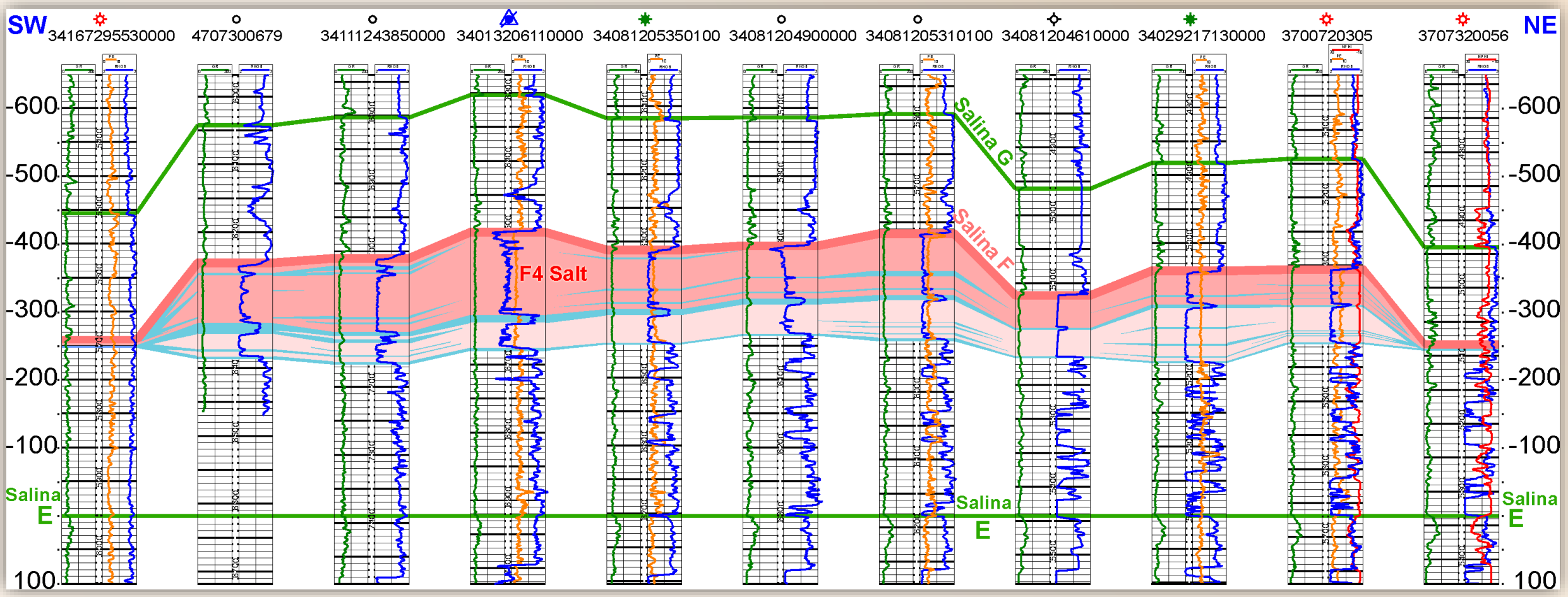

Appalachian Storage Hub (ASH) Study
Salina F4 Salt
Net Salt Isopach - Apparent Thickness
Contour Interval = 10 feet (ft)
OH
PA
WV
Average depth to F4 salt along Ohio River is approximately 6500 ft.
1
2
3
4
Legend
Contour Interval
10 ft
50 ft
faults
Thickness
150 ft
0 ft
N
0 12.5 25 50 Miles
1:1,750,000

SALINA SALT CROSS SECTIONS

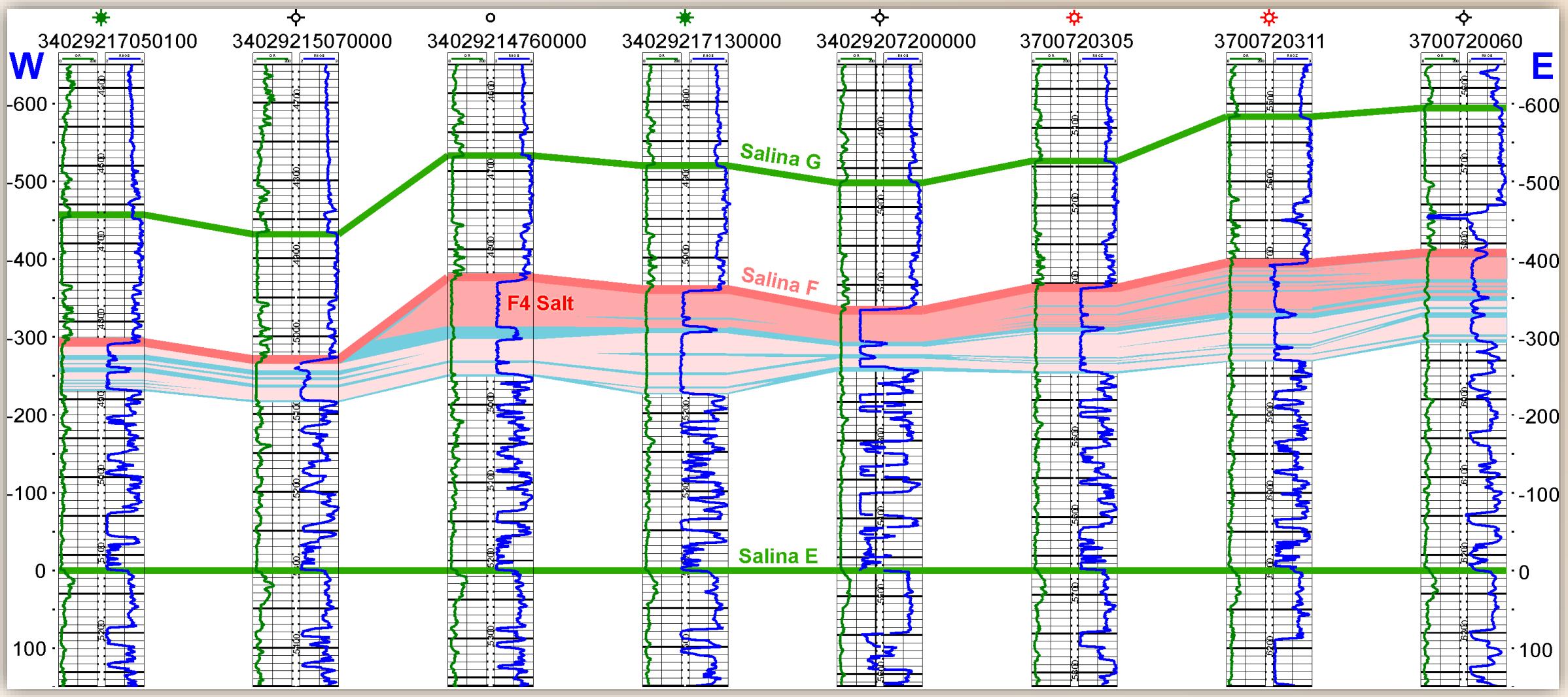
- One strike section –SW to NE along the Ohio River Valley corridor
- Four dip sections – W to E through each of the four Salina F4 Salt areas



