



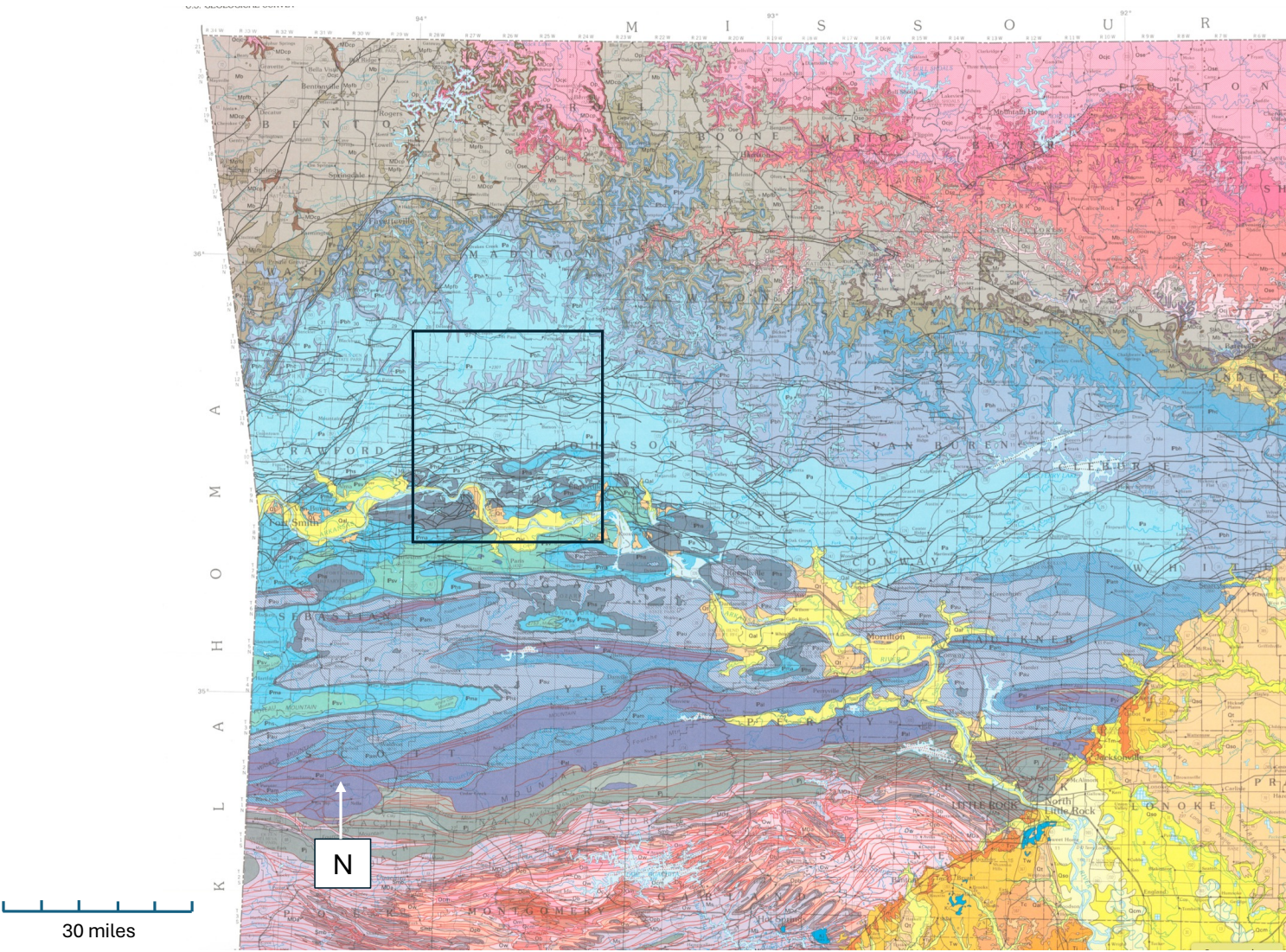
A New Method to Identify and Correlate the Pennsylvanian Atoka Formation Subdivisions in the Surface Outcrops of the Boston Mountains, Arkansas

R. Brent Boyd
University of Arkansas, Fayetteville



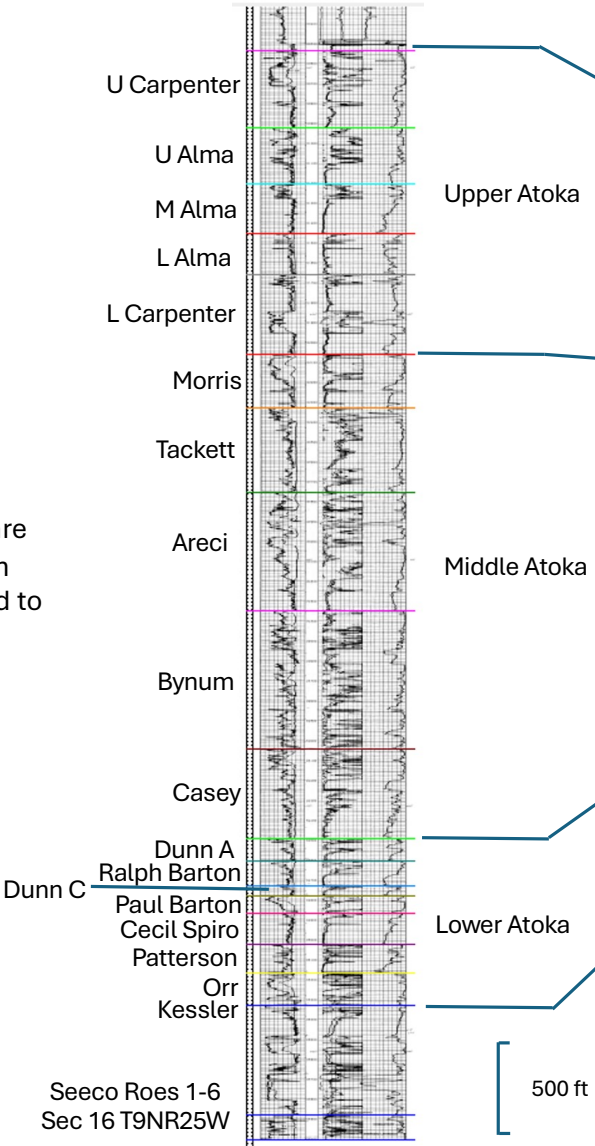
White Rock Mountain © 2025

Northwest Detail of Geologic Map of Arkansas (1993)

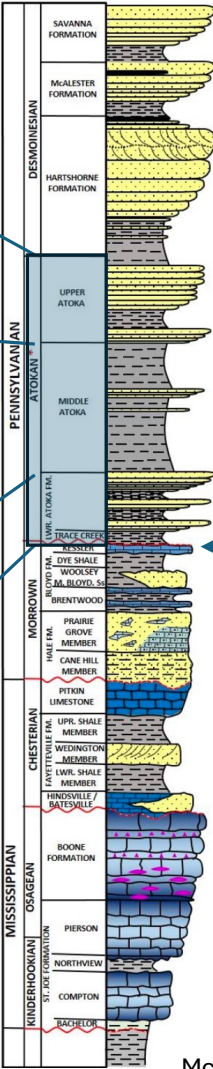


The Atoka Formation Subdivisions in Type Well Log

Annotated on the well log are the FSGS Atoka Formation subdivisions to be correlated to the surface outcrops



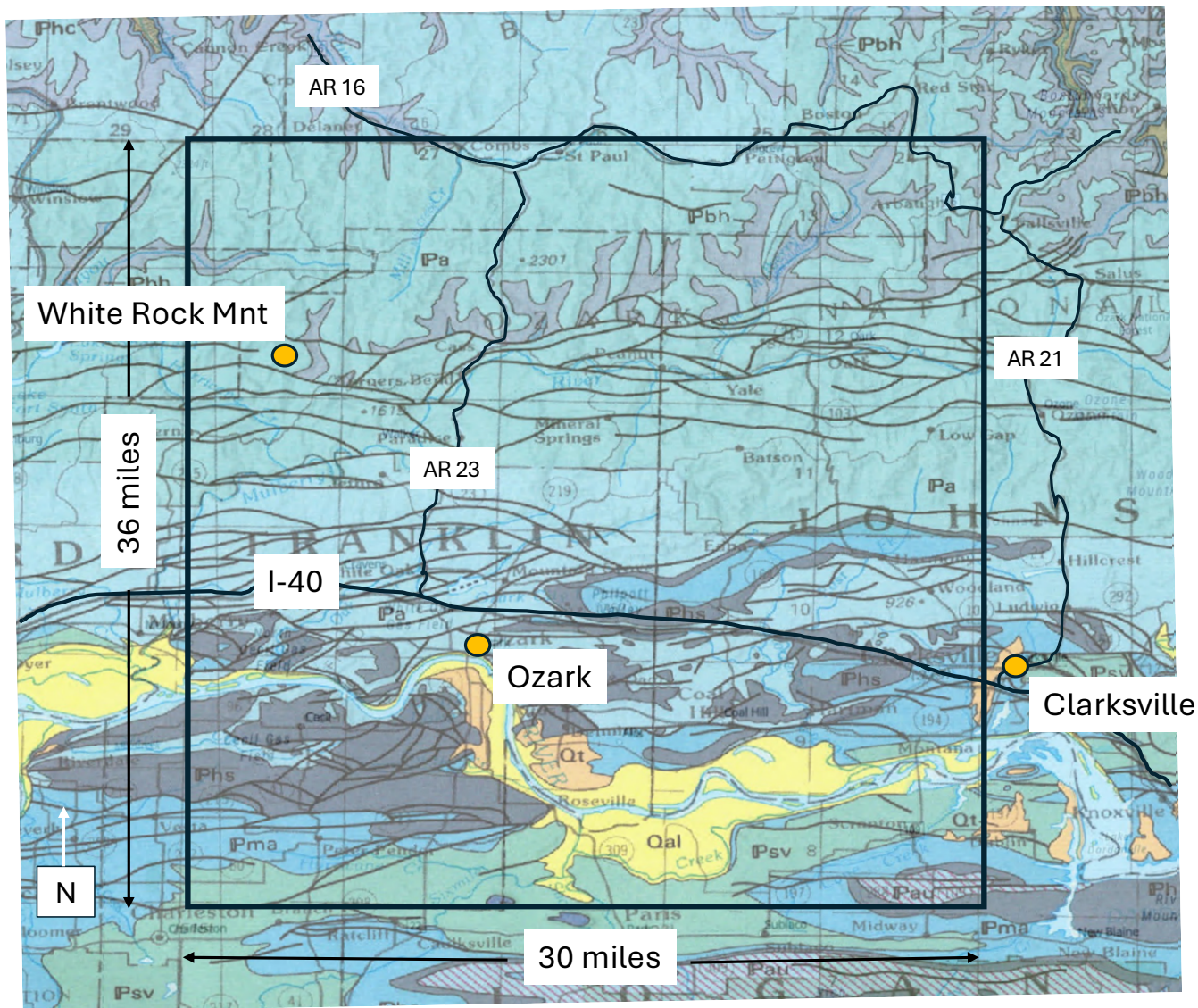
Northwest Arkansas Stratigraphy



Kessler Formation: youngest limestone

McGilvery et al (2016)

Study Area

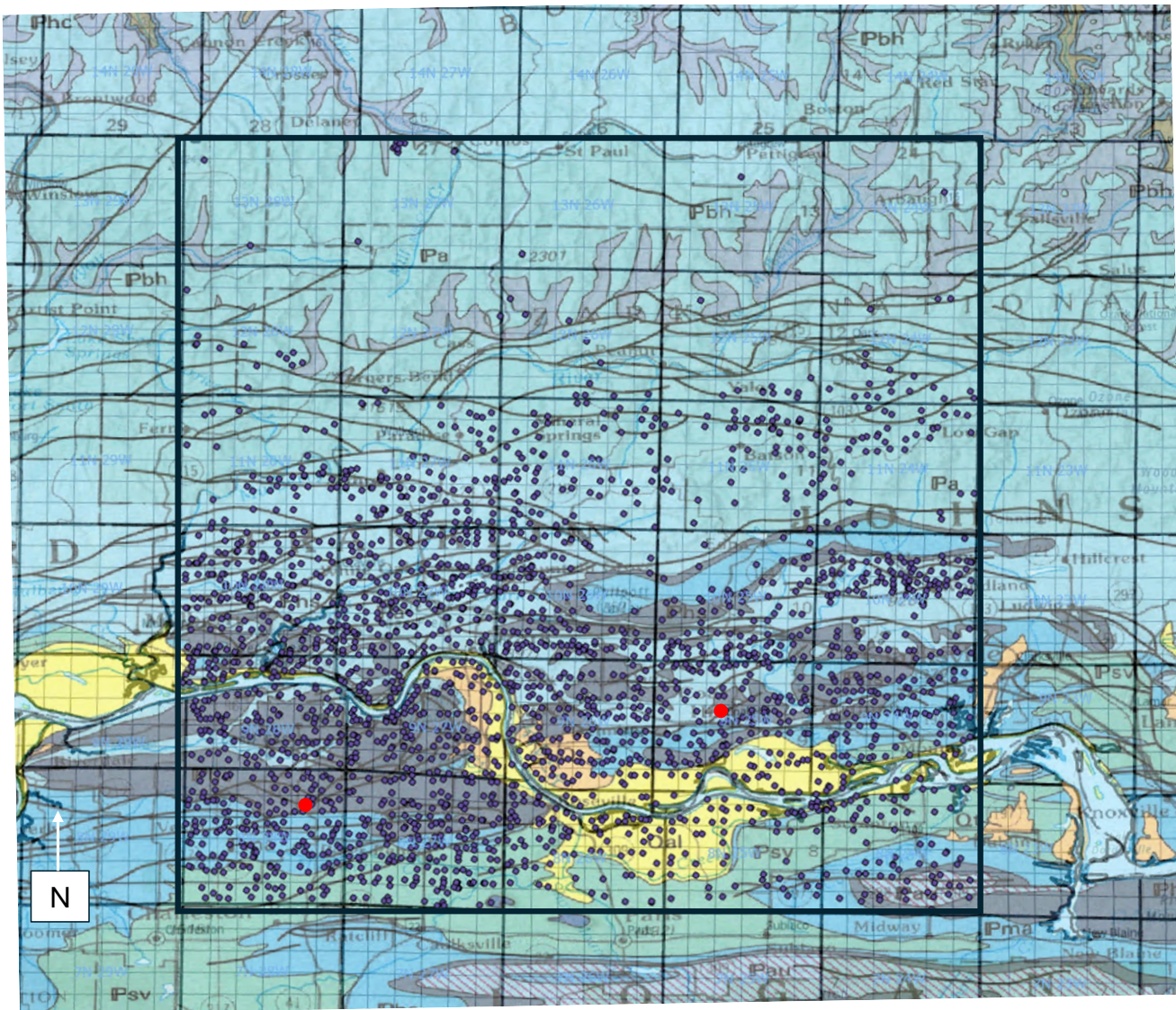


Geologic Map of
Arkansas (1993)