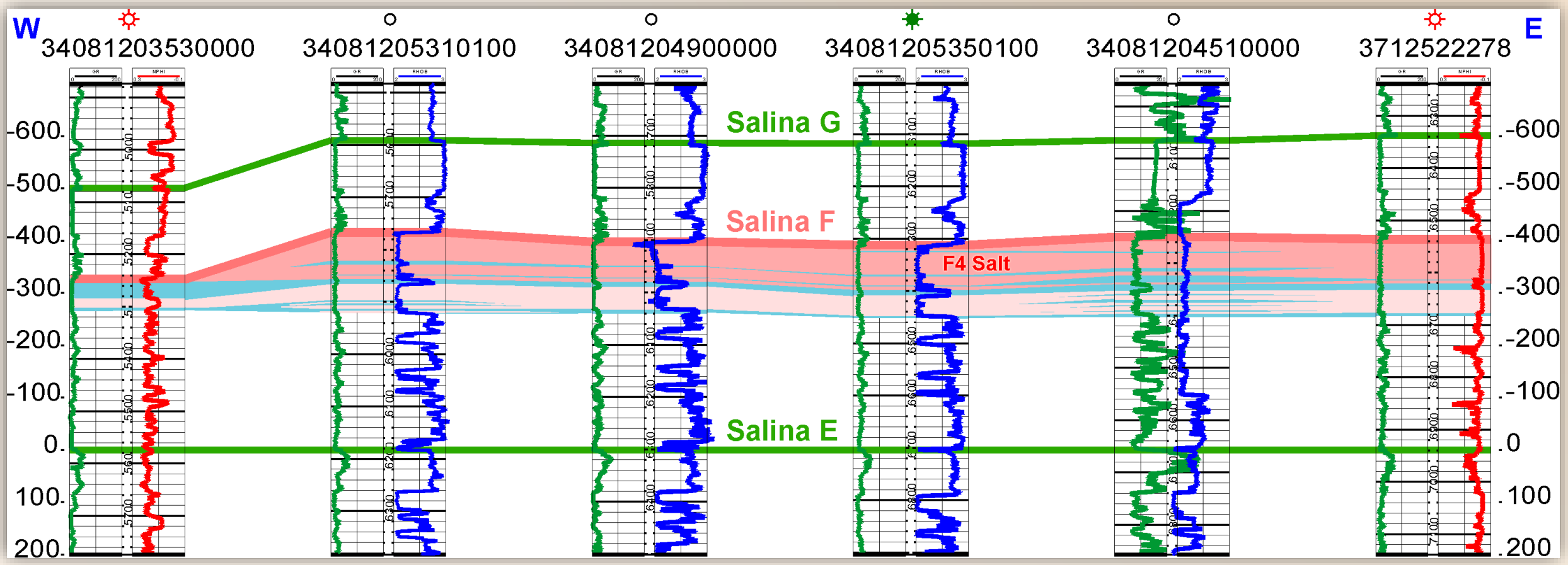
SW-NE (STRIKE) CROSS SECTION



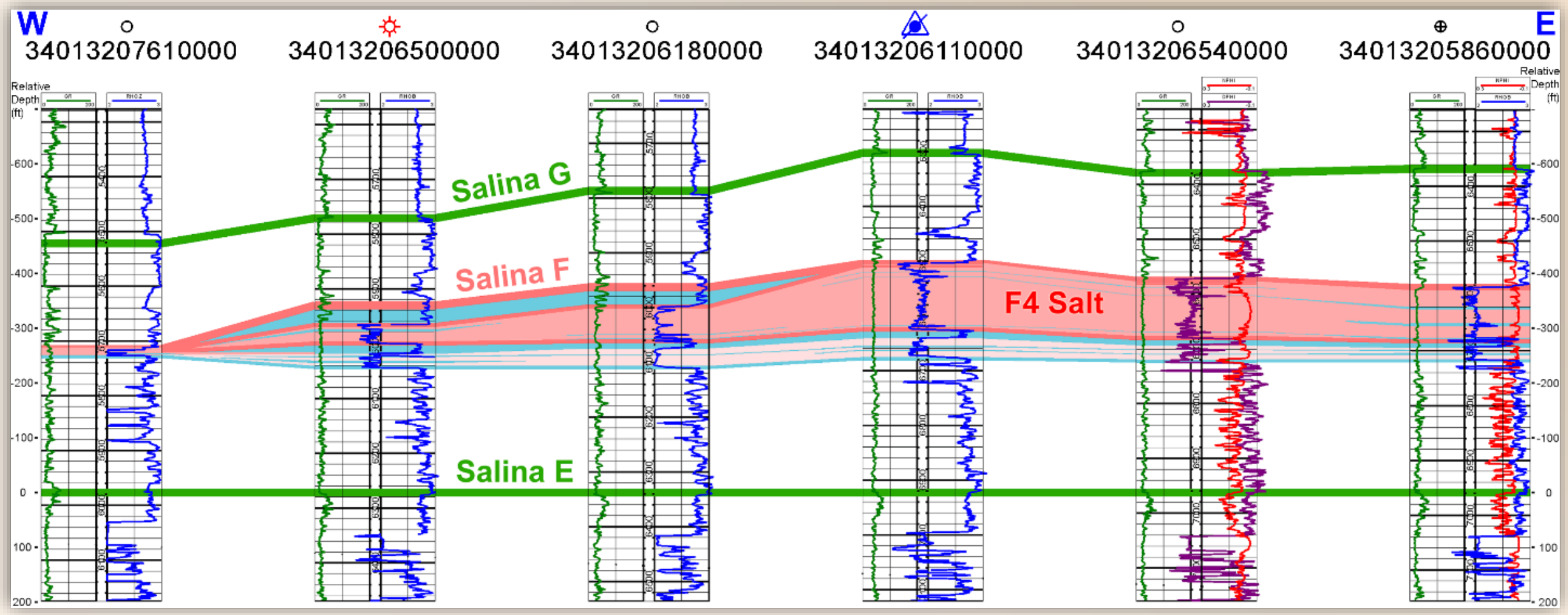
W-E (DIP) CROSS SECTION – AREA 1



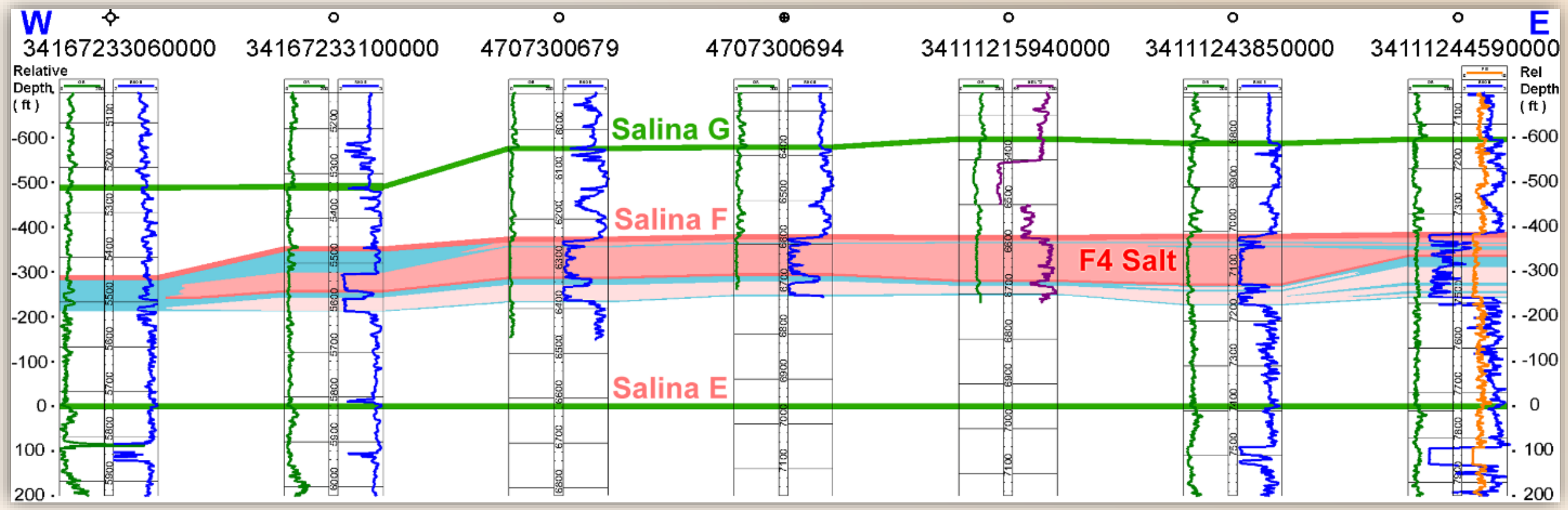
W-E (DIP) CROSS SECTION – AREA 2



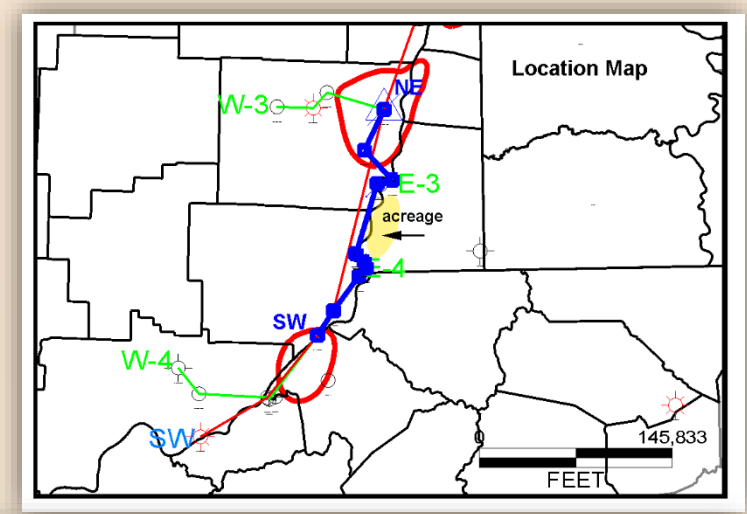
W-E (DIP) CROSS SECTION – AREA 3

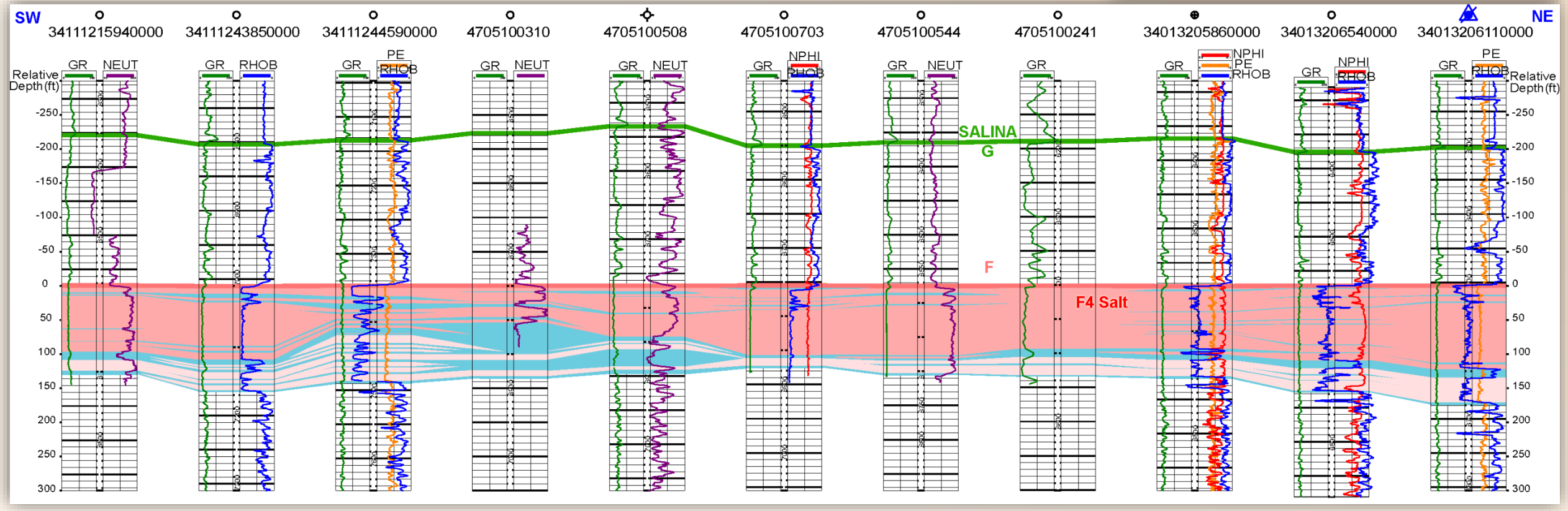


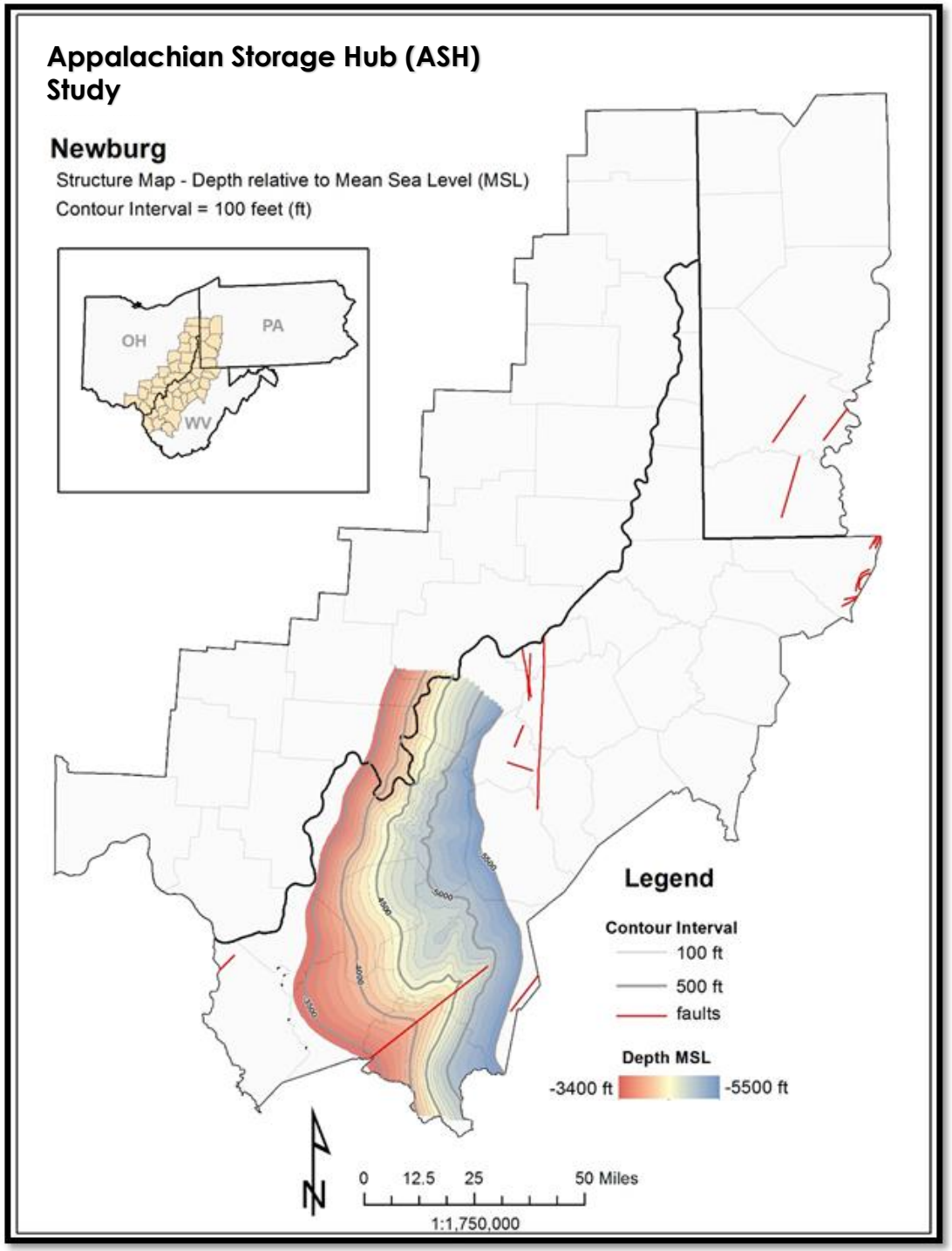
W-E (DIP) CROSS SECTION – AREA 4



DETAILED F4 SALT CROSS SECTION MARSHALL COUNTY, WV



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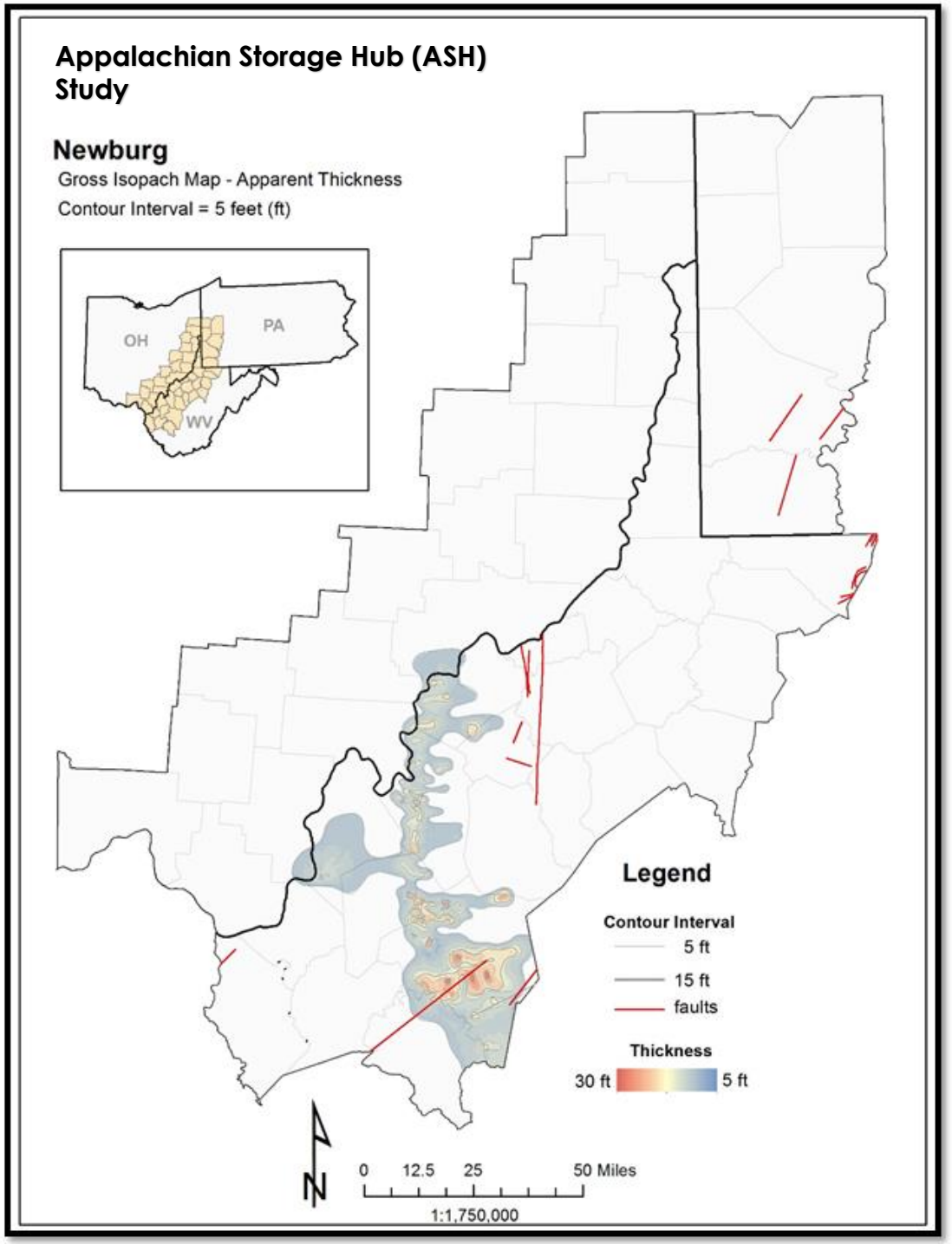
Newburg
Structure Map - Depth relative to Mean Sea Level (MSL)
Contour Interval = 100 feet (ft)
OH
PA
WV
Legend
Contour Interval
100 ft
500 ft
faults
Depth MSL
-3400 ft
-5500 ft
0 12.5 25 50 Miles
1:1,750,000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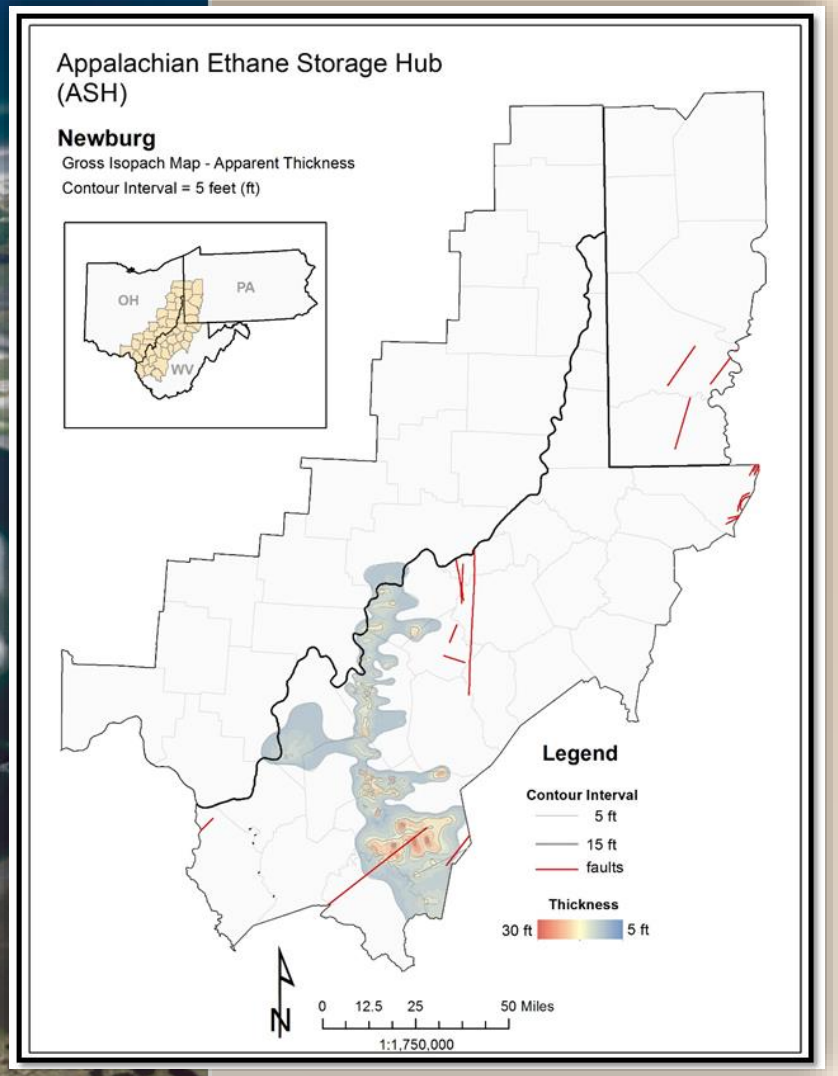
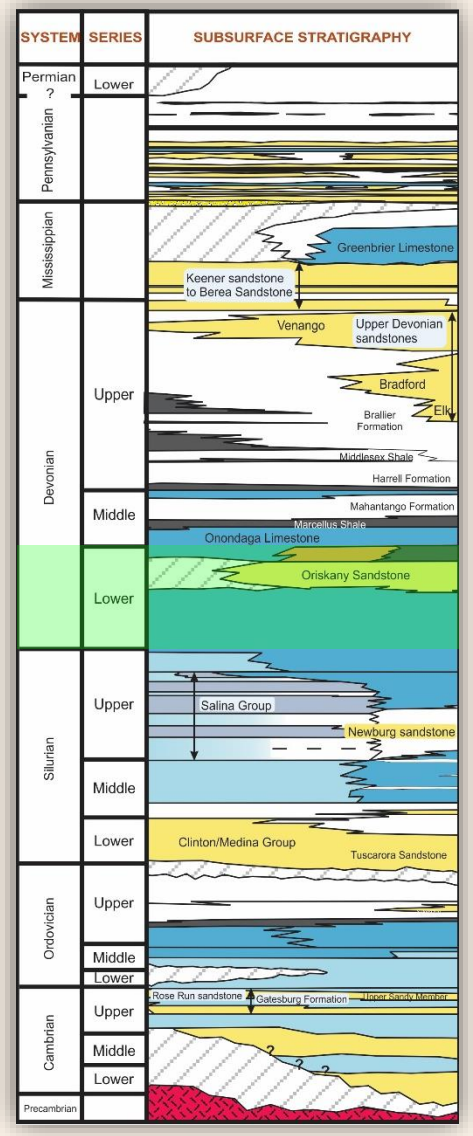