Correlation tool:
Well logs

2600 wells in study area
705 wells correlated

FSGS well control in red

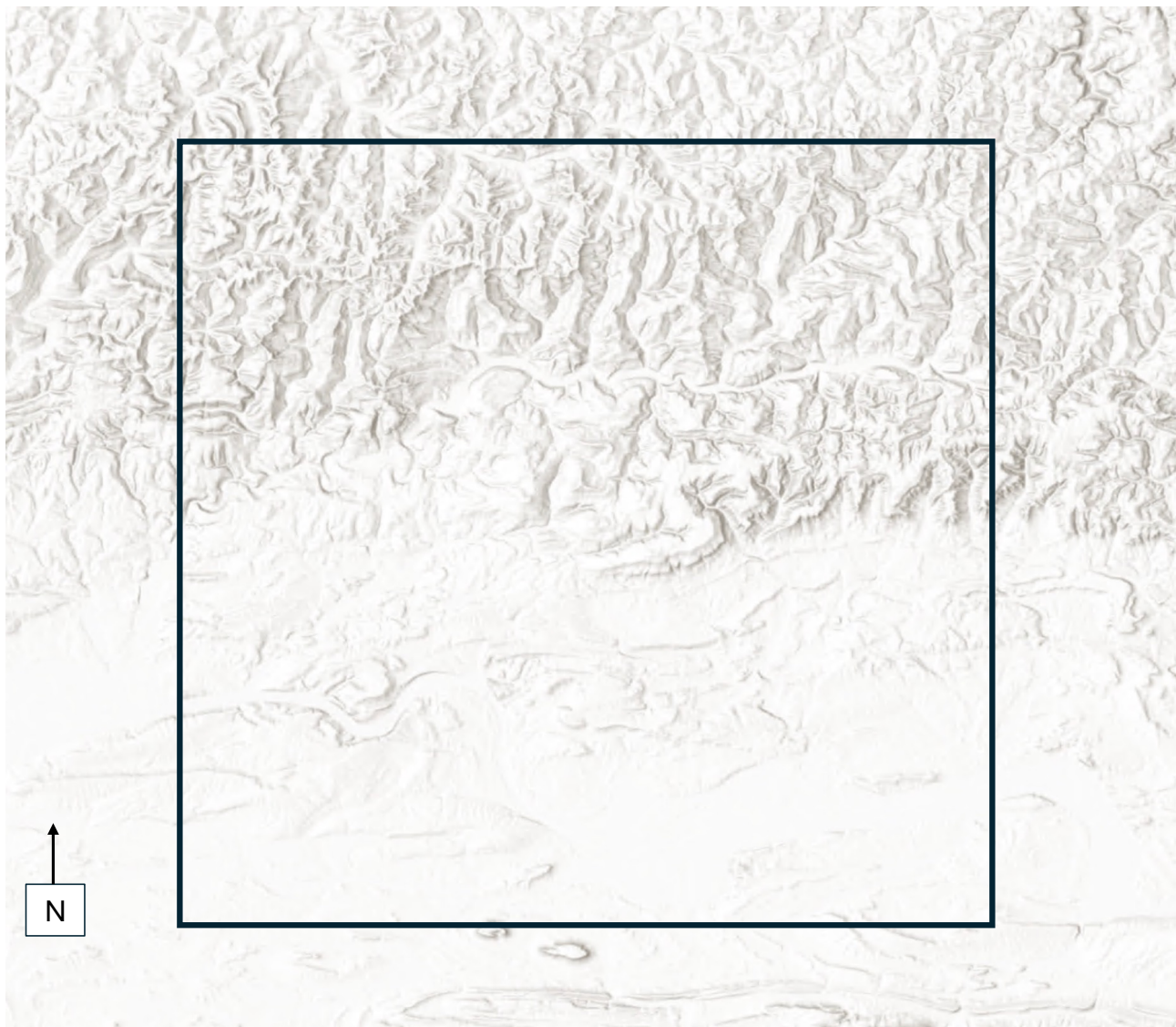


Geologic Map of
Arkansas (1993)

Correlation tool:
LiDAR

91 DEMs in study area

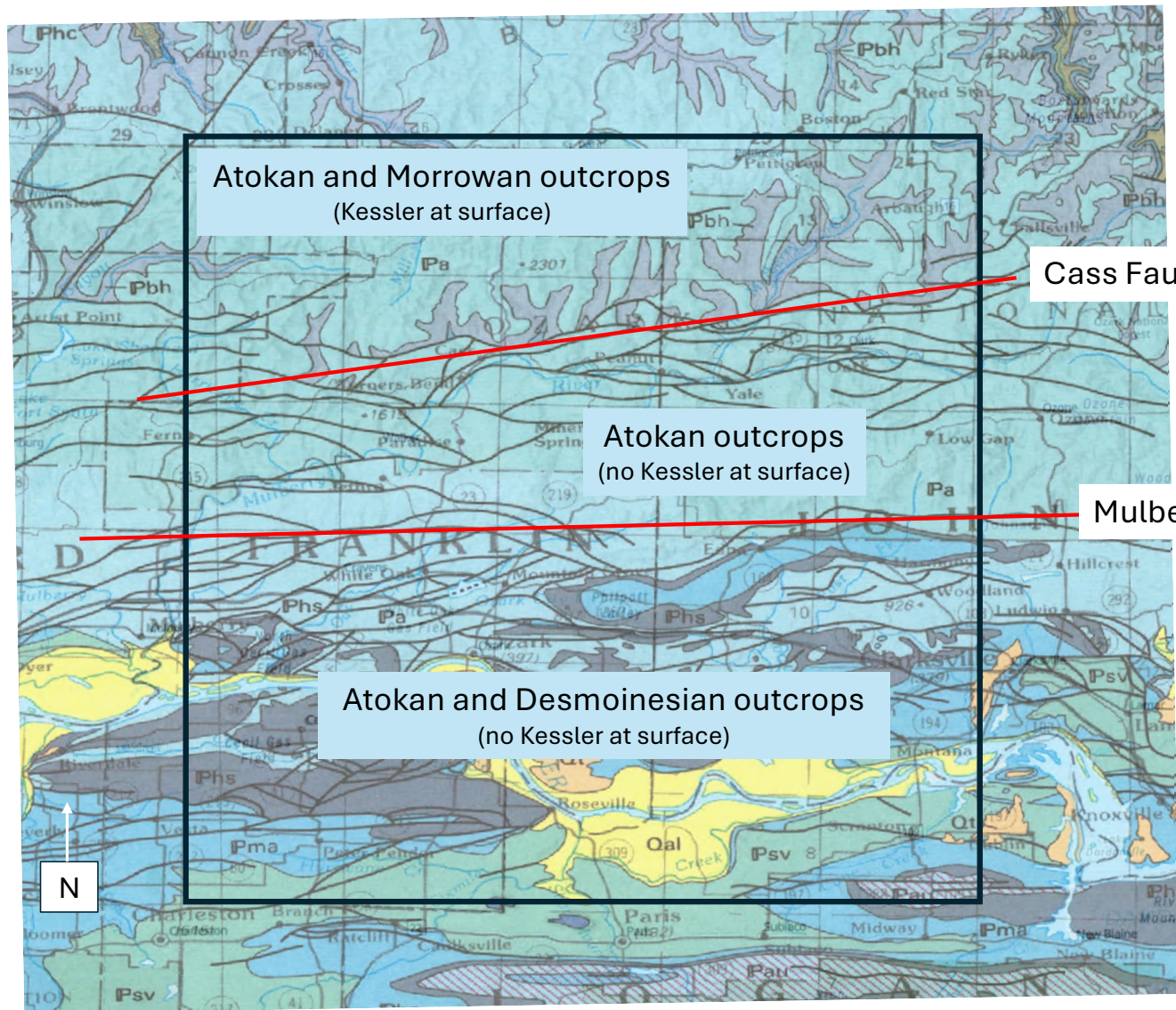
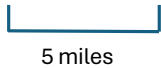
5 miles



USGS (2024)

What do we know about the surface rocks?

Three outcrop areas separated by major faulting zones



Cass Fault

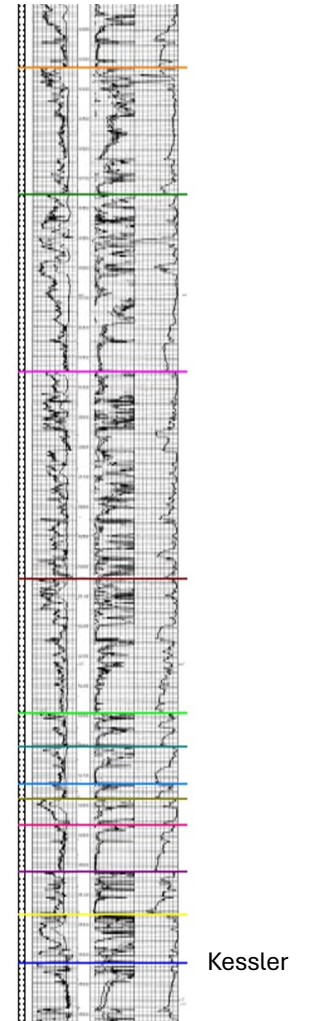
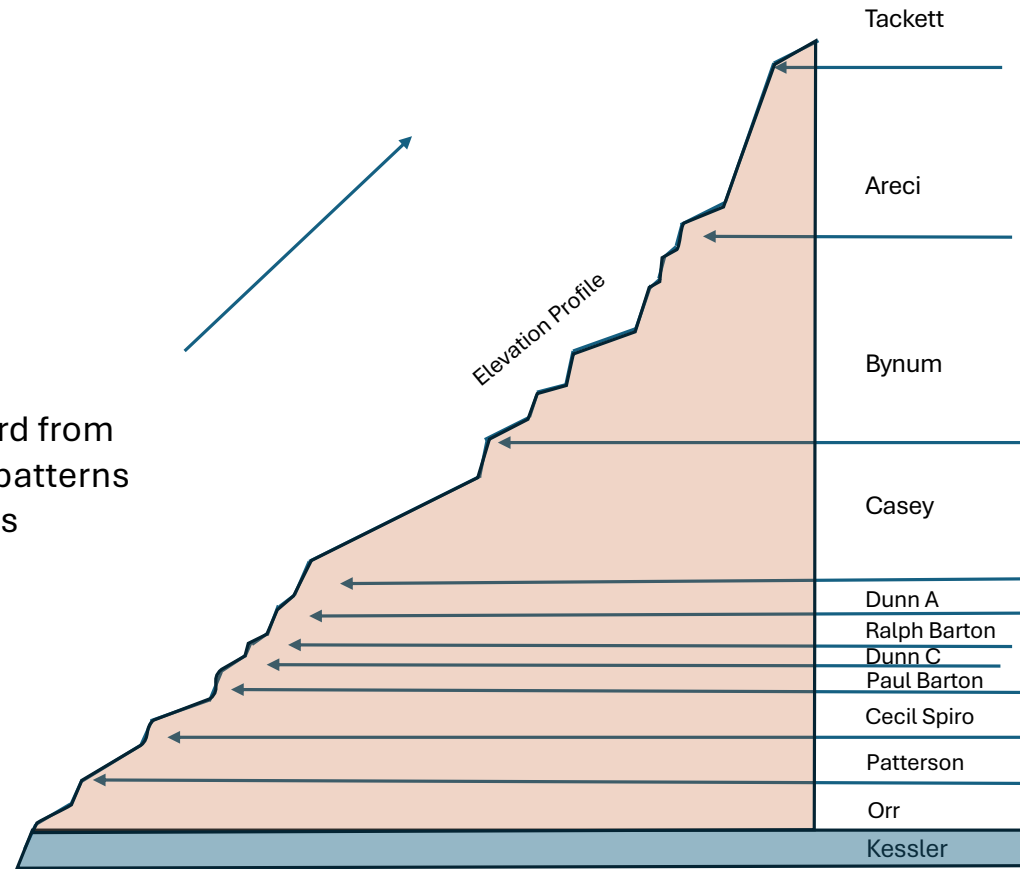
Mulberry Fault

Geologic Map of Arkansas (1993)

Method for determining Atoka at surface if Kessler outcrops

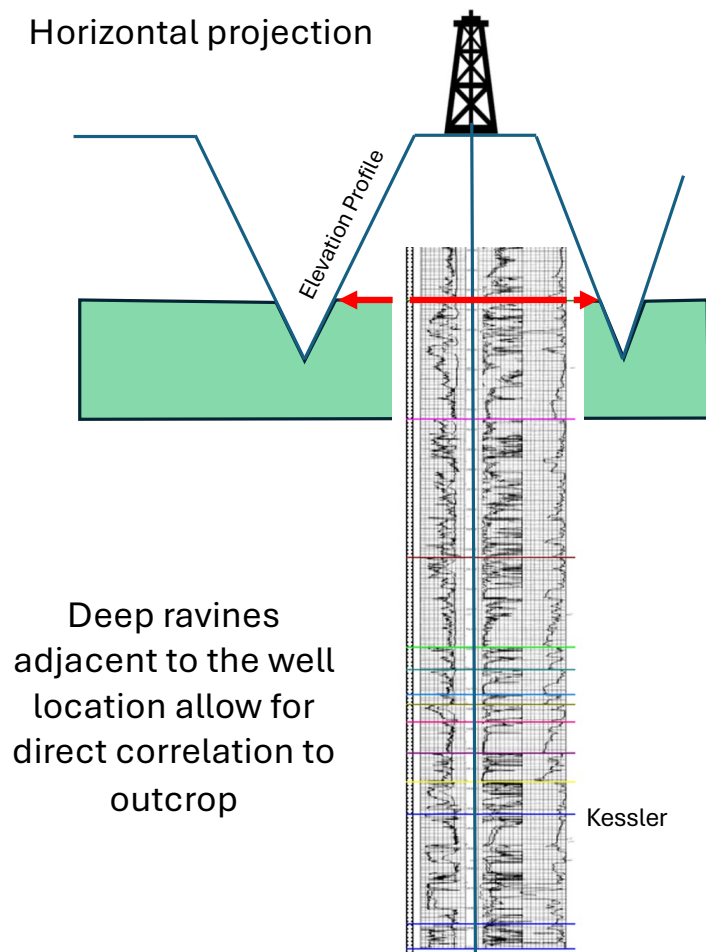
Project correlations upward from
Kessler using sand/shale patterns
and estimated thicknesses