OH
PA
WV
Legend
Contour Interval
5 ft
15 ft
faults
Thickness
30 ft
5 ft
0 12.5 25 50 Miles
1:1,750,000

Modern Analog: U.S. East Coast (Massachusetts) Coastal Sand Bodies

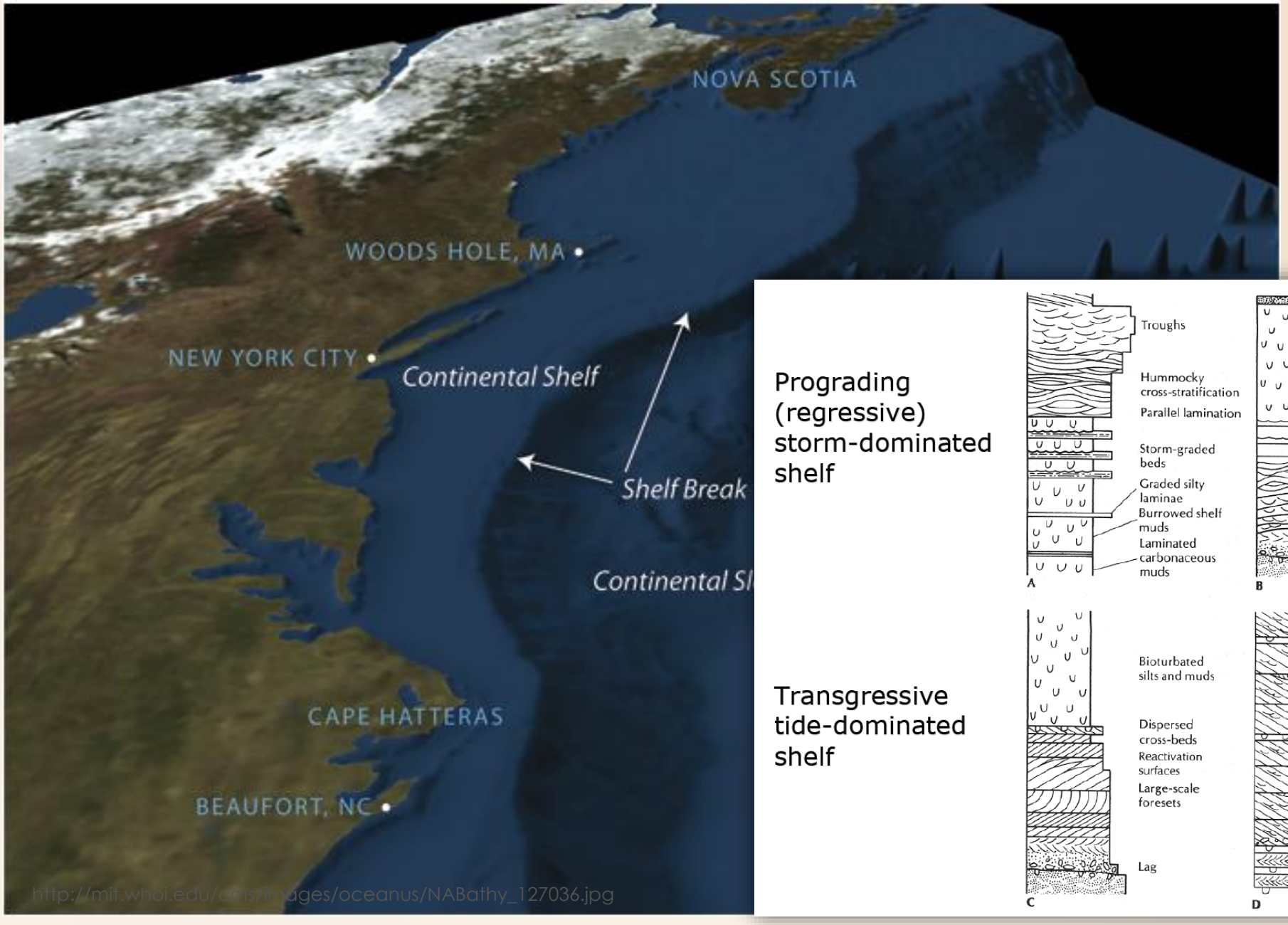


http://www2.oberlin.edu/faculty/dhubbard/PersWebPage/Photos/EssexInlet.jpg

400 Ma
Early Devonian

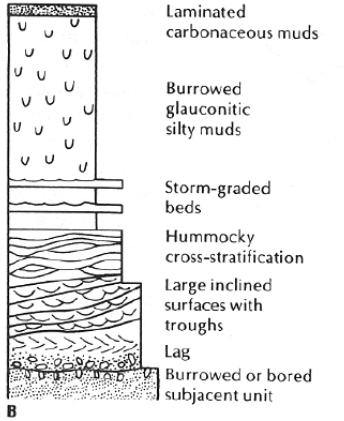


Modern Analog: U.S. East Coast Continental Shelf



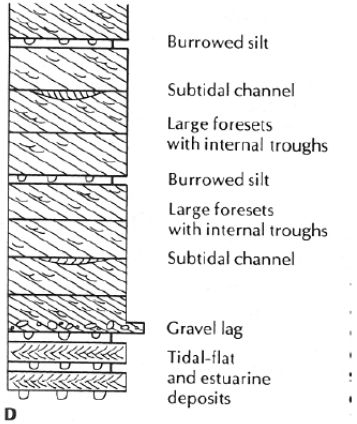
http://mit.whoi.edu/cms/images/oceanus/NABathy_127036.jpg

Prograding (regressive) storm-dominated shelf



Transgressive storm-dominated shelf

Transgressive tide-dominated shelf



Balanced accumulation, tide and storm shelf

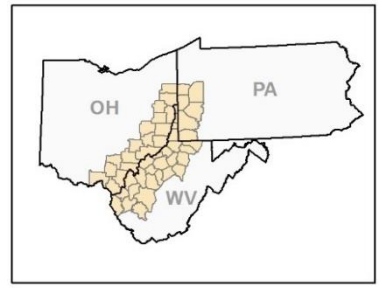
https://www.geol.umd.edu/~jmerck/geol342/lectures/13.html

Appalachian Storage Hub (ASH) Study

Oriskany

Structure Map - Depth relative to Mean Sea Level (MSL)

Contour Interval = 100 feet (ft)

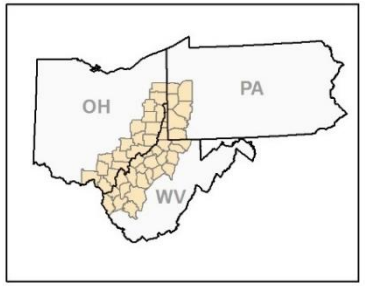


Appalachian Storage Hub (ASH) Study

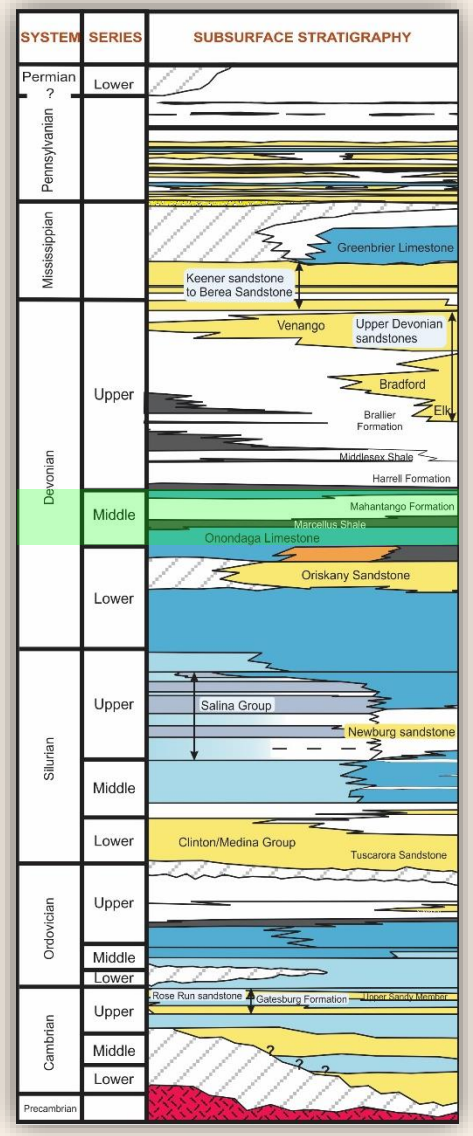
Oriskany

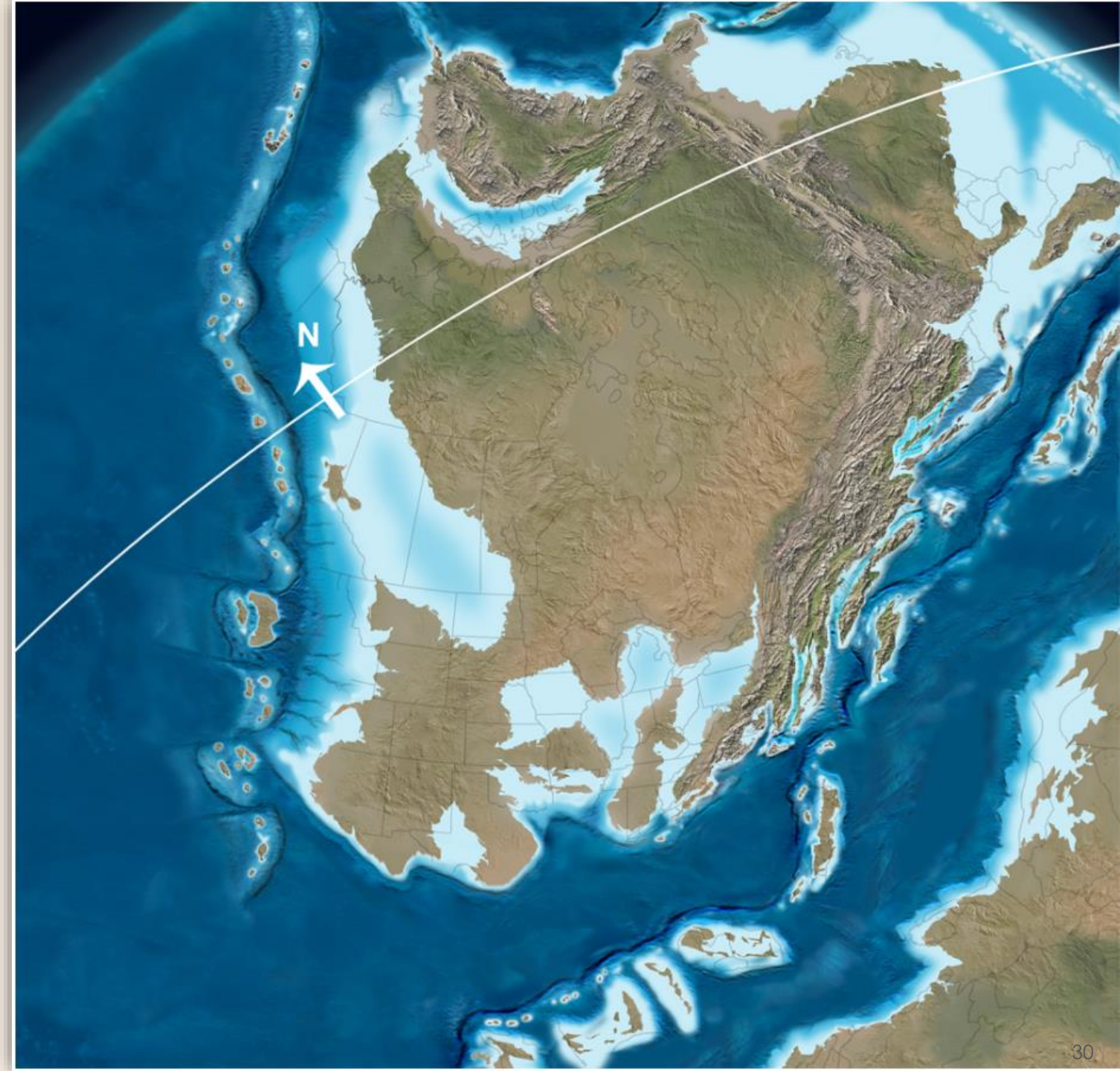
Gross Isopach Map - Apparent Thivckness

Contour Interval = 10 feet (ft)

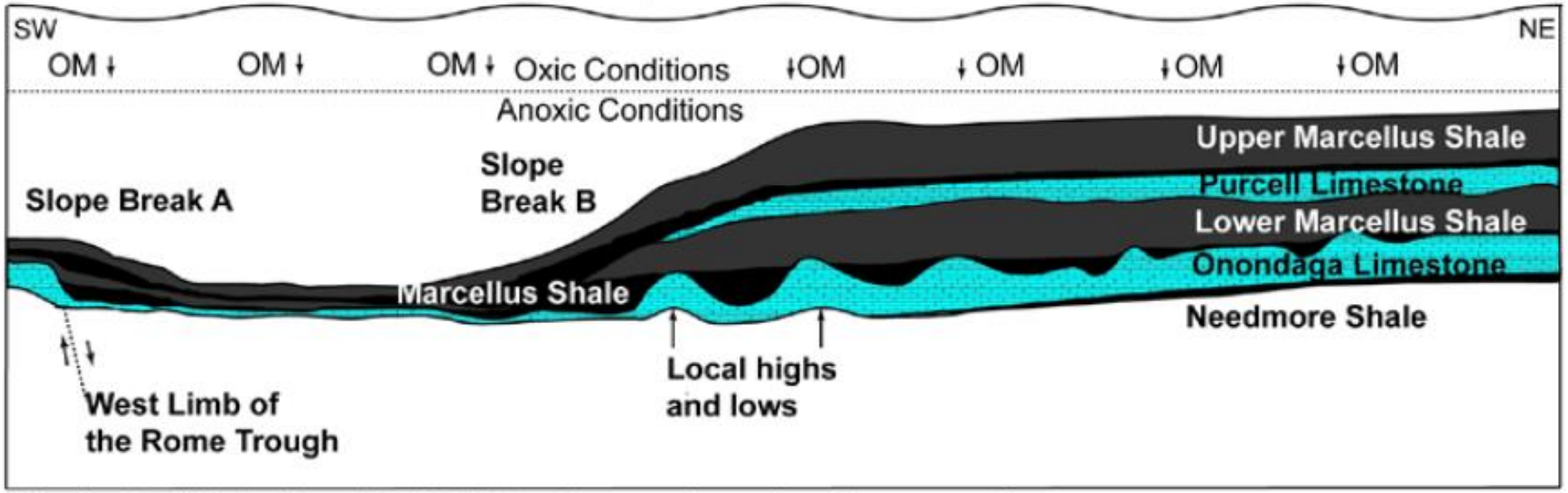


385 Ma
Middle Devonian



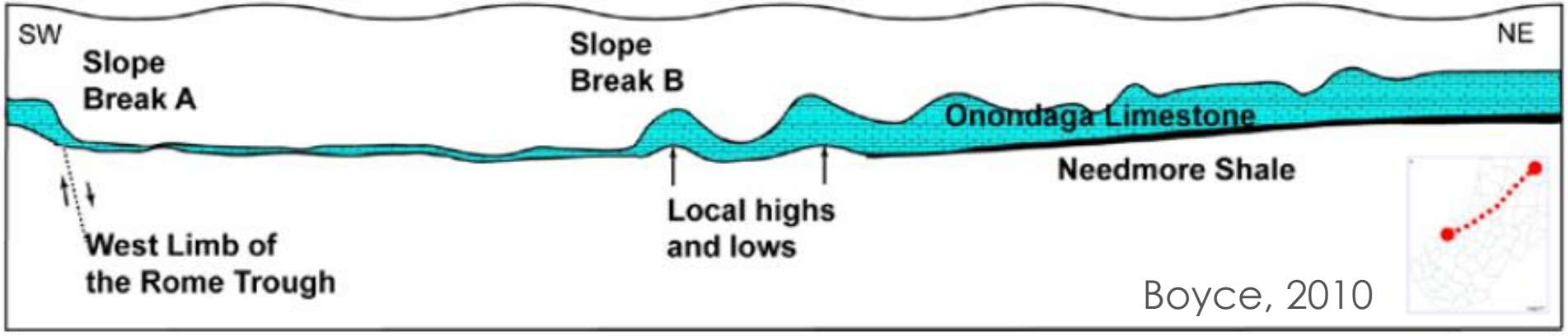


Marcellus and Purcell Deposition



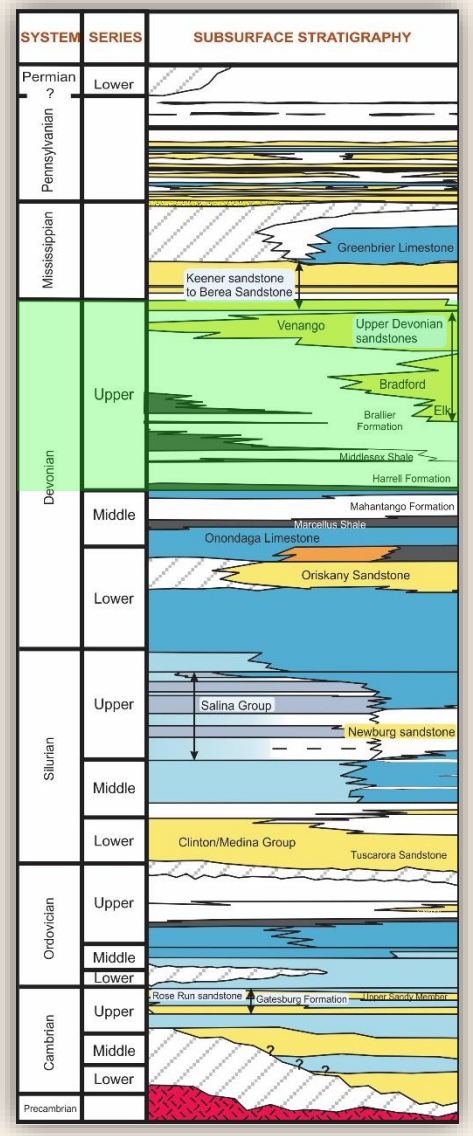
* Black color fill in the Marcellus highlights of increased organic matter preservation