Kessler in outcrop →

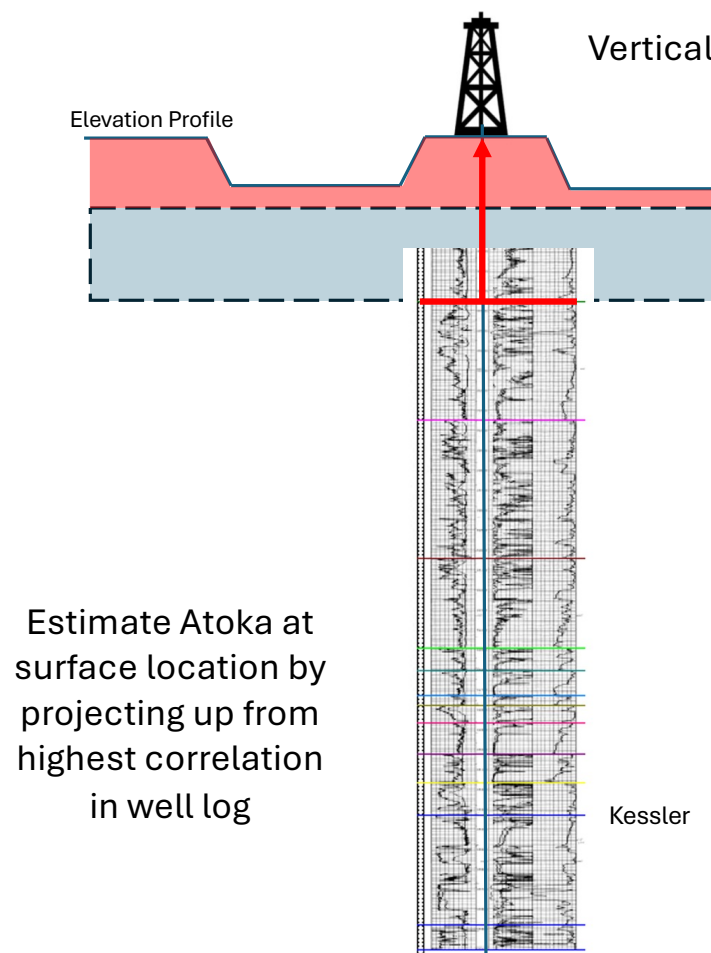


Methods for Determining Atoka at Surface using Well Logs

Horizontal projection



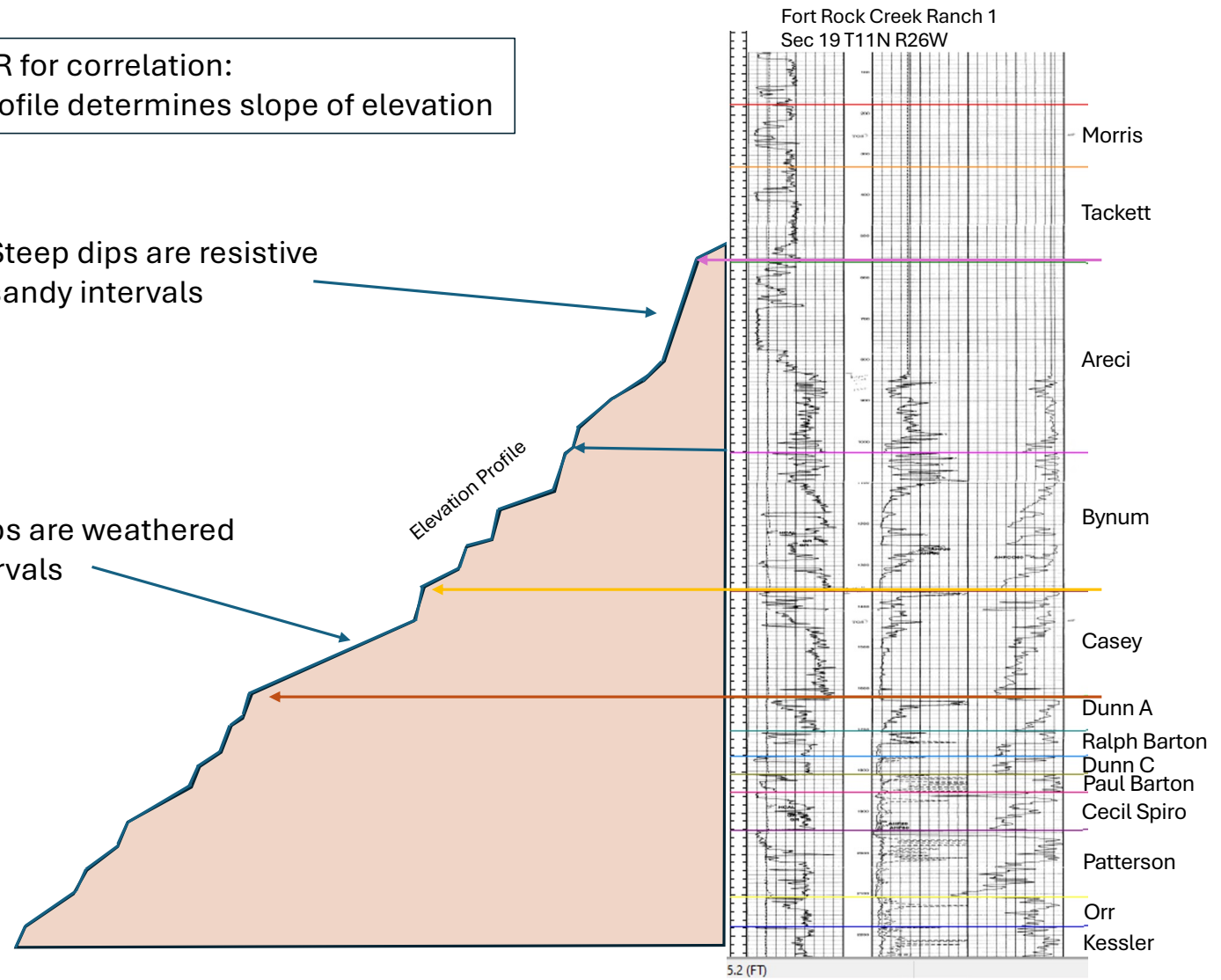
Vertical projection



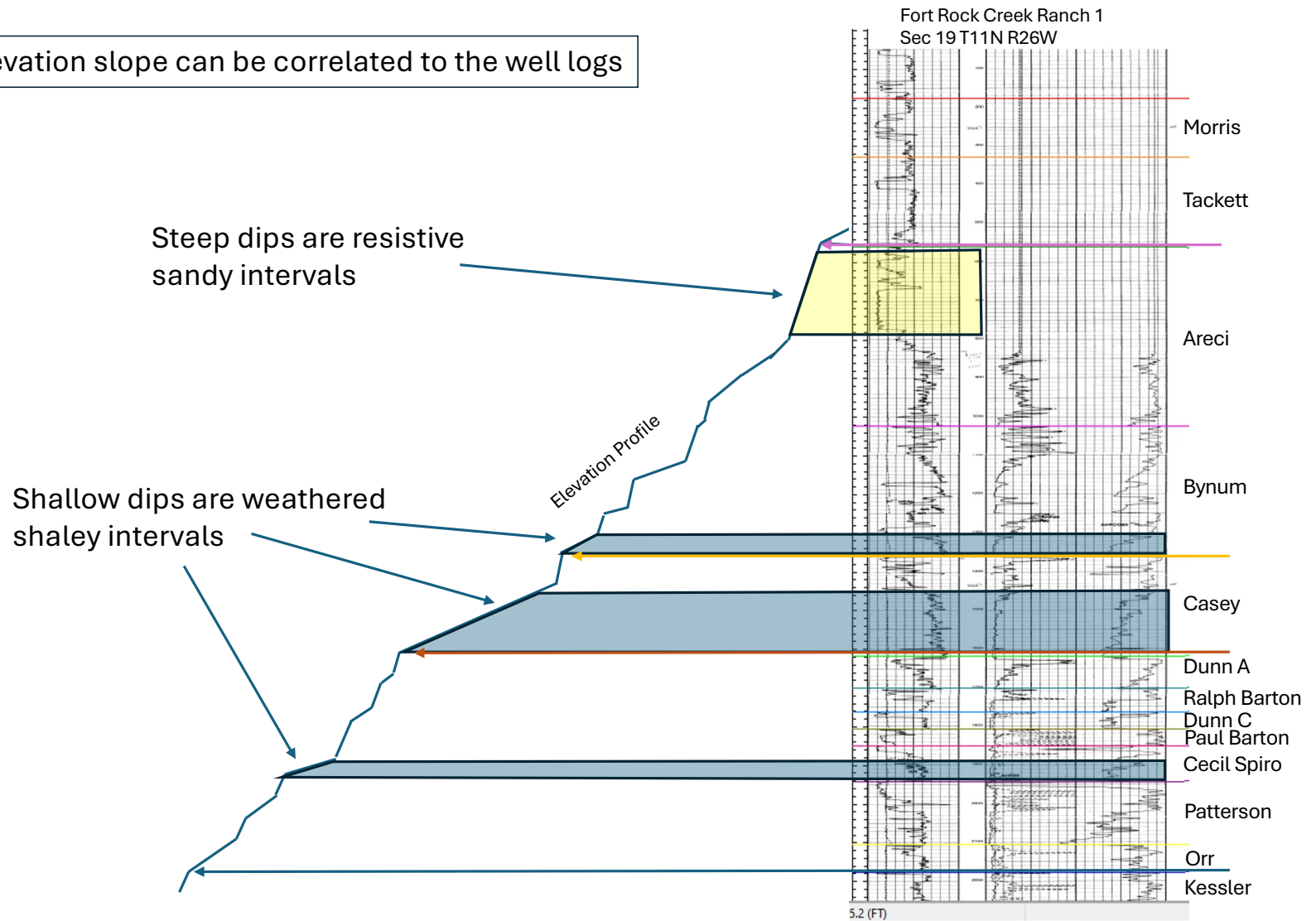
Using LiDAR for correlation:
First derivative of elevation profile determines slope of elevation

Steep dips are resistive
sandy intervals

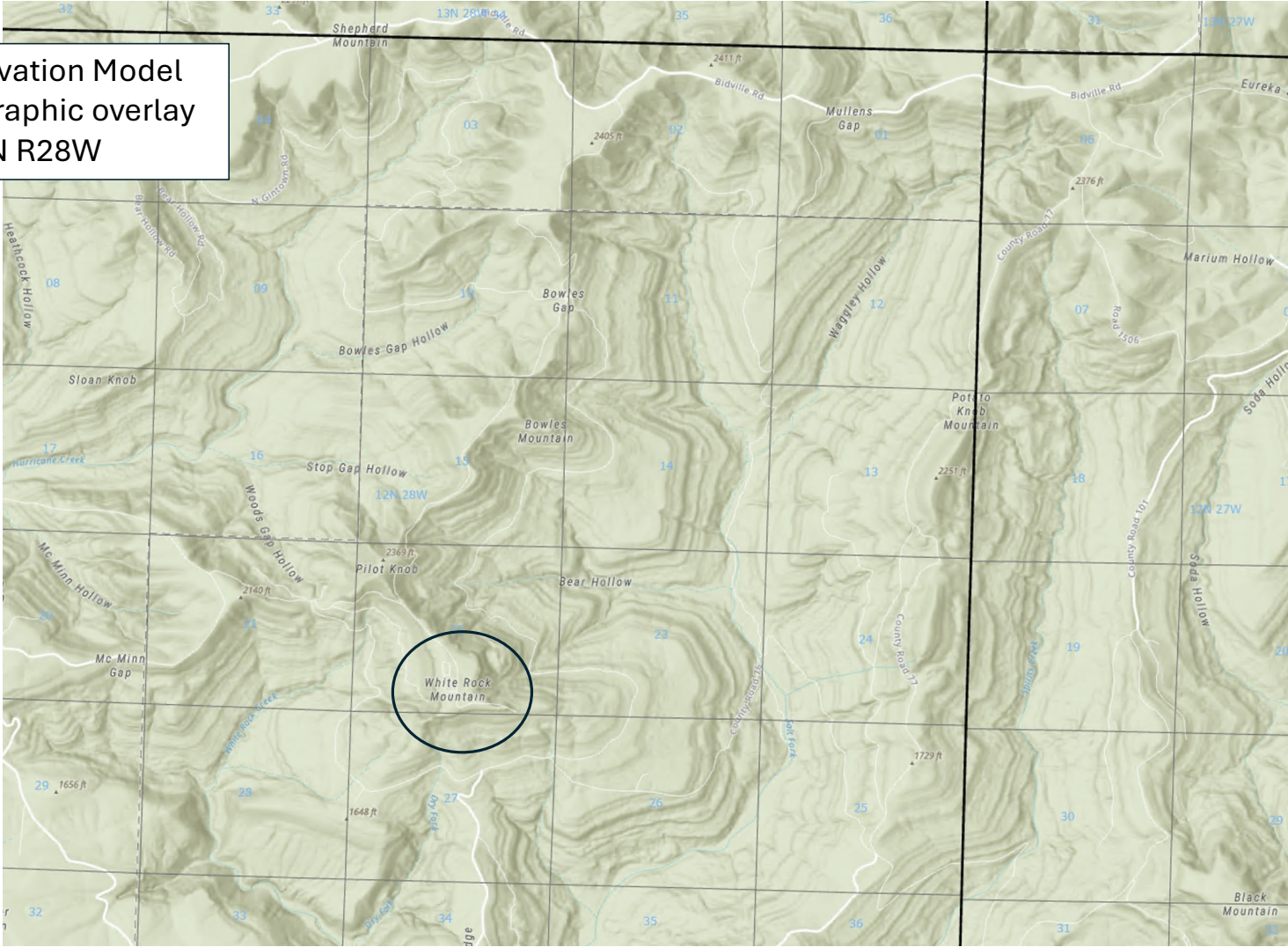
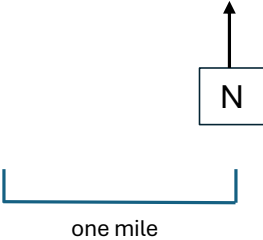
Shallow dips are weathered
shaley intervals



Patterns in the elevation slope can be correlated to the well logs

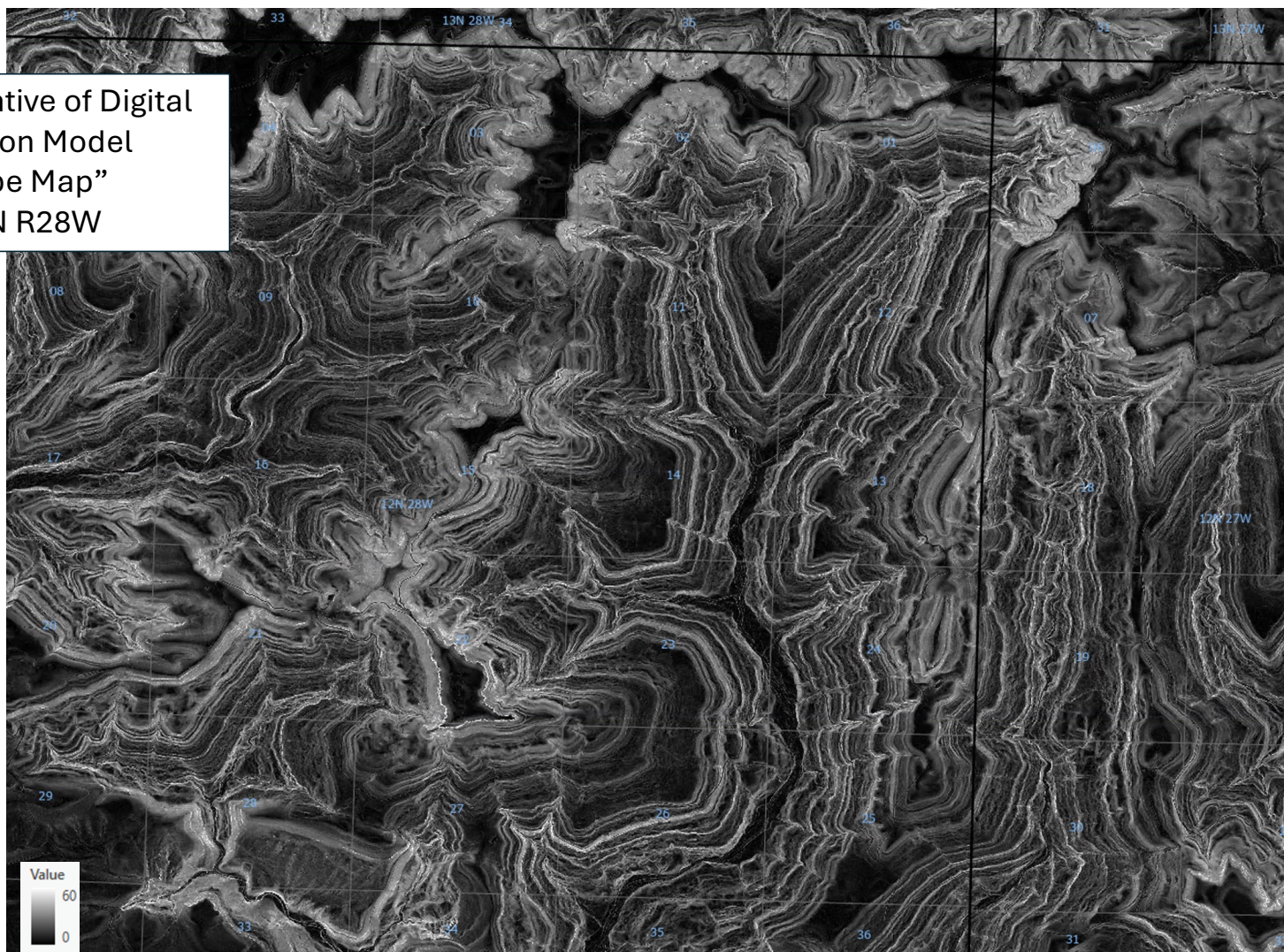


Digital Elevation Model
with Topographic overlay
T12N R28W

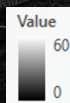


USGS (2024)