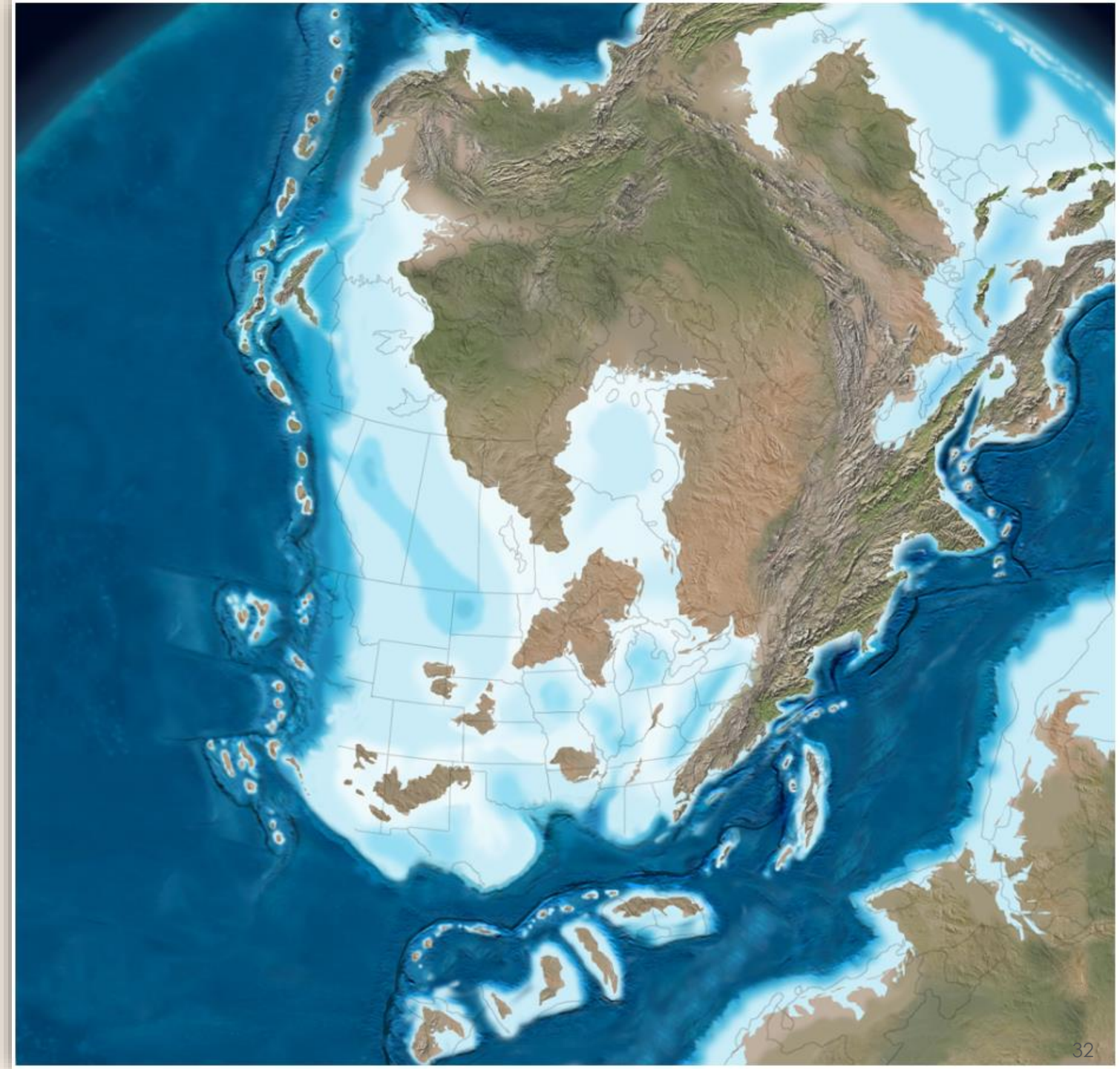
Onondaga Deposition



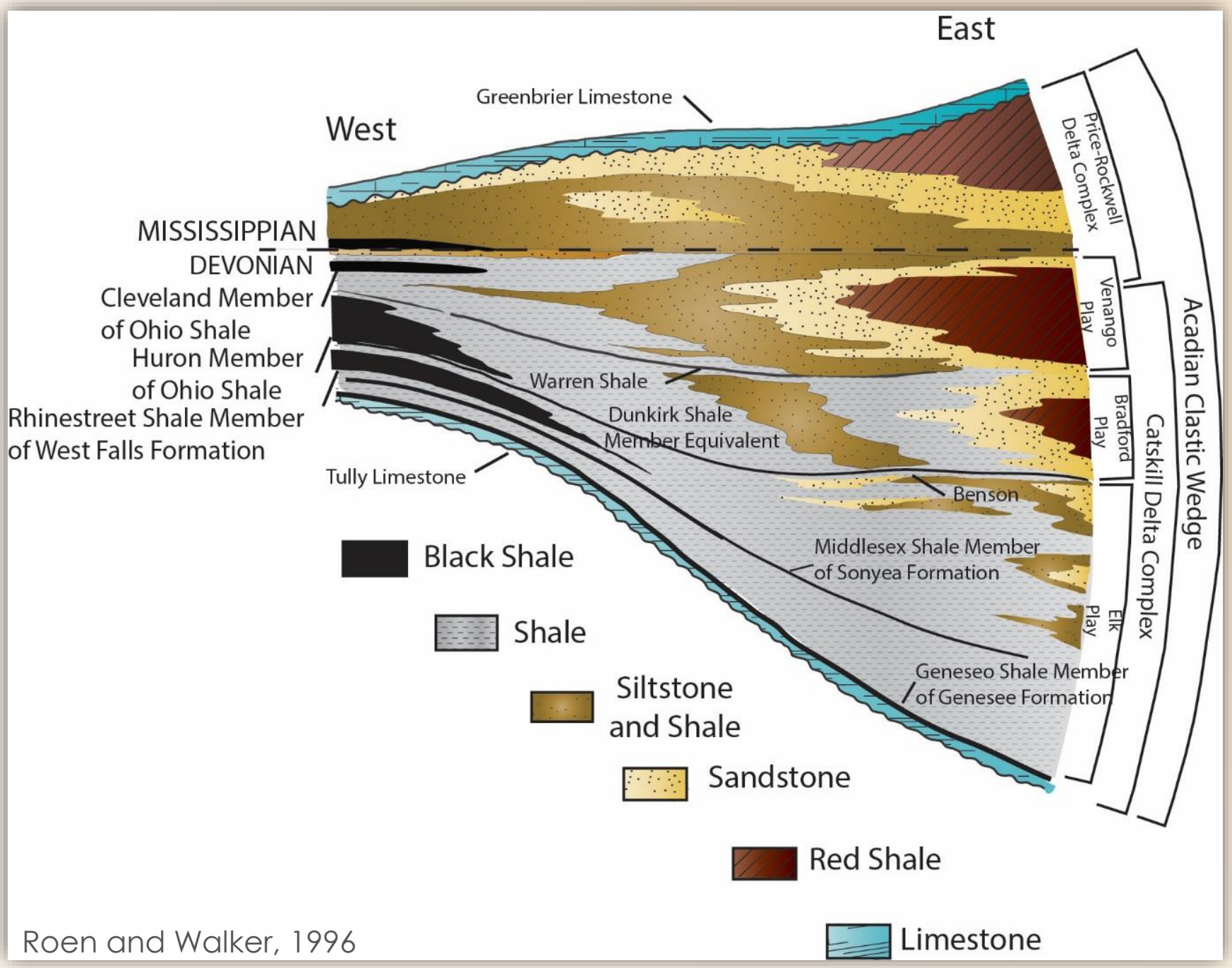
Boyce, 2010

360 Ma
Late Devonian





Catskill Delta Complex



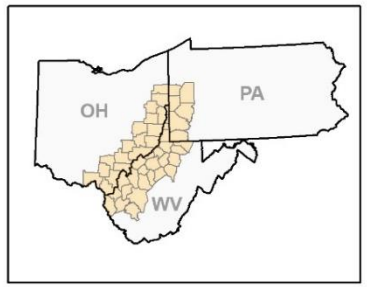
Roen and Walker, 1996

Appalachian Storage Hub (ASH) Study

Elk

Structure Map - Depth relative to Mean Sea Level (MSL)

Contour Interval = 100 feet (ft)

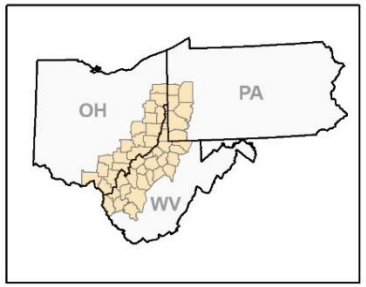


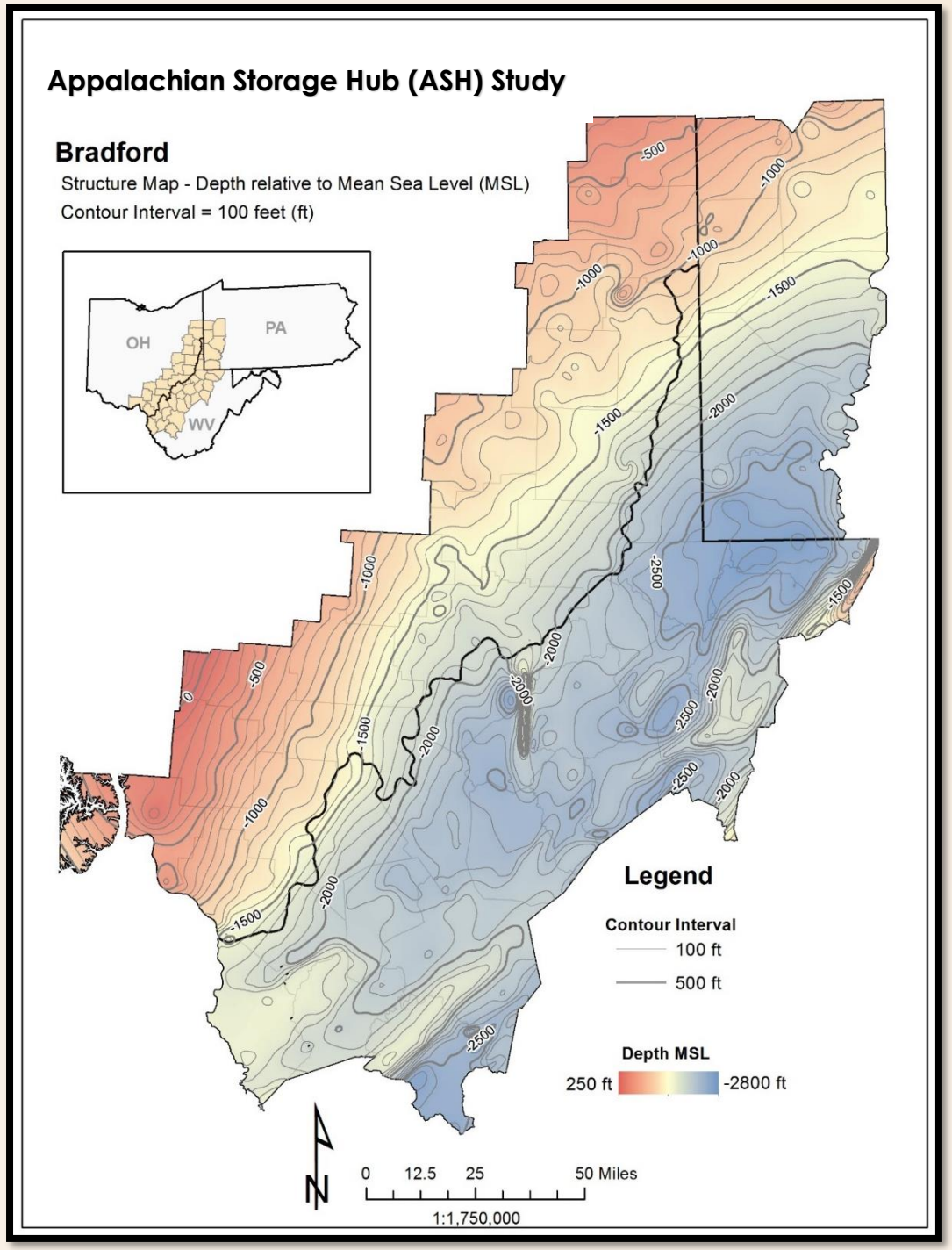
Appalachian Storage Hub (ASH) Study

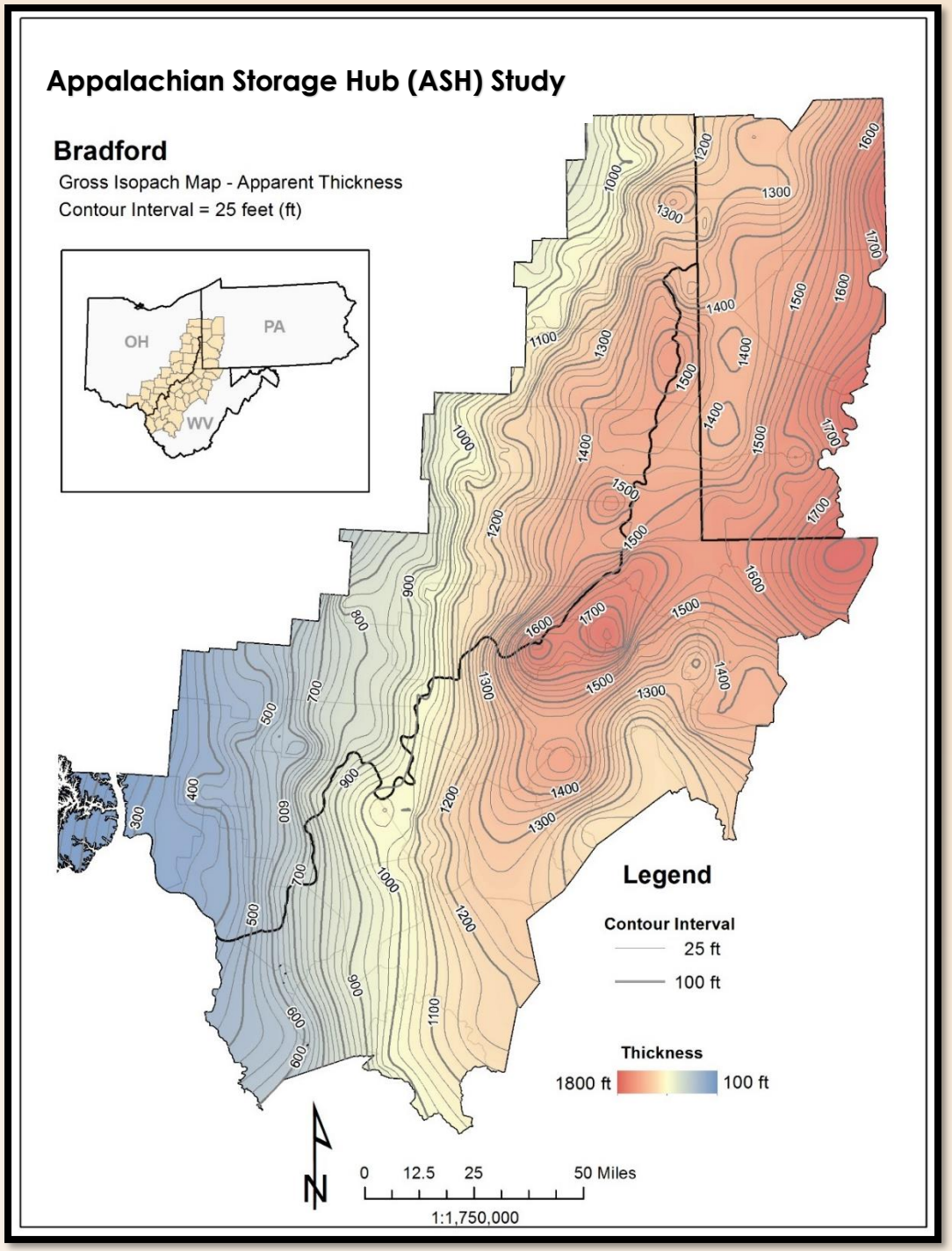
Elk

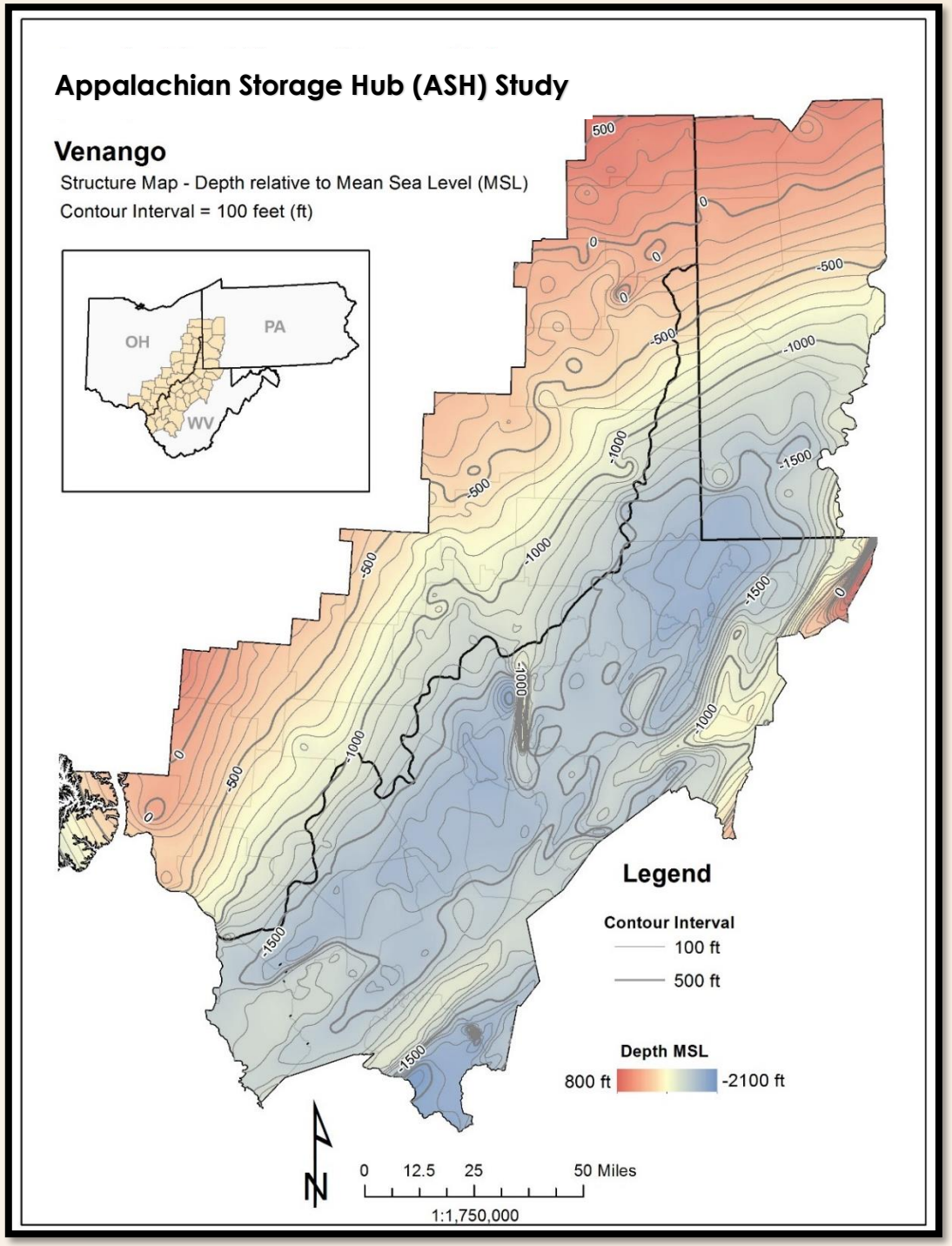
Gross Isopach Map - Apparent Thickness

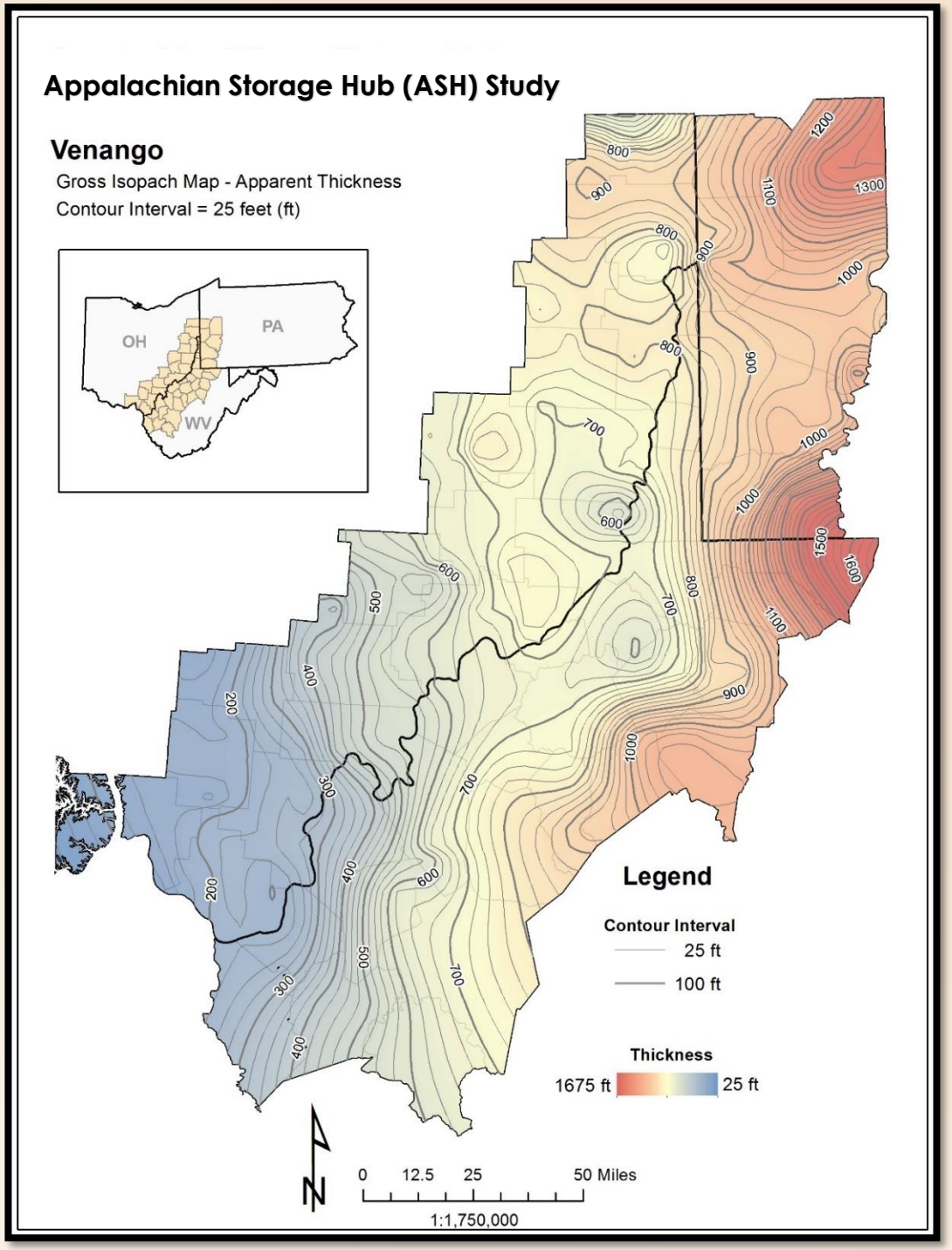
Contour Interval = 25 feet (ft)



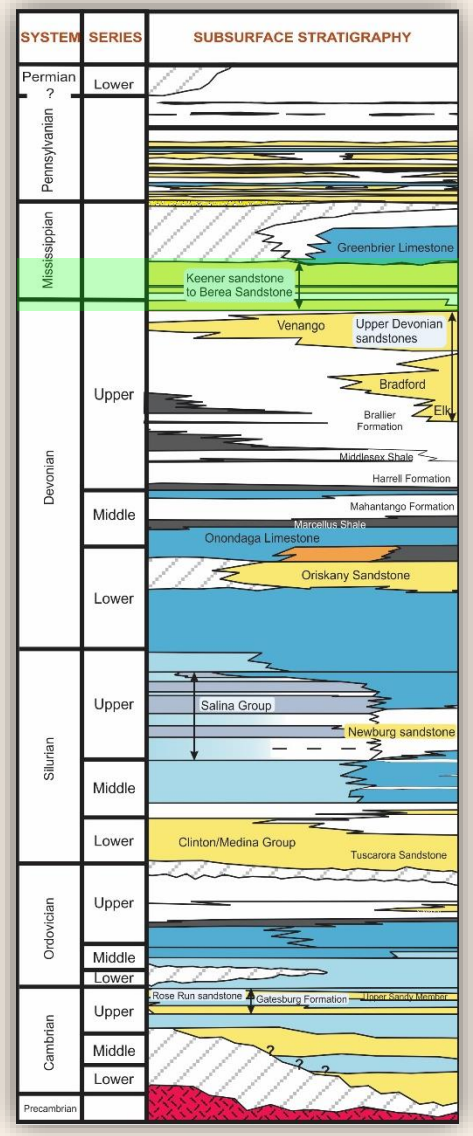

Appalachian Storage Hub (ASH) Study
Bradford
Structure Map - Depth relative to Mean Sea Level (MSL)
Contour Interval = 100 feet (ft)
OH
PA
WV
Legend
Contour Interval
100 ft
500 ft
Depth MSL
250 ft
-2800 ft
N
0 12.5 25 50 Miles
1:1,750,000

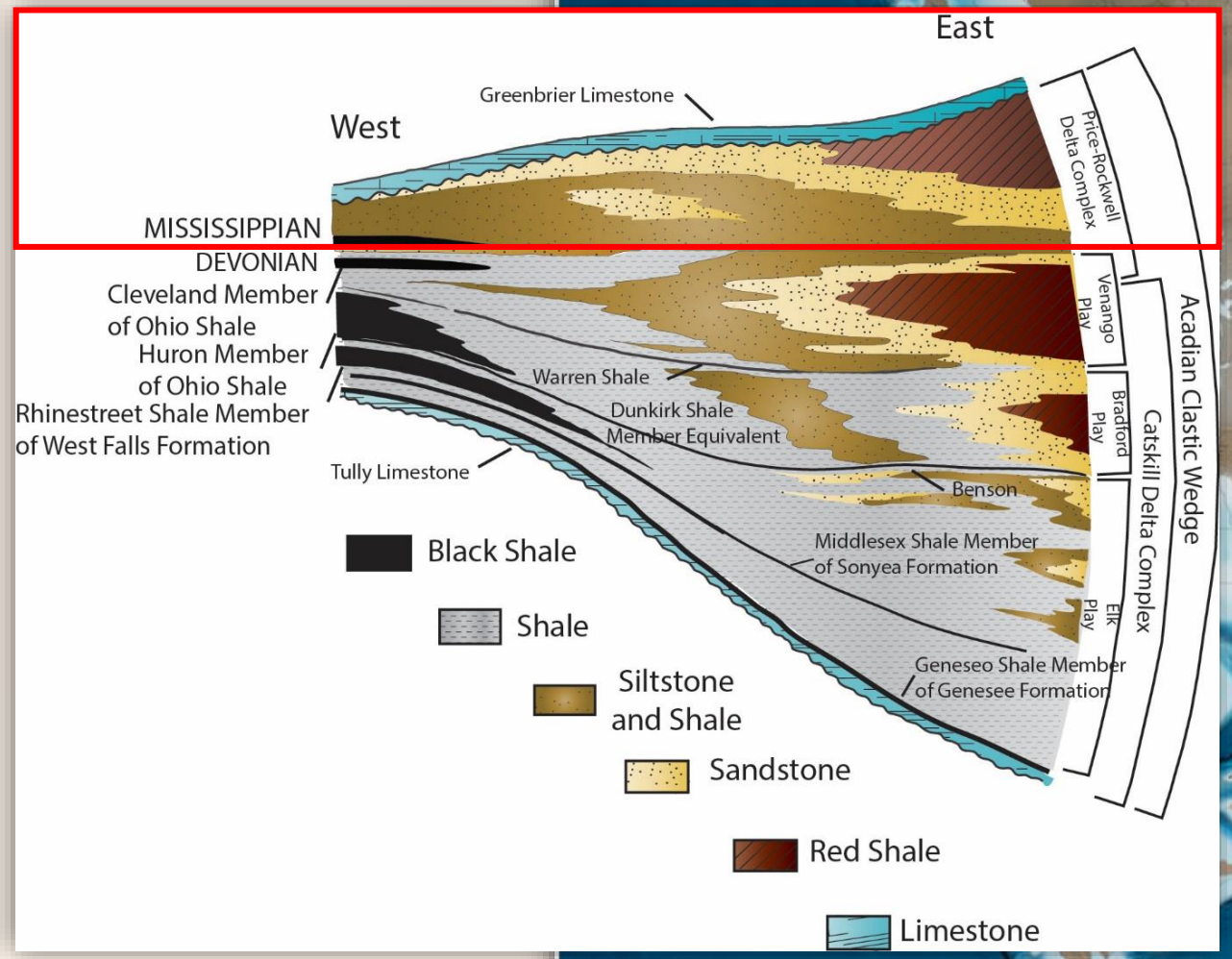

Appalachian Storage Hub (ASH) Study
Bradford
Gross Isopach Map - Apparent Thickness
Contour Interval = 25 feet (ft)
OH
PA
WV
Legend
Contour Interval
25 ft
100 ft
Thickness
1800 ft
100 ft
N
0 12.5 25 50 Miles
1:1,750,000