First Derivative of Digital
Elevation Model
“Slope Map”
T12N R28W



one mile



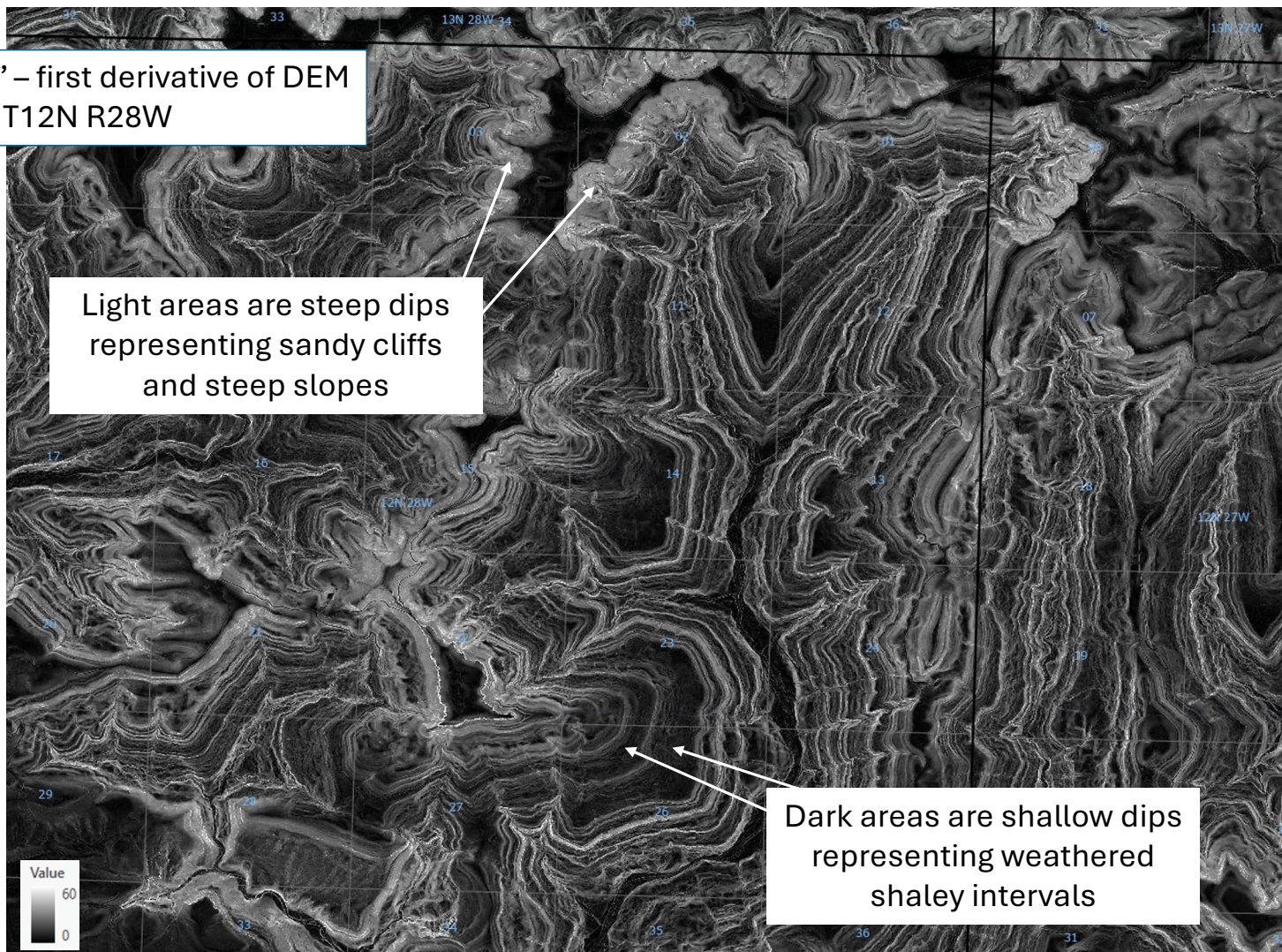
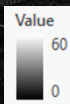
"Slope Map" – first derivative of DEM
T12N R28W

Light areas are steep dips
representing sandy cliffs
and steep slopes

Dark areas are shallow dips
representing weathered
shaley intervals

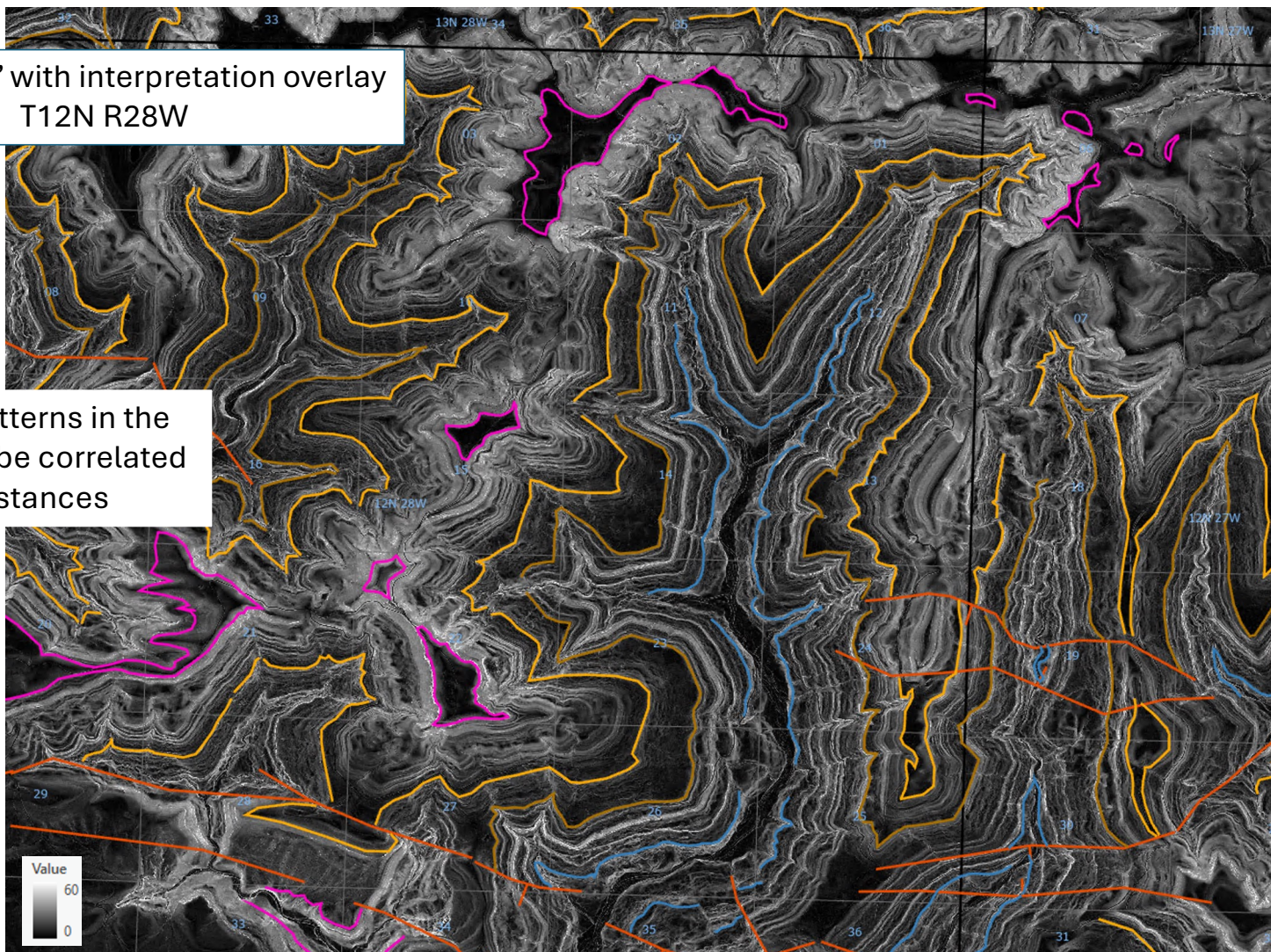


one mile

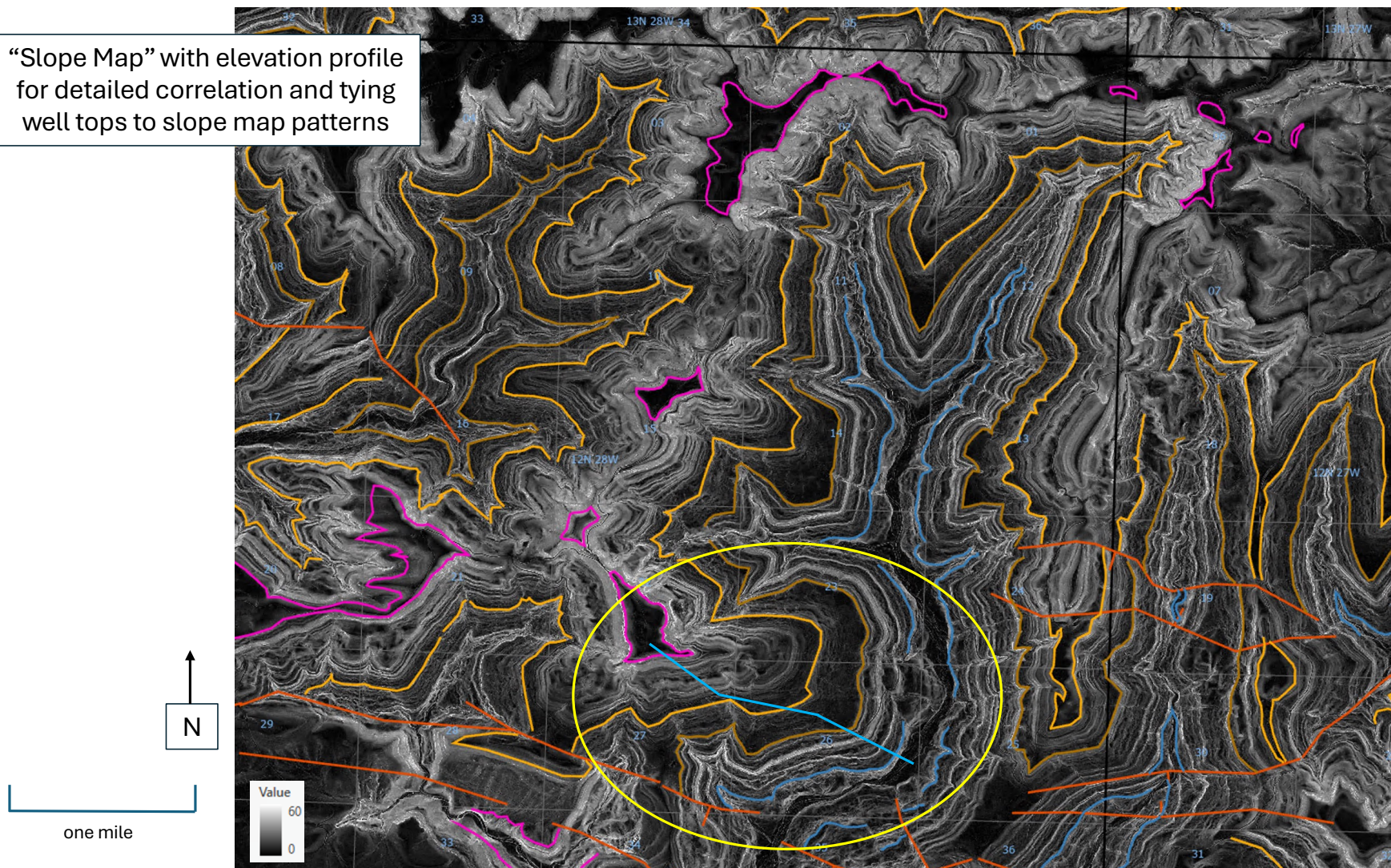


"Slope Map" with interpretation overlay
T12N R28W

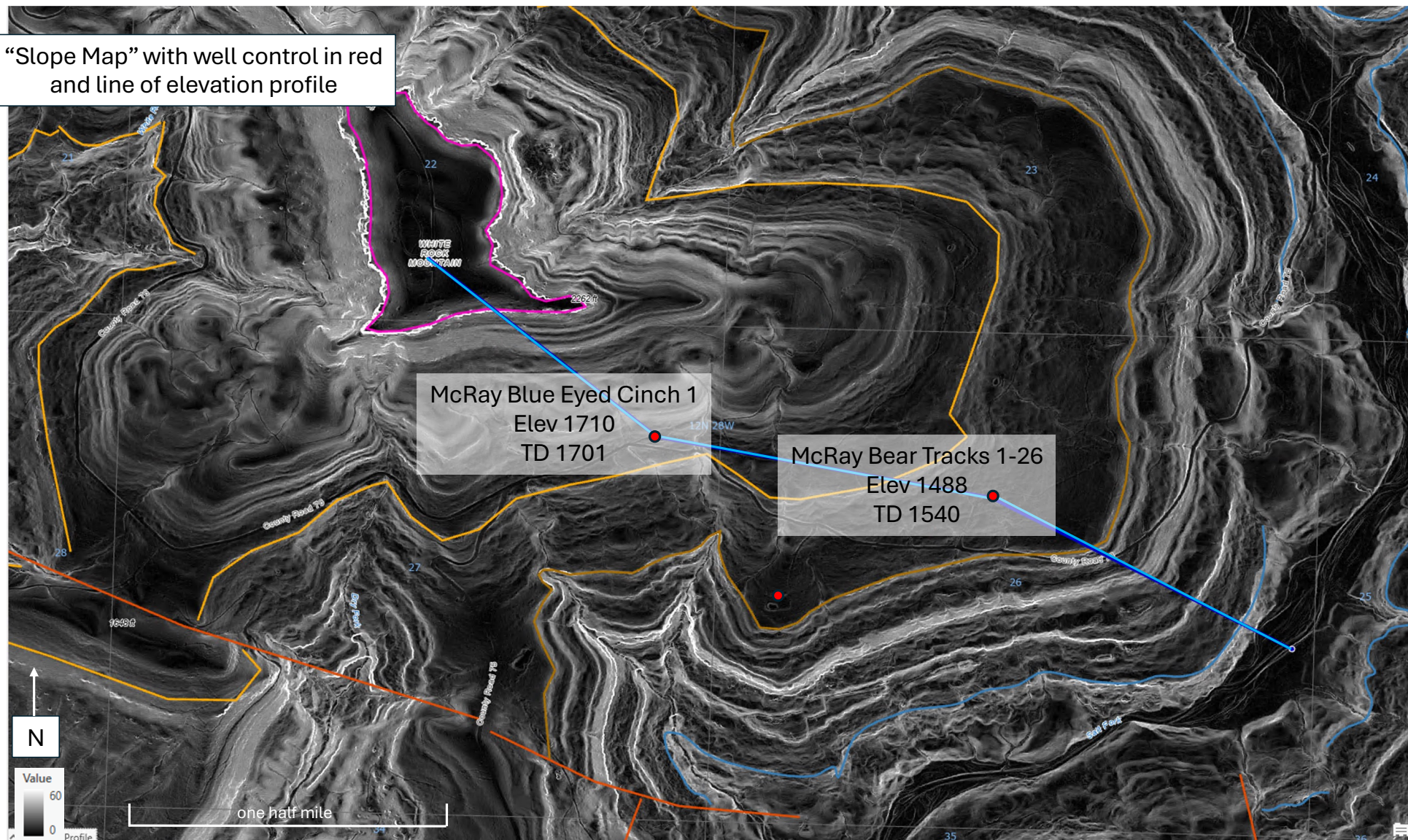
Sand/shale patterns in the
slope map can be correlated
for long distances