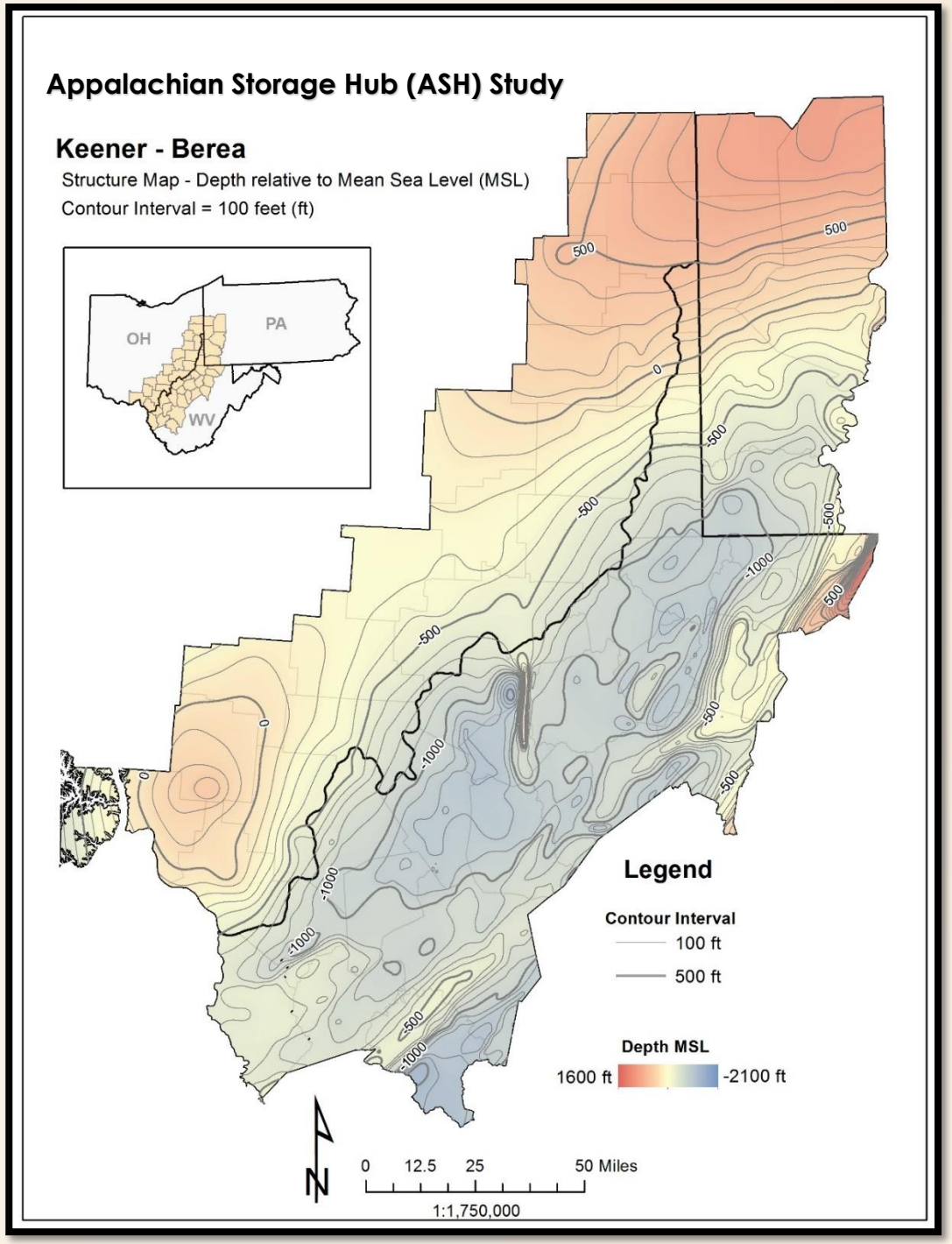

Appalachian Storage Hub (ASH) Study
Venango
Structure Map - Depth relative to Mean Sea Level (MSL)
Contour Interval = 100 feet (ft)
OH
PA
WV
Legend
Contour Interval
100 ft
500 ft
Depth MSL
800 ft
-2100 ft
0 12.5 25 50 Miles
1:1,750,000

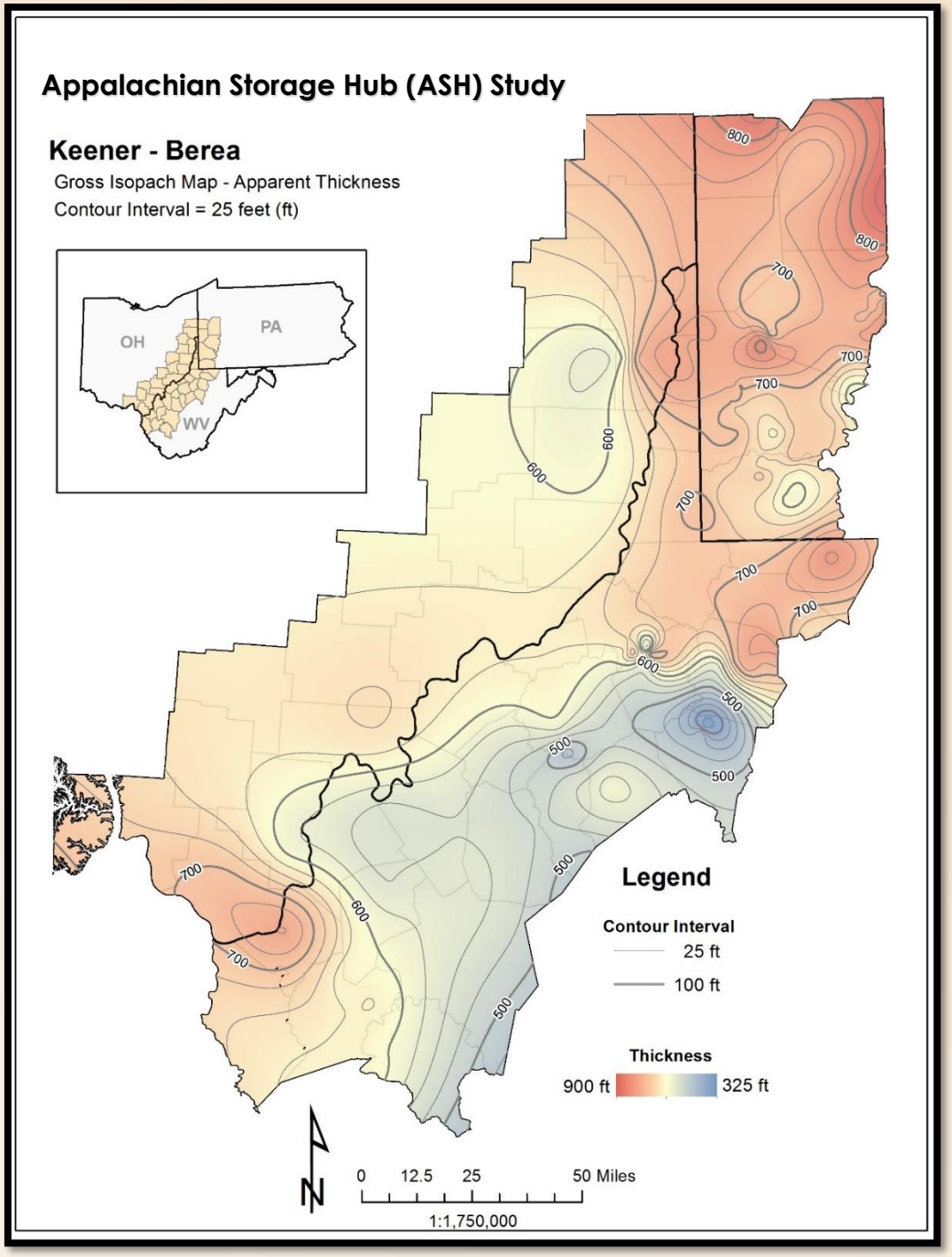

Appalachian Storage Hub (ASH) Study
Venango
Gross Isopach Map - Apparent Thickness
Contour Interval = 25 feet (ft)
OH
PA
WV
Legend
Contour Interval
25 ft
100 ft
Thickness
1675 ft
25 ft
0 12.5 25 50 Miles
1:1,750,000

345 Ma
Early Mississippian

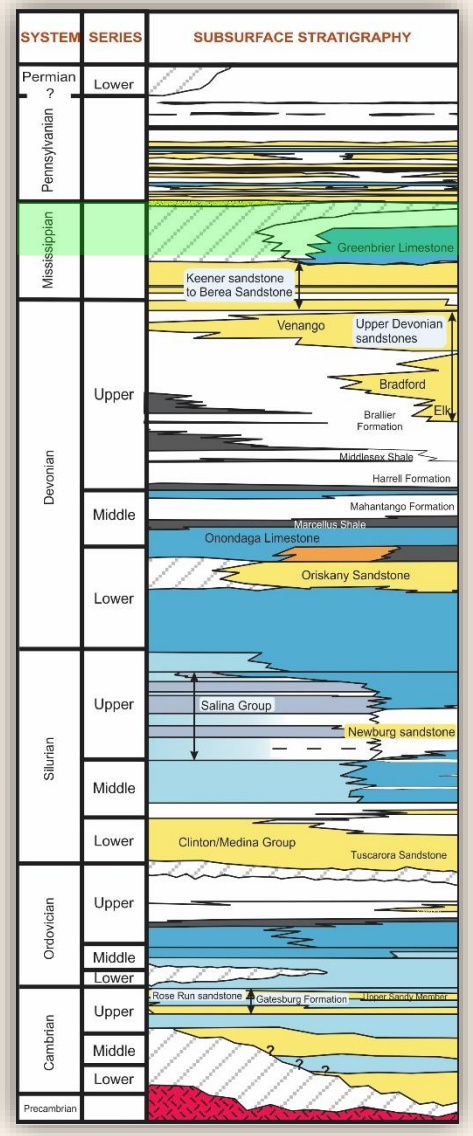




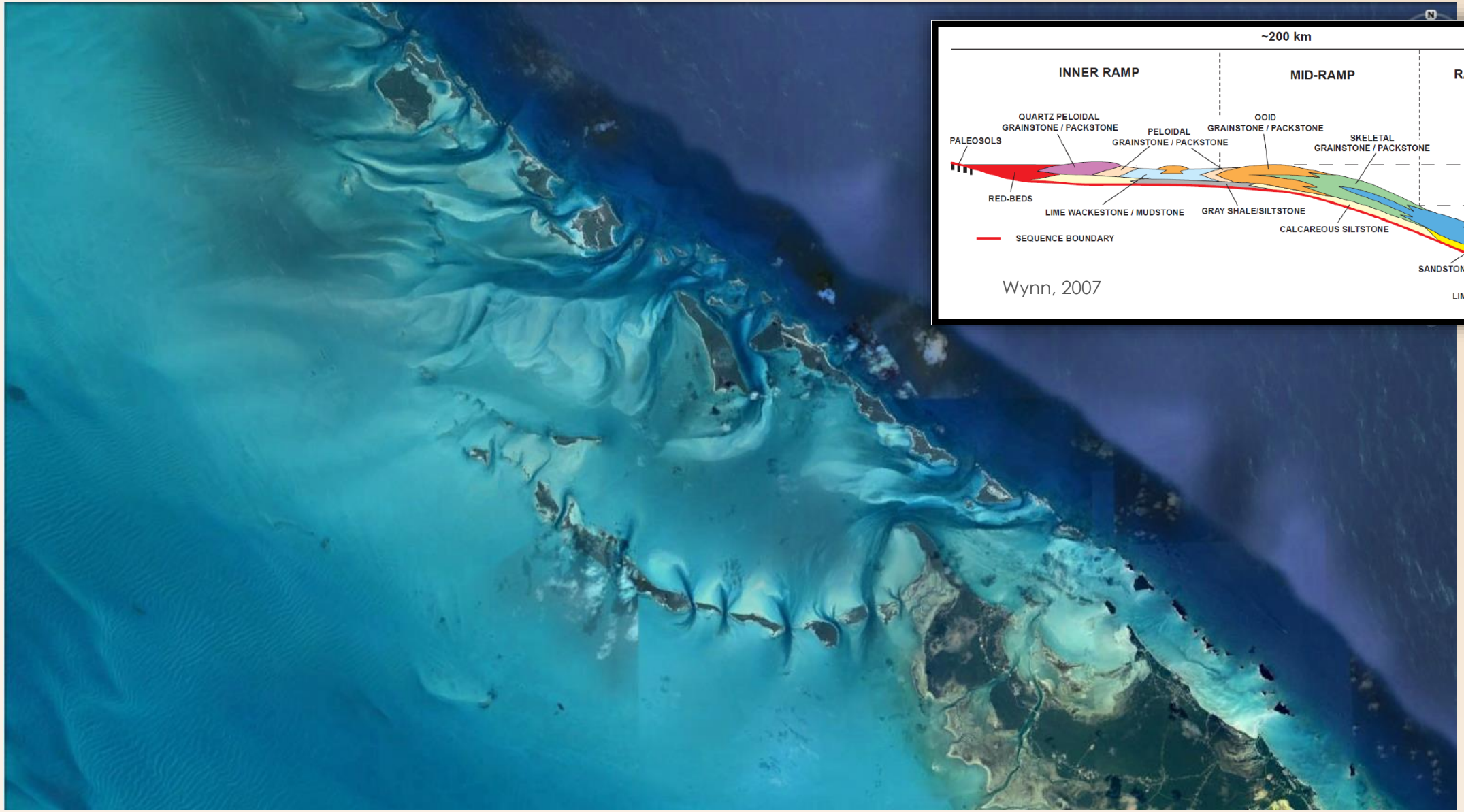

Appalachian Storage Hub (ASH) Study
Keener - Berea
Structure Map - Depth relative to Mean Sea Level (MSL)
Contour Interval = 100 feet (ft)
OH
PA
WV
Legend
Contour Interval
100 ft
500 ft
Depth MSL
1600 ft
-2100 ft
0 12.5 25 50 Miles
1:1,750,000


Appalachian Storage Hub (ASH) Study
Keener - Berea
Gross Isopach Map - Apparent Thickness
Contour Interval = 25 feet (ft)
OH
PA
WV
Legend
Contour Interval
25 ft
100 ft
Thickness
900 ft
325 ft
0 12.5 25 50 Miles
1:1,750,000