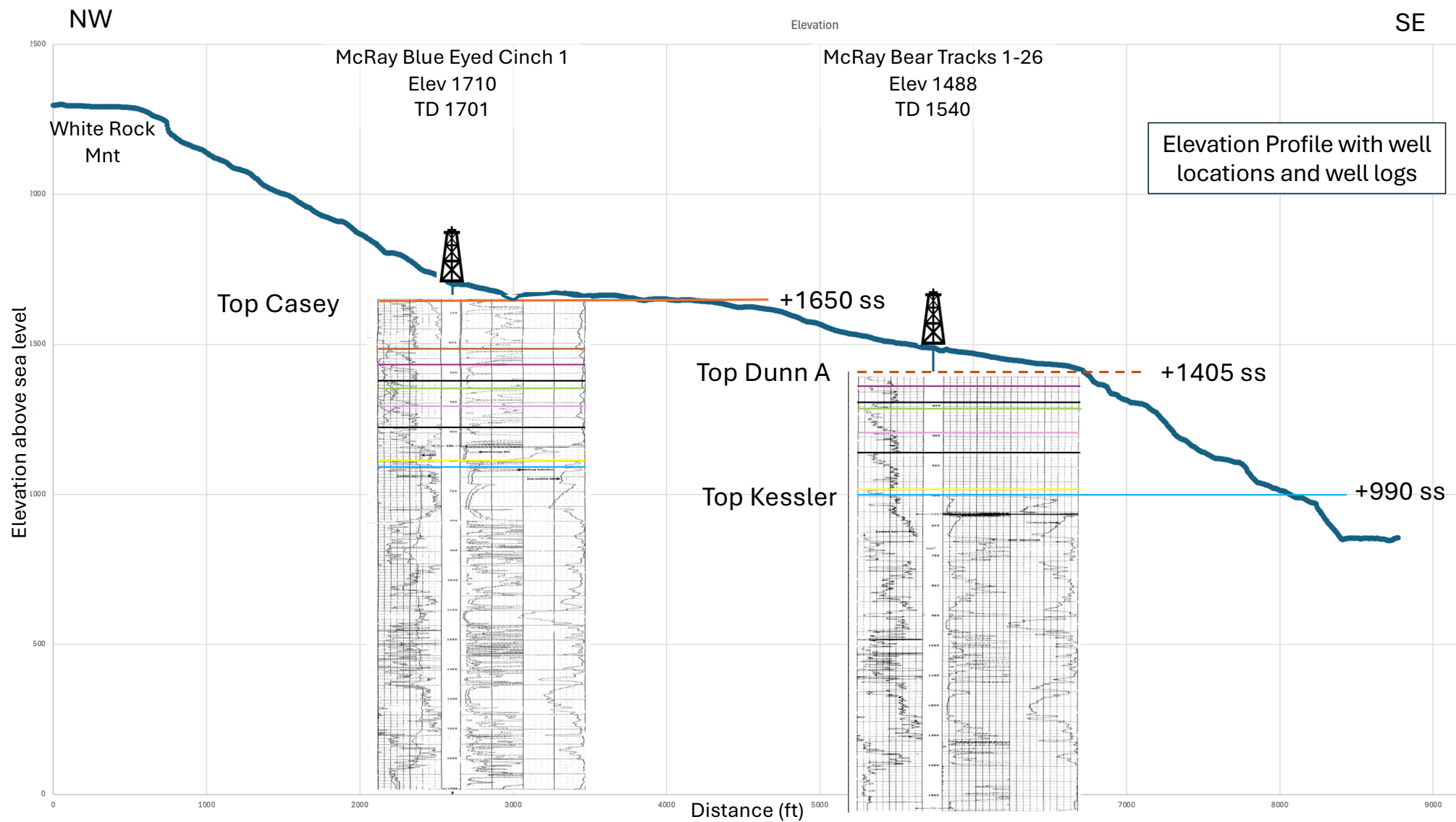


“Slope Map” with elevation profile
for detailed correlation and tying
well tops to slope map patterns

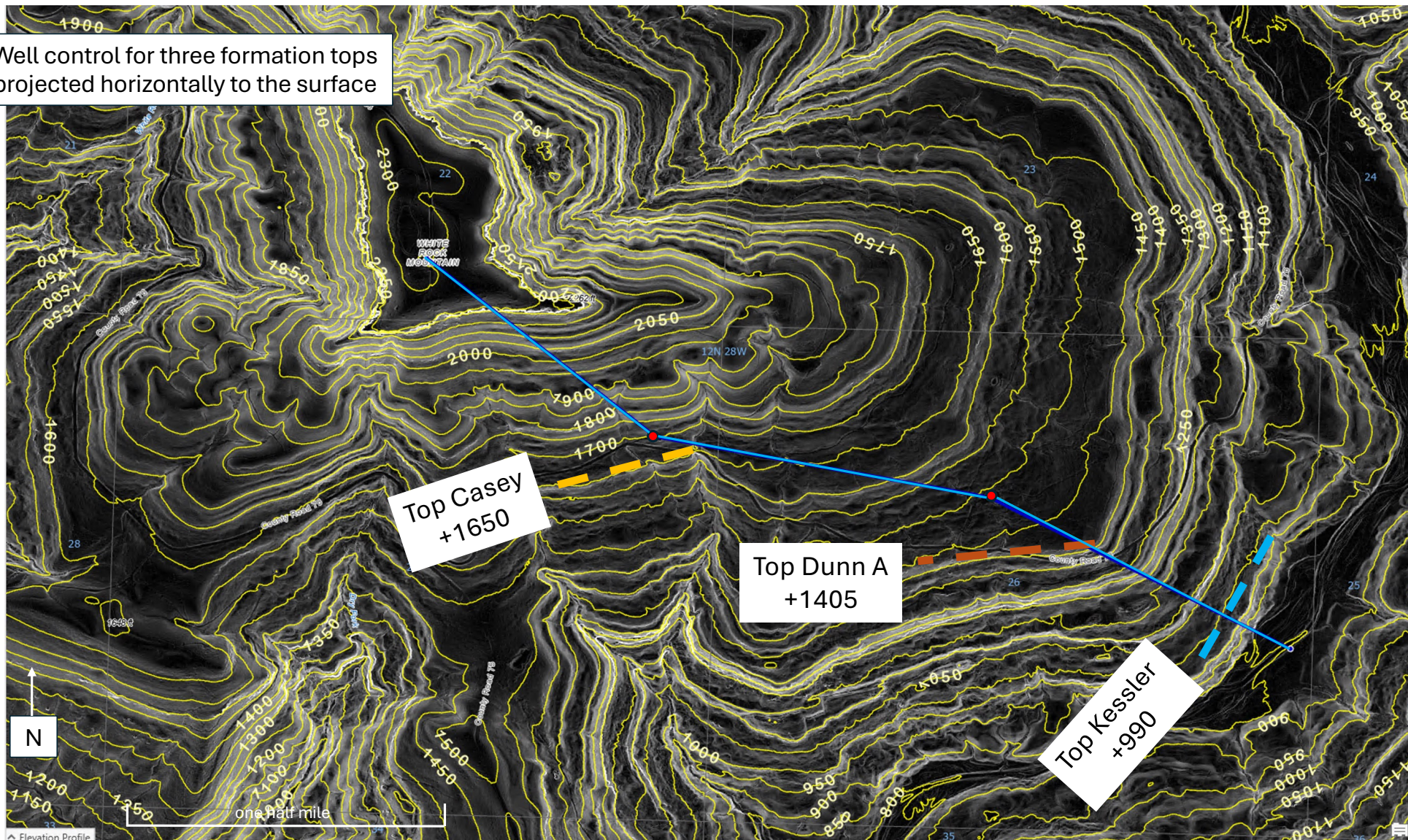


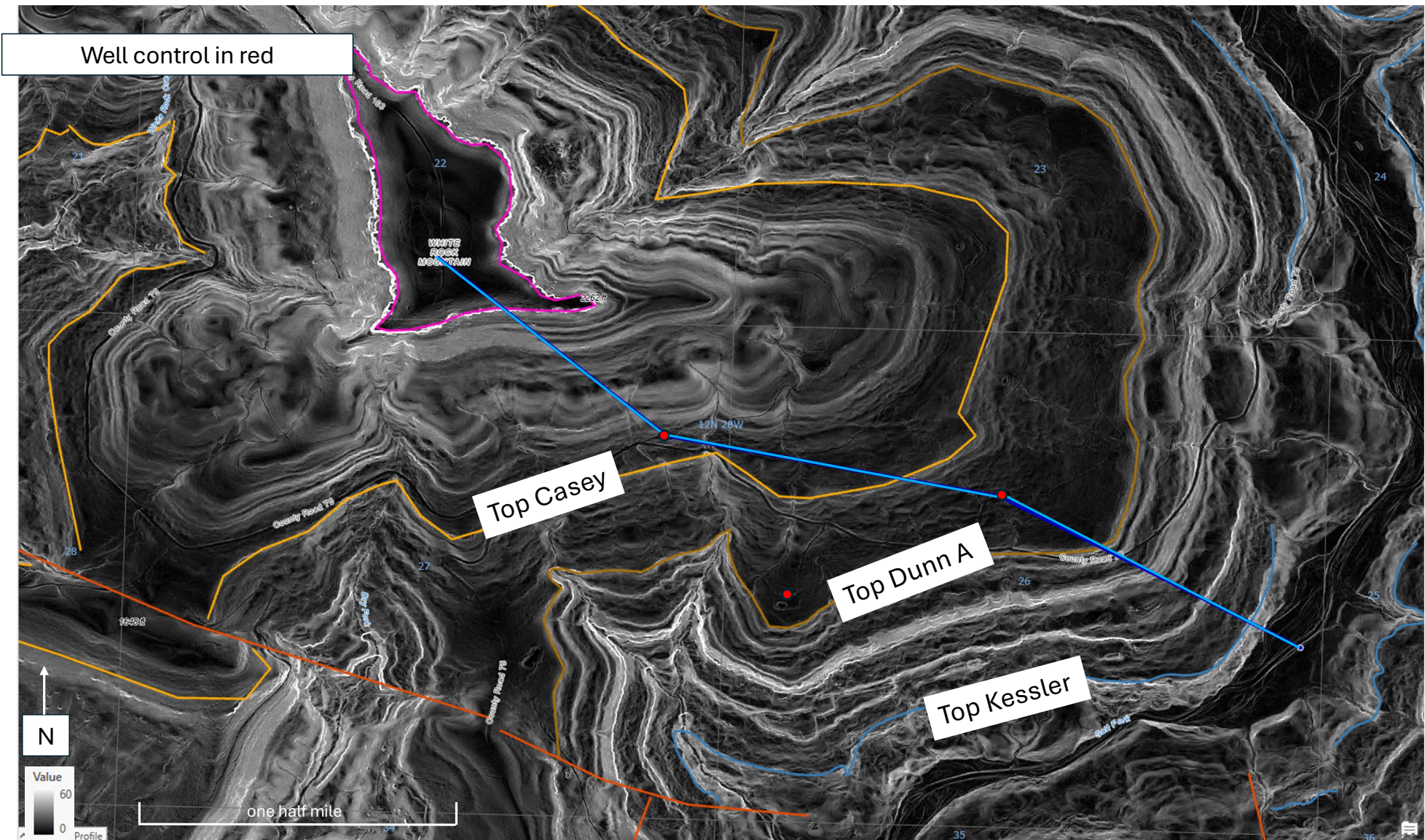
“Slope Map” with well control in red
and line of elevation profile



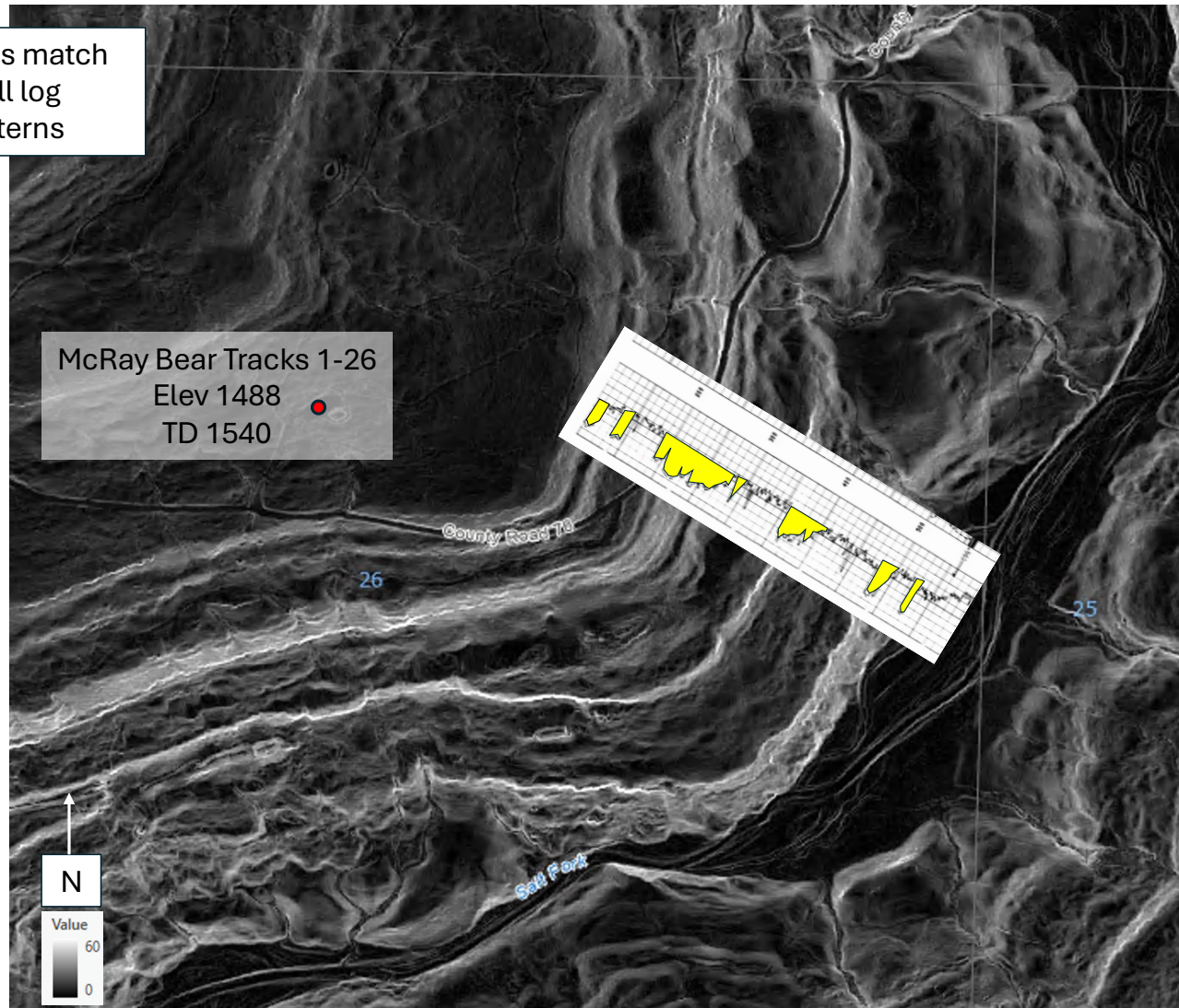


Well control for three formation tops projected horizontally to the surface



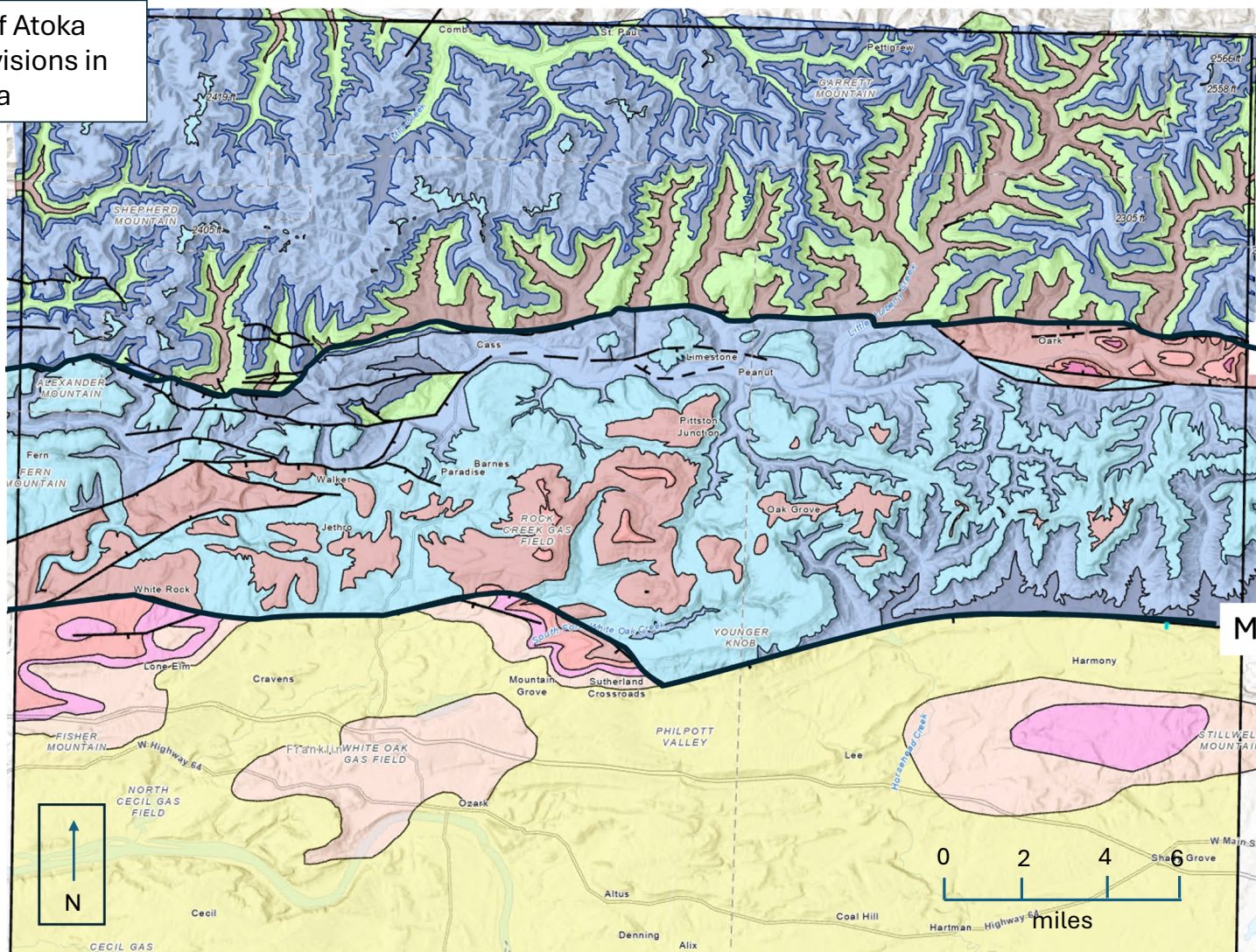


Slope map patterns match
gamma-ray well log
sand/shale patterns



Geologic Map of Atoka Formation Subdivisions in Study Area

Upper Atoka	Desmoinesian
	U Carpenter
	U Alma
	M Alma
	L Alma/L Carpenter
Middle Atoka	Morris/Tackett
	Areci/Bynum
	Casey
	Lower Atoka
Lower Atoka	Morrowan
	Mississippian



Cass Fault

Mulberry Fault

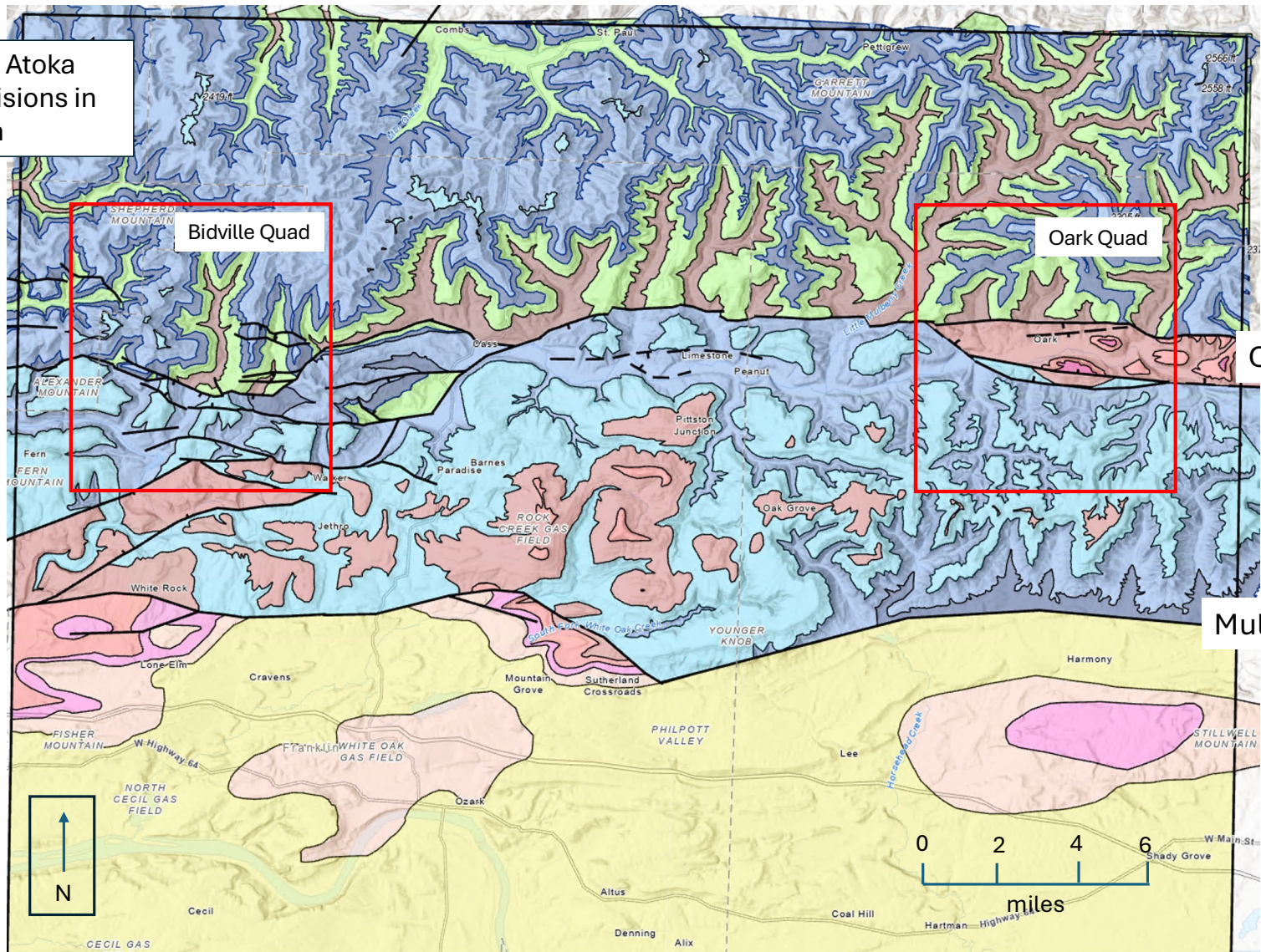
Geologic Map of Arkansas 1993

This is a detailed geologic map of Arkansas, showing various geological units, topographic features, and place names. The map includes a scale bar (0 to 6 miles) and a north arrow. Key features include the Mississippi River, the Arkansas River, and the Ozark Mountains. Geological units are labeled with codes such as Pa, Pbh, Pbs, and Pks. Place names include St. Paul, Little Rock, Fayetteville, and many others. The map is color-coded to represent different geological formations, with a legend provided in the bottom left corner.



Geologic Map of Atoka Formation Subdivisions in Study Area

Upper Atoka	Desmoinesian
	U Carpenter
	U Alma
	M Alma
	L Alma/L Carpenter
Middle Atoka	Morris/Tackett
	Areci/Bynum
	Casey
Lower Atoka	Lower Atoka
	Morrowan
	Mississippian



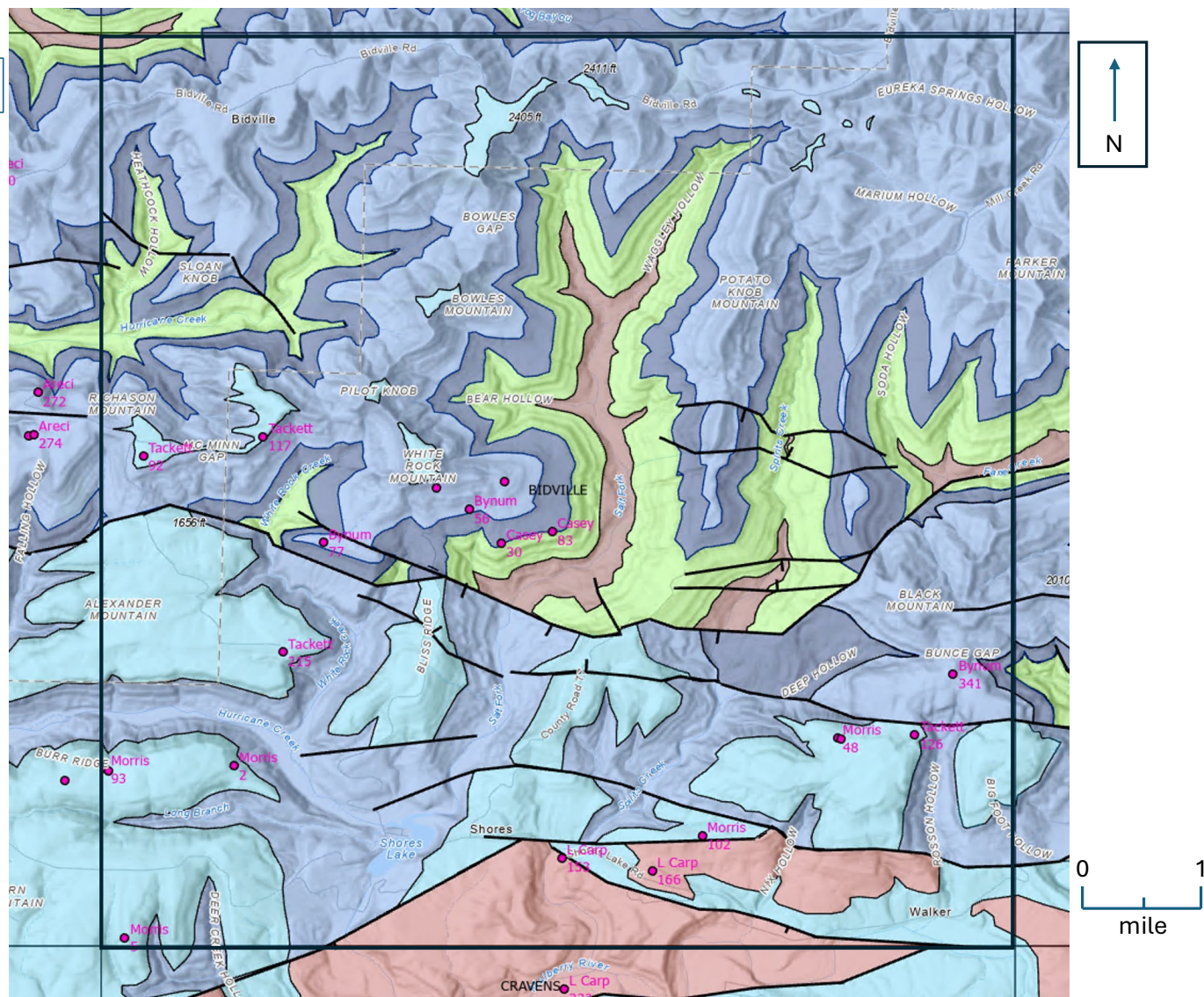
Cass Fault

Mulberry Fault

Bidville Quad with Well Control

Estimated Atoka at surface with
height in feet above base of
formation posted at each well

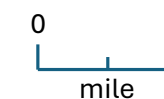
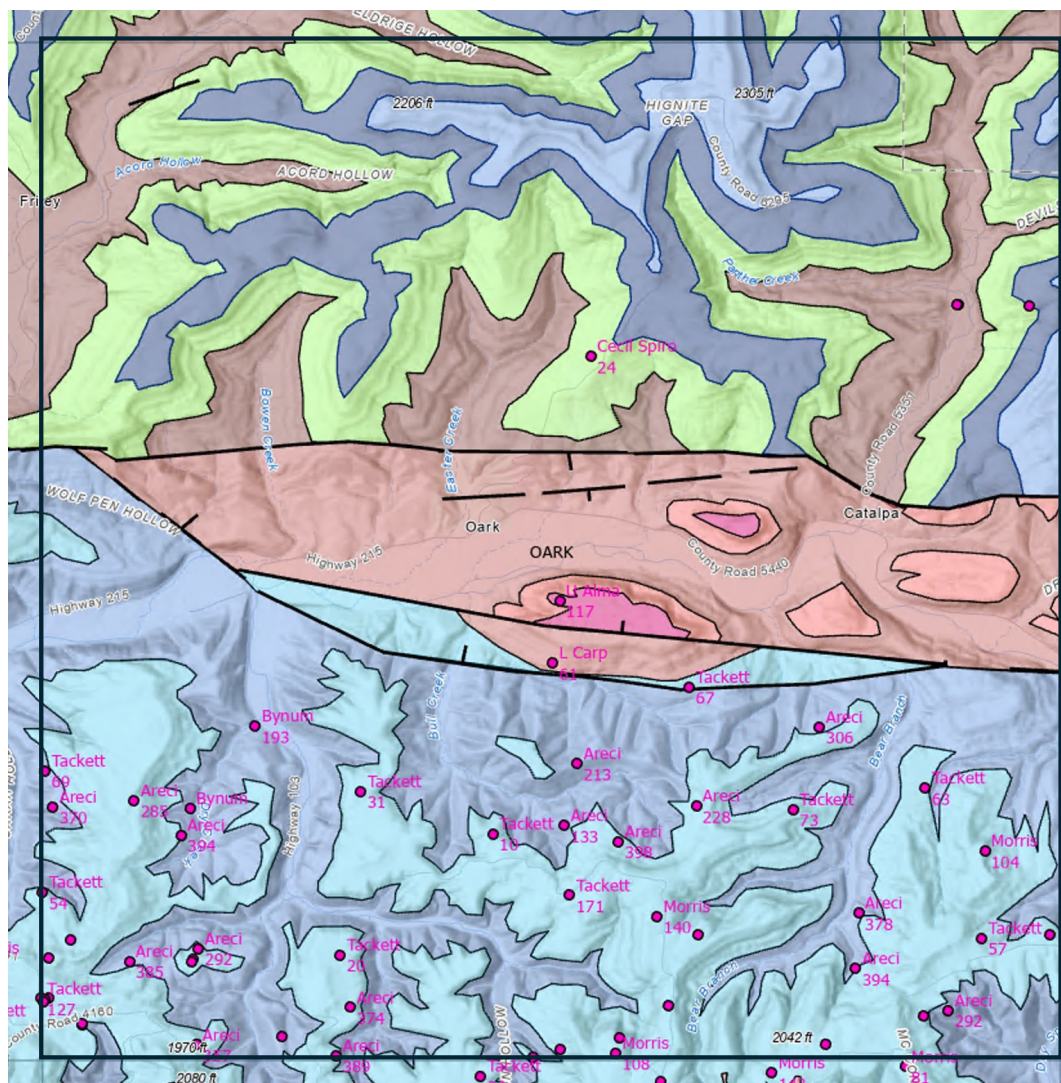
Upper Atoka	Desmoinesian
	U Carpenter
	U Alma
	M Alma
	L Alma/L Carpenter
Middle Atoka	Morris/Tackett
	Areci/Bynum
	Casey
Lower Atoka	Lower Atoka
	Morrowan
	Mississippian