325 Ma
Late Mississippian



Modern Analog: Bahama Banks Carbonate Platform

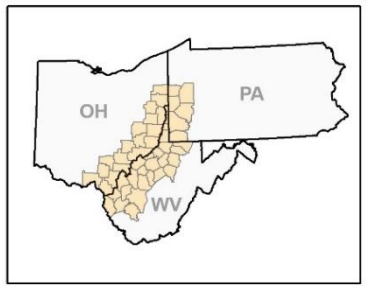


Appalachian Storage Hub (ASH) Study

Greenbrier

Structure Map - Depth relative to Mean Sea Level (MSL)

Contour Interval = 100 feet (ft)

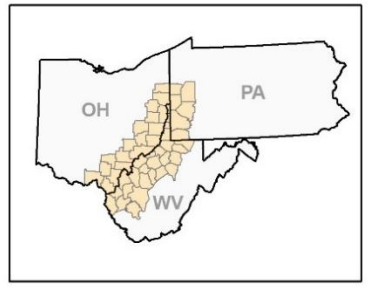


Appalachian Storage Hub (ASH) Study

Greenbrier

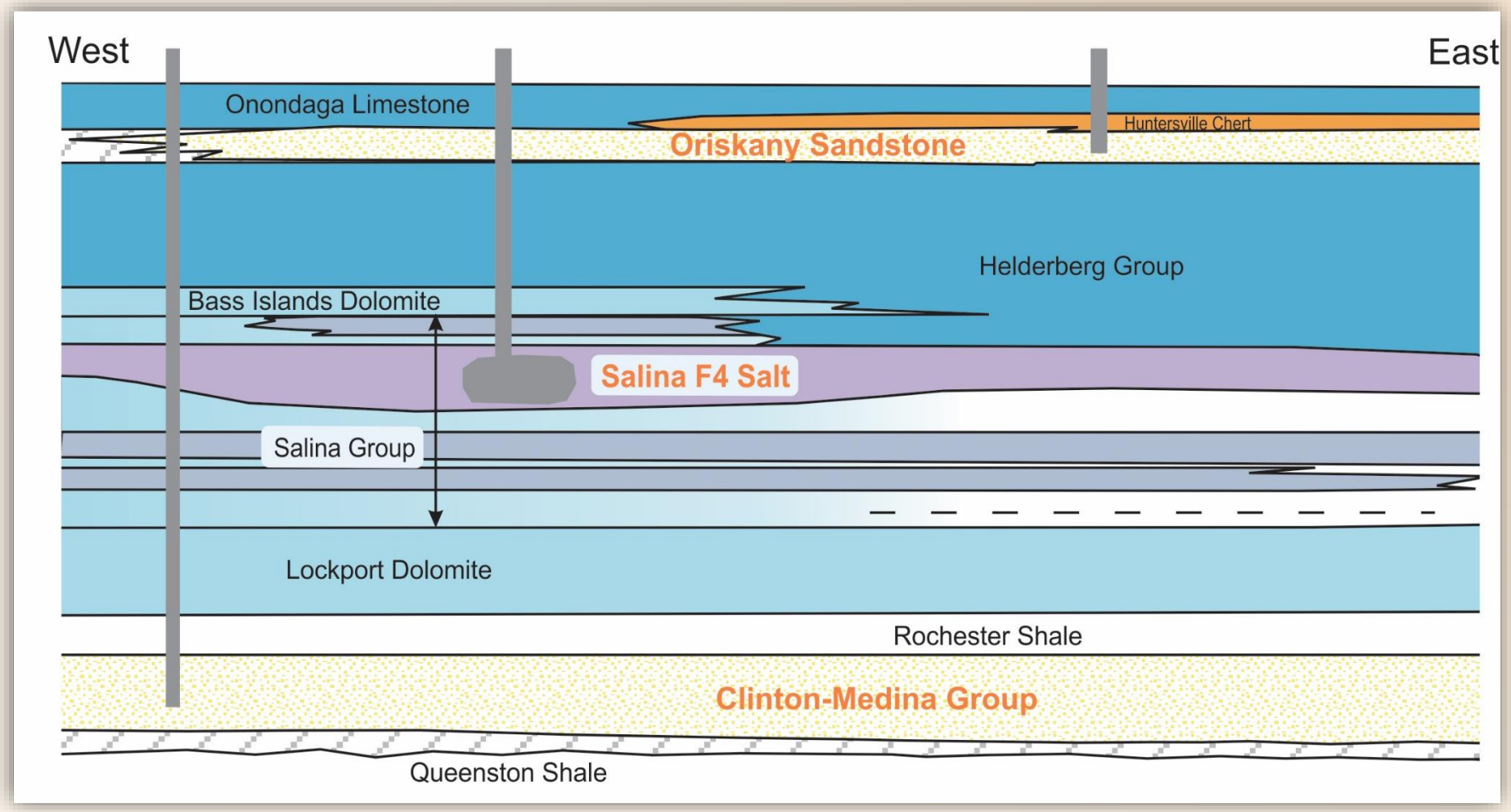
Gross Isopach Map - Apparent Thickness

Contour Interval = 10 feet (ft)

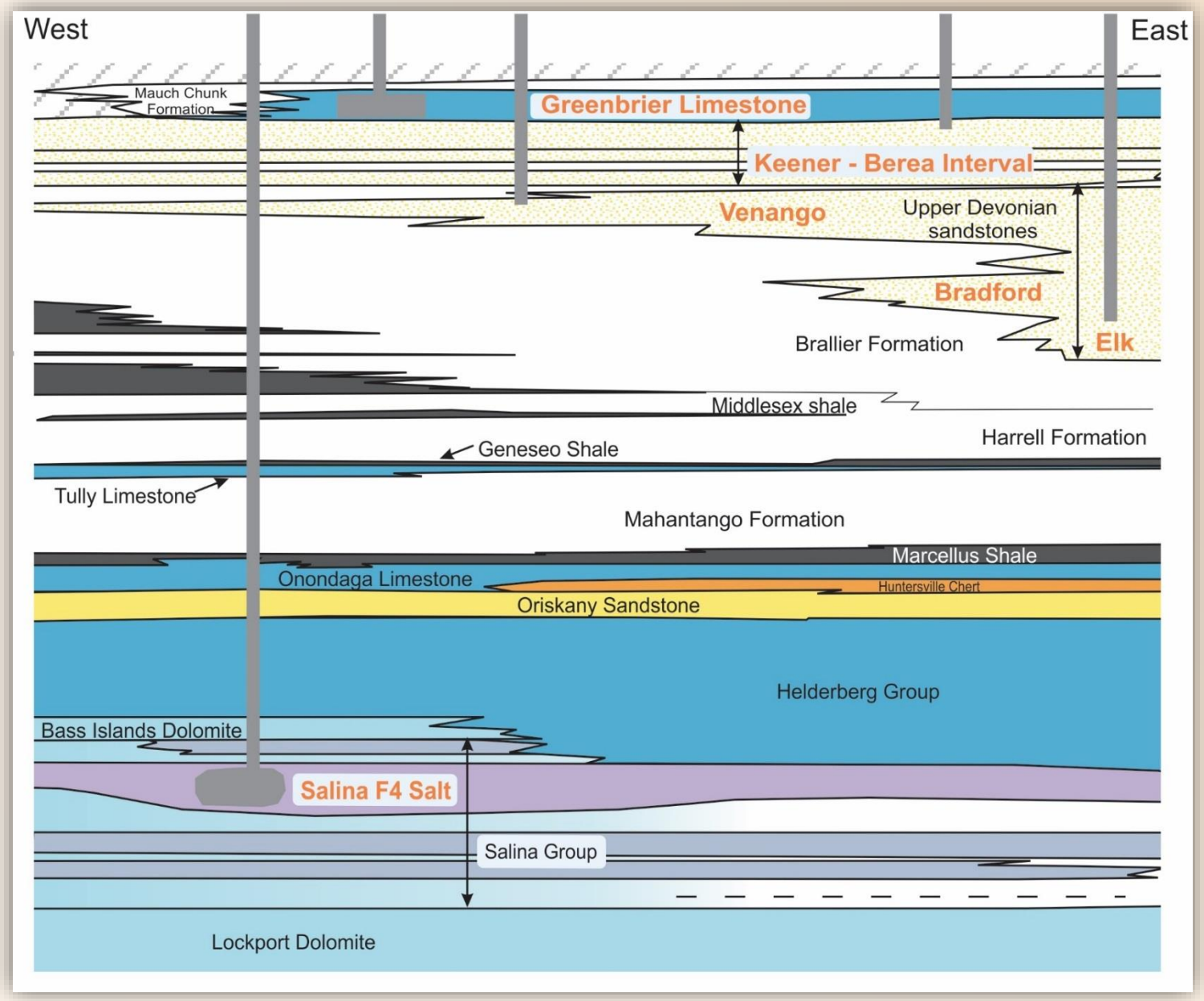


STACKED OPPORTUNITIES: NORTHERN PROSPECT

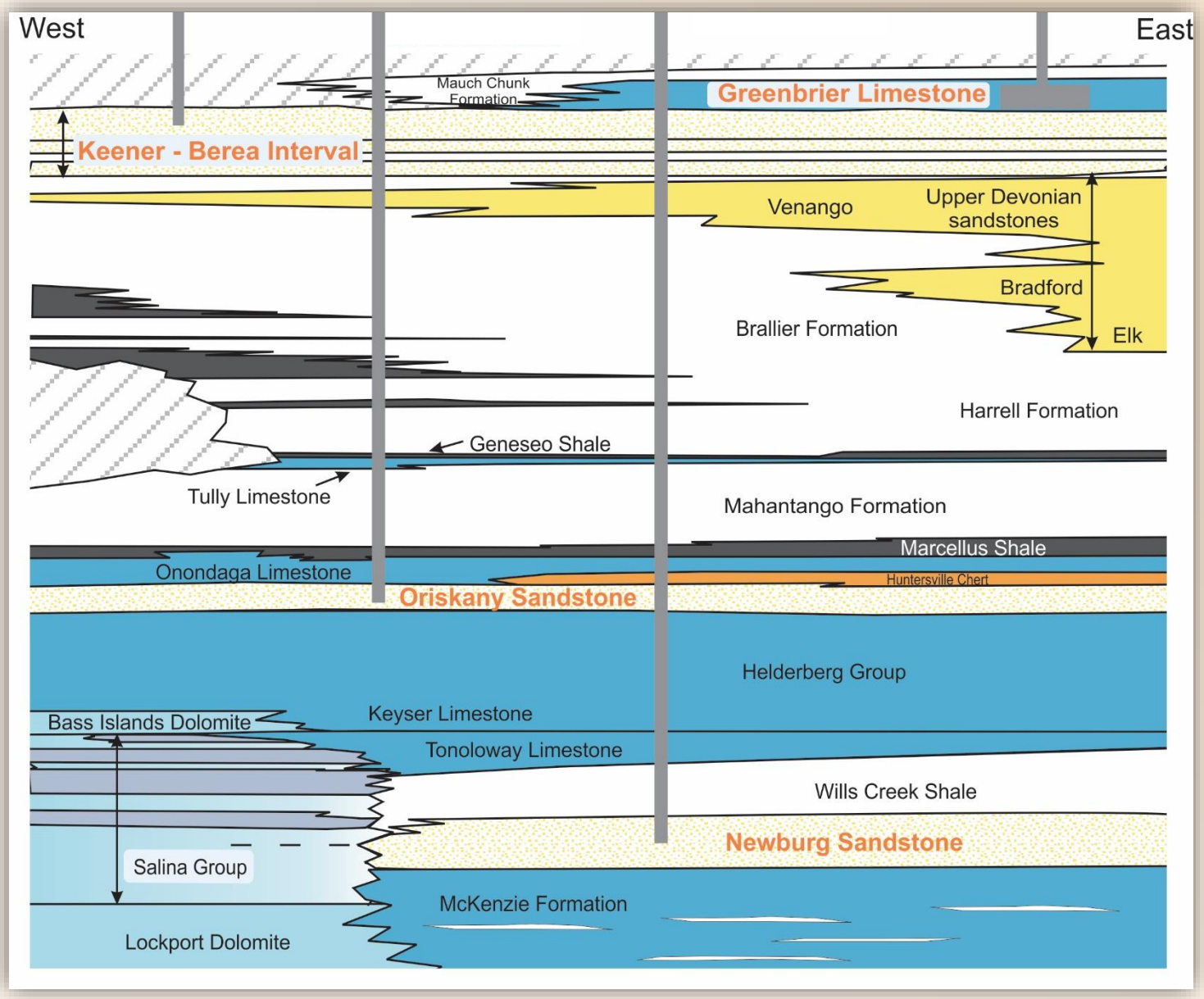
Optimal reservoir types within each unit may (or may not) be co-located.



STACKED OPPORTUNITIES: CENTRAL PROSPECT



STACKED OPPORTUNITIES: SOUTHERN PROSPECT



SUMMARY

- 500 million years is a long period of time and a LOT happened:
- 3 major mountain-building events
- Foreland basins captured sediments
- Older rocks folded and faulted over multiple episodes
- Reservoir quality dependent on many different factors
- Optimal reservoir types in the 10 units of interest may (or may not) be co-located above or below one another


Findlay
Akron
Youngstown
Lima
Mansfield
State College
Pittsburgh
Altoona
Wheeling
Columbus
Zanesville
Dayton
Fairmont
Martinsburg
Athens
Parkersburg
Clarksburg
Cincinnati
Winchester
Portsmouth
Huntington
WEST
VIRGINIA
Charleston
Harrisonburg
Staunton

THANK YOU!