Oark Quad with Well Control

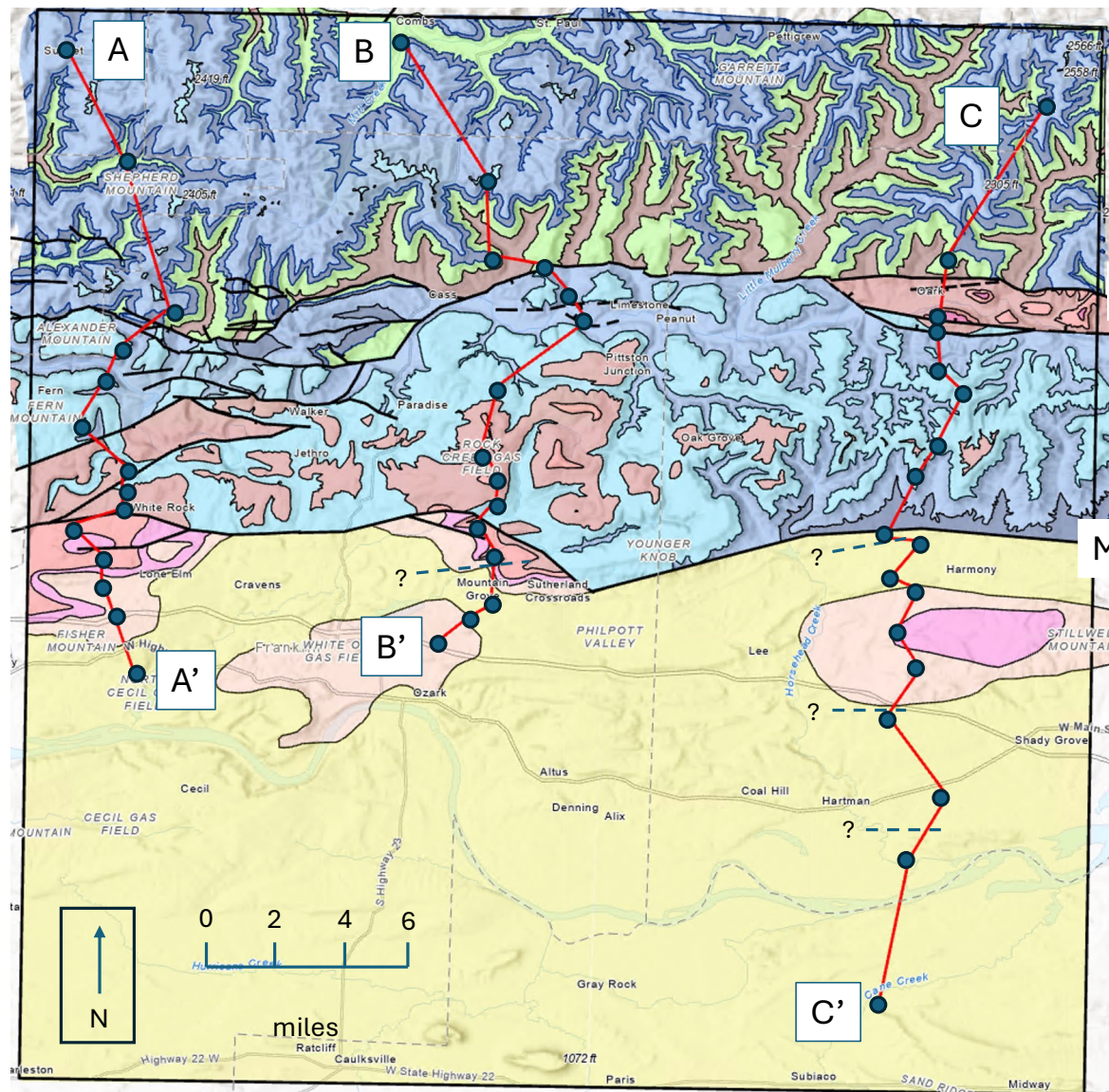
Estimated Atoka at surface with height in feet above base of formation posted at each well

Upper Atoka	Desmoinesian
	U Carpenter
	U Alma
	M Alma
	L Alma/L Carpenter
Middle Atoka	Morris/Tackett
	Areci/Bynum
	Casey
Lower Atoka	Lower Atoka
	Morrowan
	Mississippian



Geologic Map of Atoka
Formation Subdivisions with
North-South cross-section lines

	Desmoinesian
Upper Atoka	U Carpenter
	U Alma
	M Alma
	L Alma/L Carpenter
Middle Atoka	Morris/Tackett
	Areci/Bynum
	Casey
Lower Atoka	Lower Atoka
	Morrowan
	Mississippian



Cass Fault

Mulberry Fault

North

C

North-south cross section with elevation profile and well control T13N R24W to T8N R24W

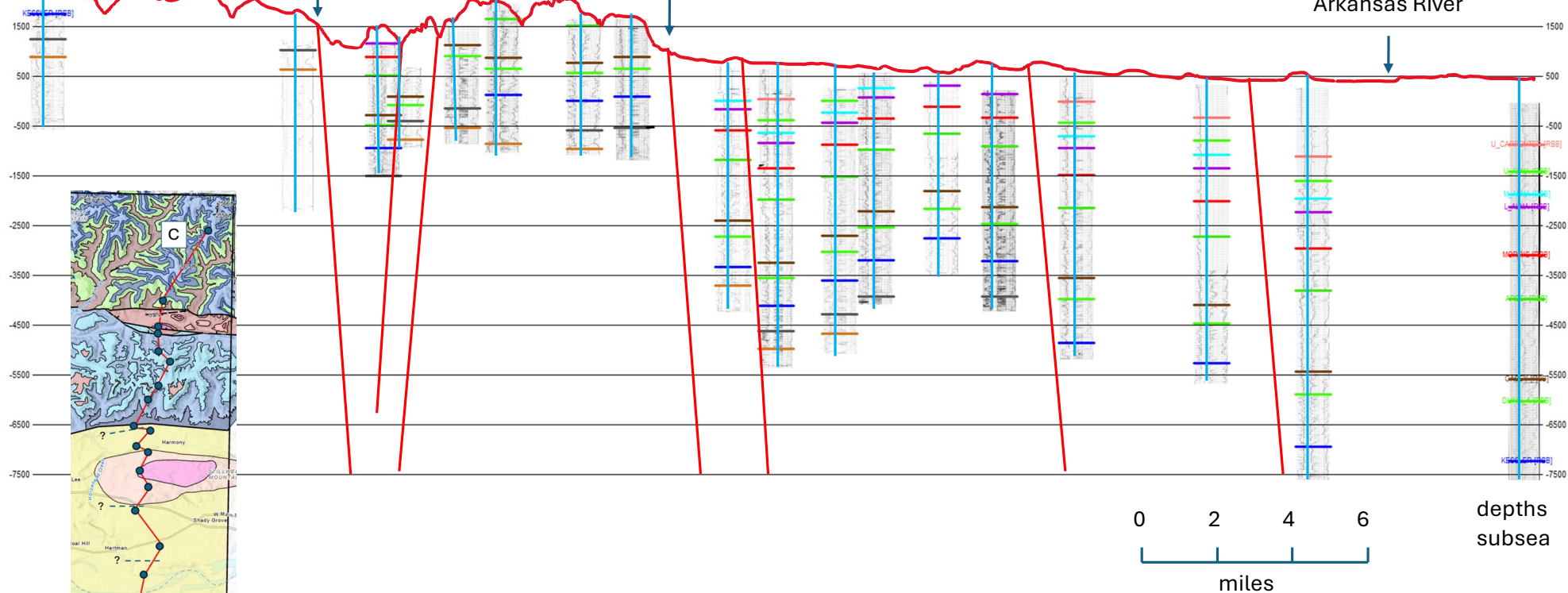
South

C'

Cass Fault

Mulberry Fault

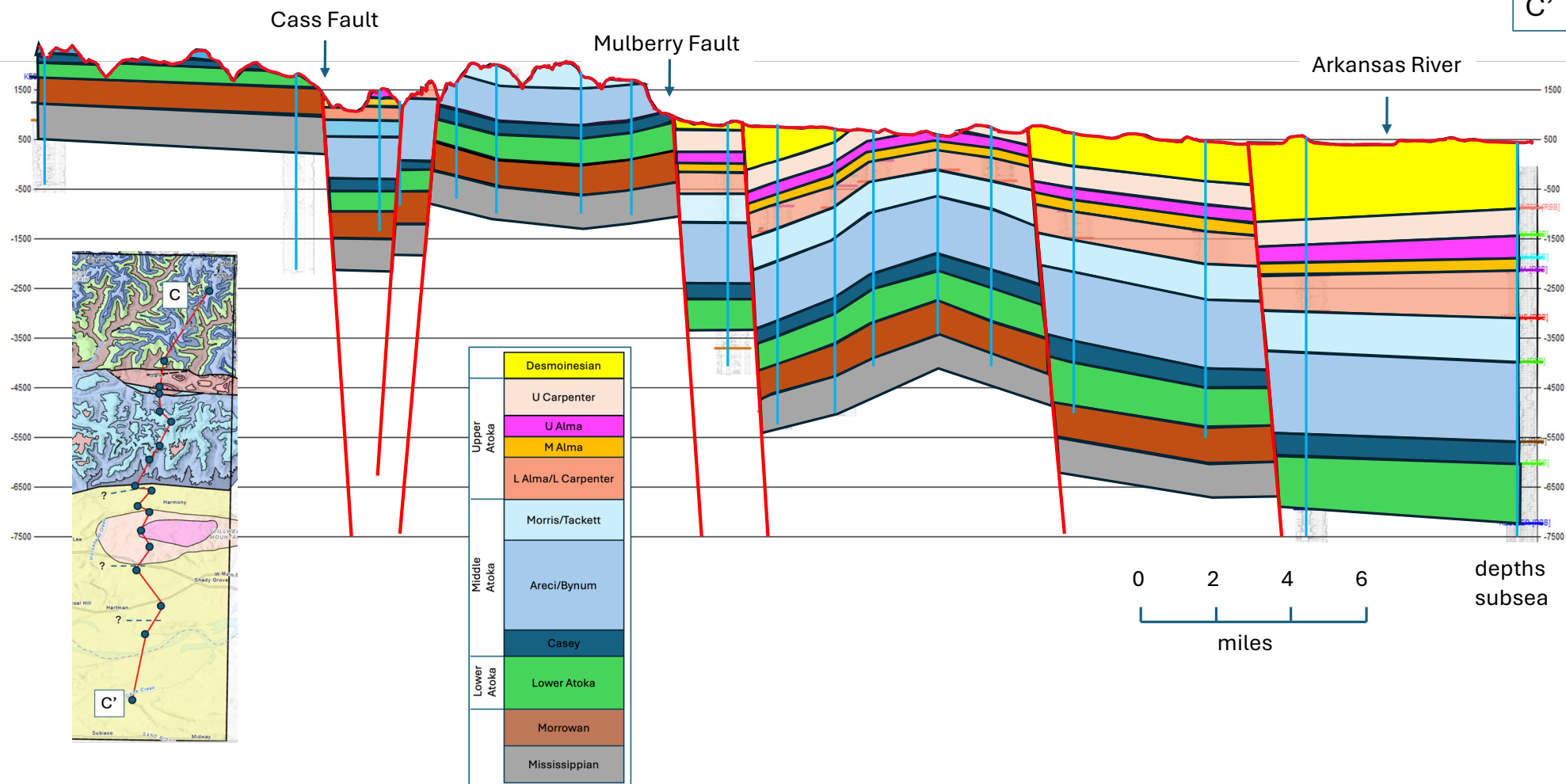
Arkansas River



North
C

North-south cross section with elevation profile and well control T13N R24W to T8N R24W

South
C'



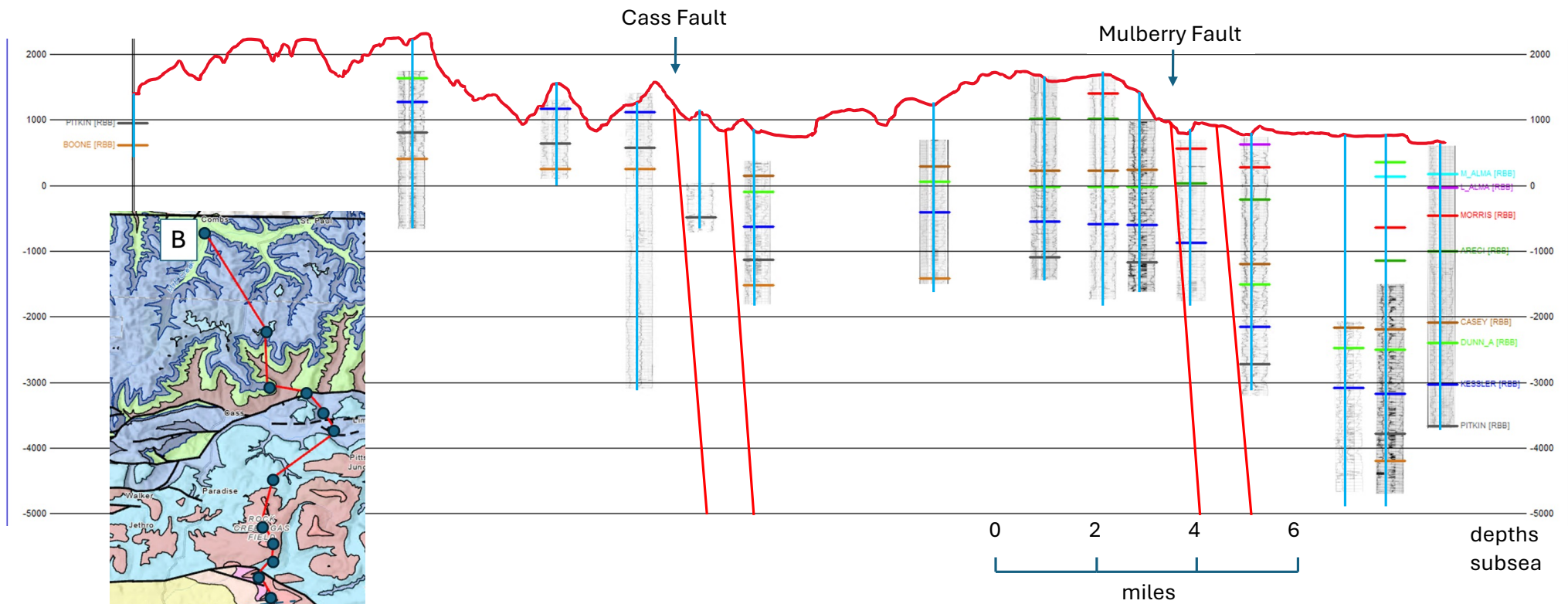
North

B

North-south cross section with elevation profile and well control
T13N R26W to T10N R26W

South

B'



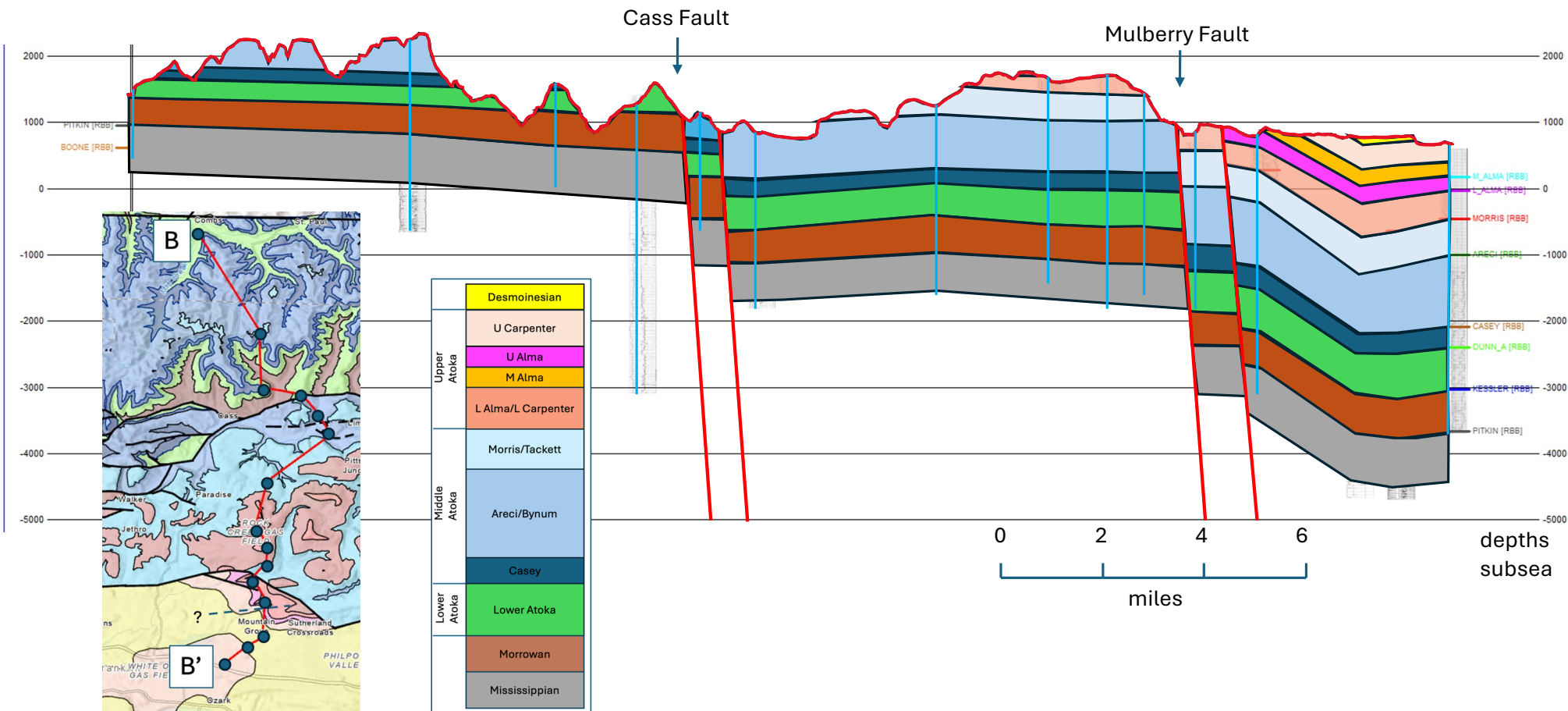
North

B

North-south cross section with elevation profile and well control T13N R26W to T10N R26W

South

B'



North

A

North-south cross section with elevation profile and well control T13N R28W to T10N R28W

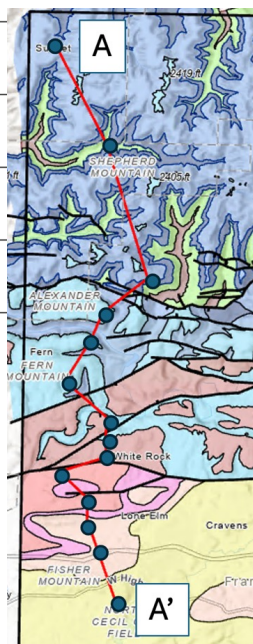
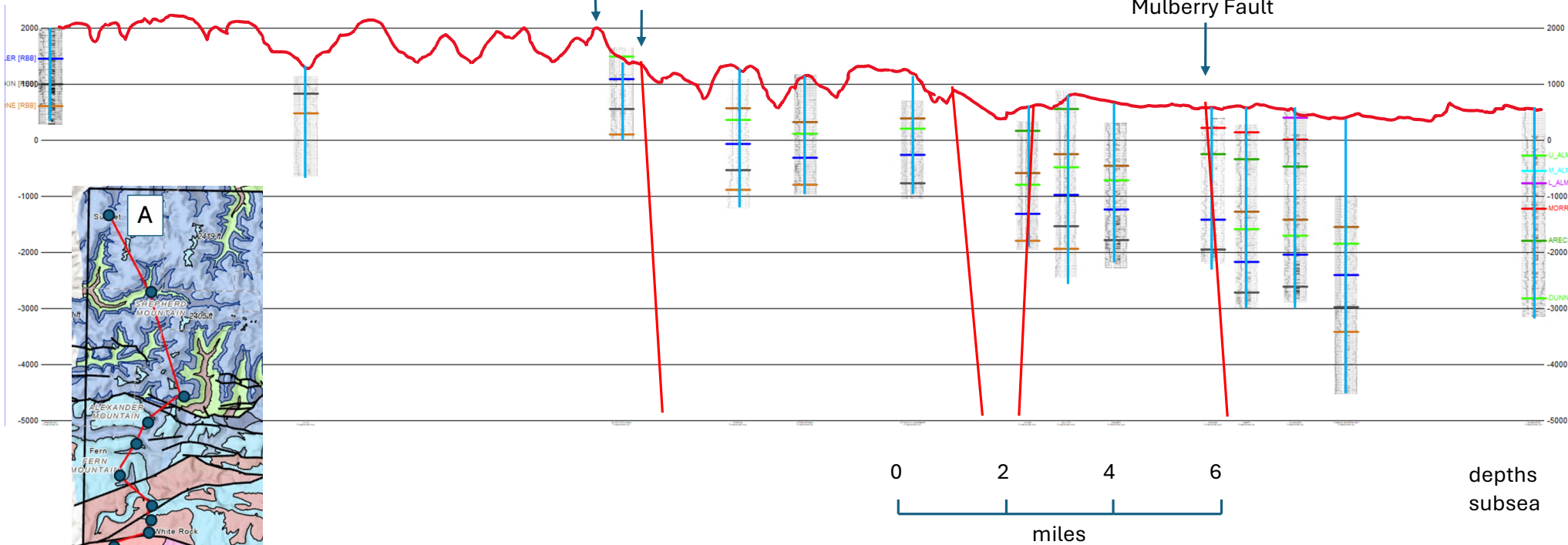
South

A'

White Rock Mnt

Cass Fault

Mulberry Fault



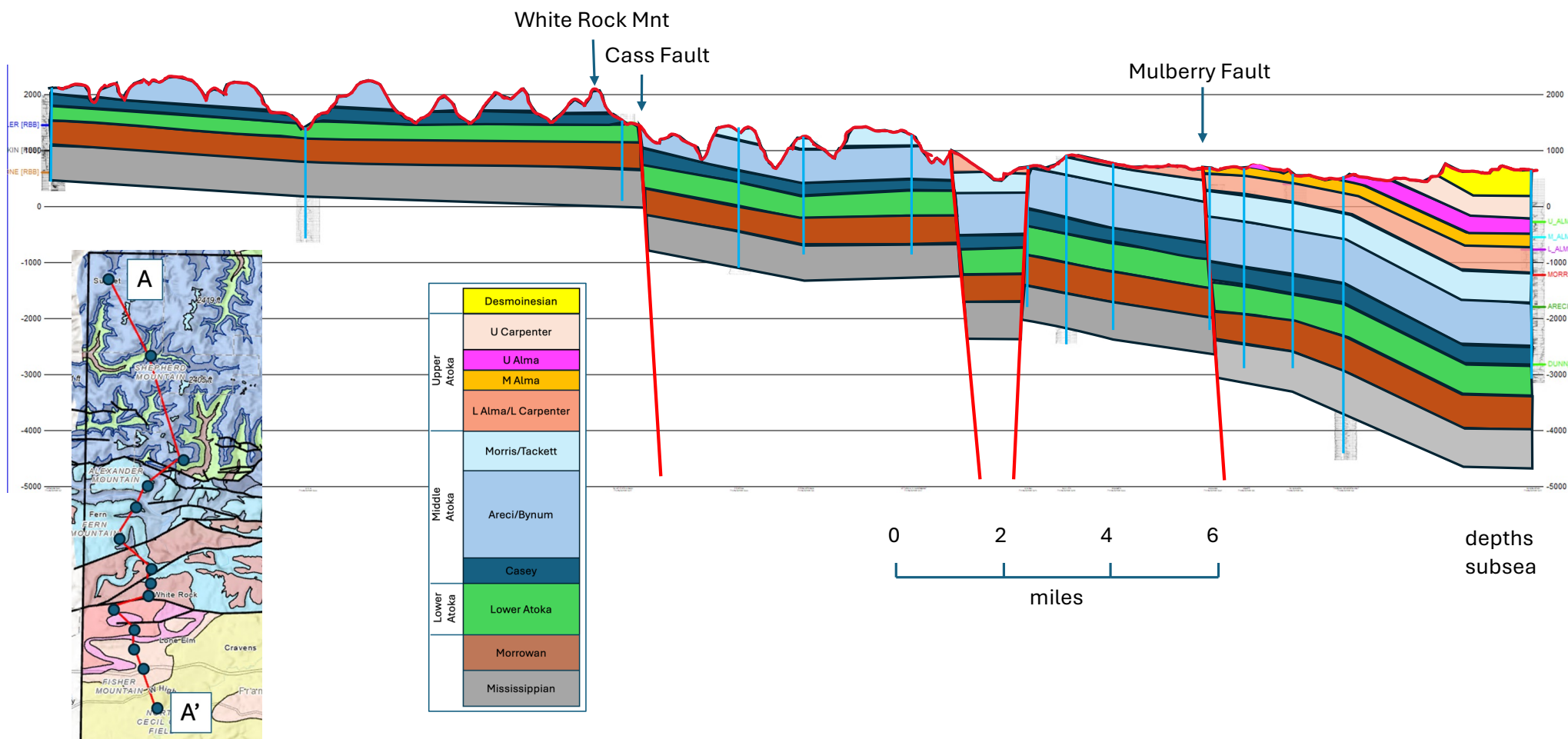
North

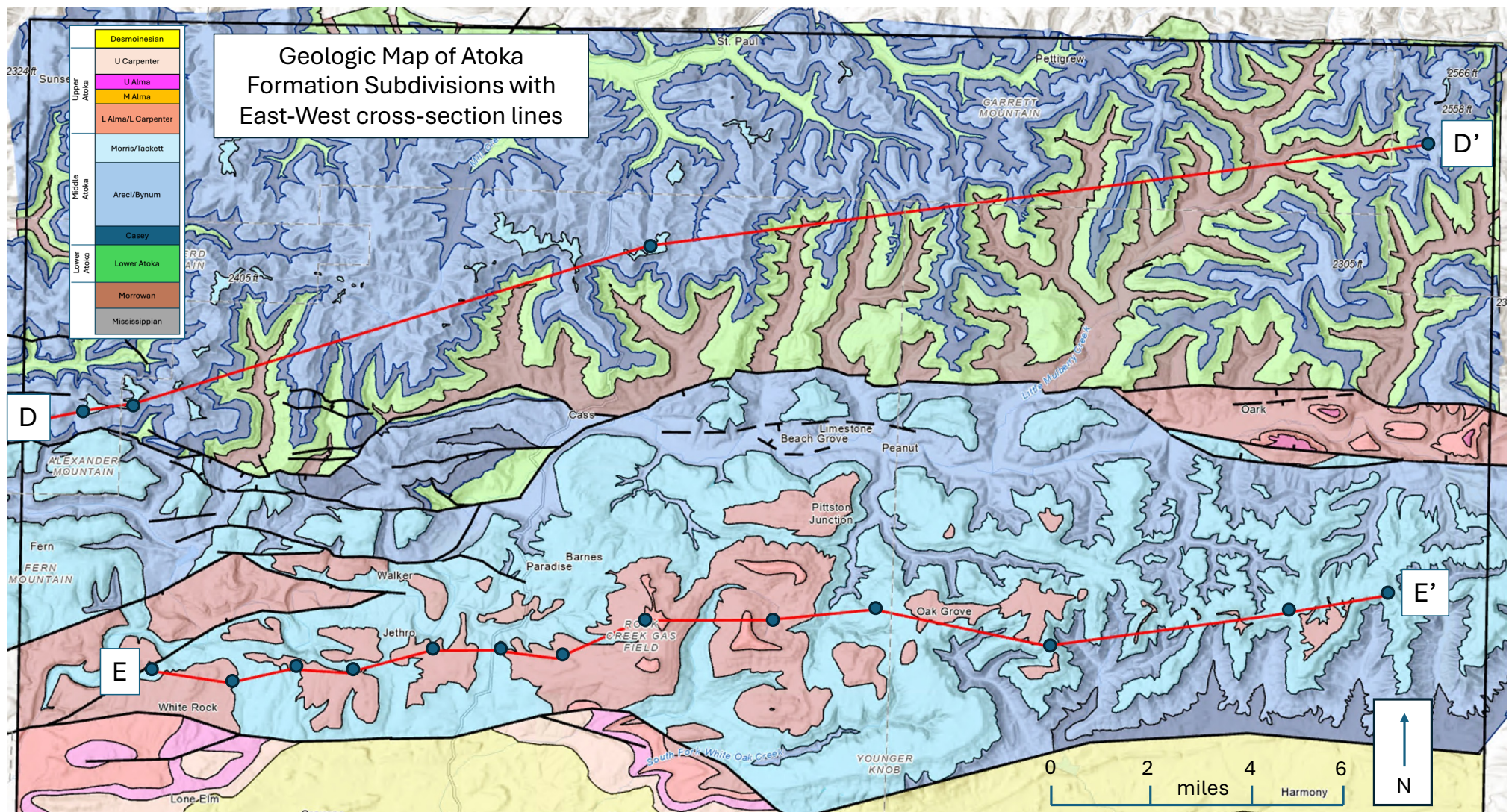
A

North-south cross section with elevation profile and well control T13N R28W to T10N R28W

South

A'





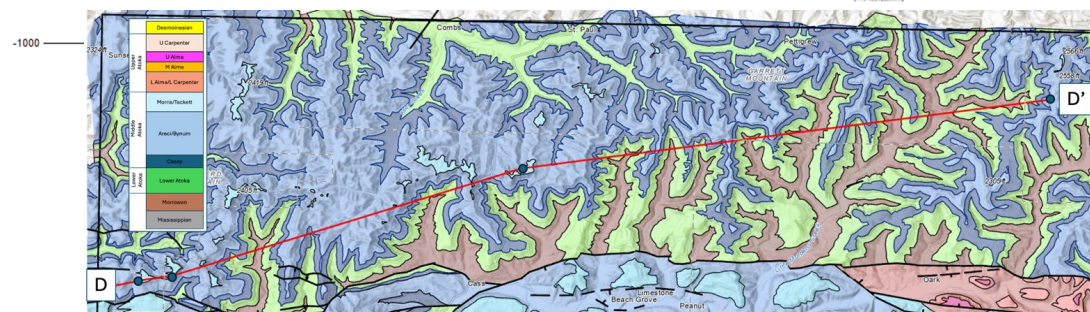
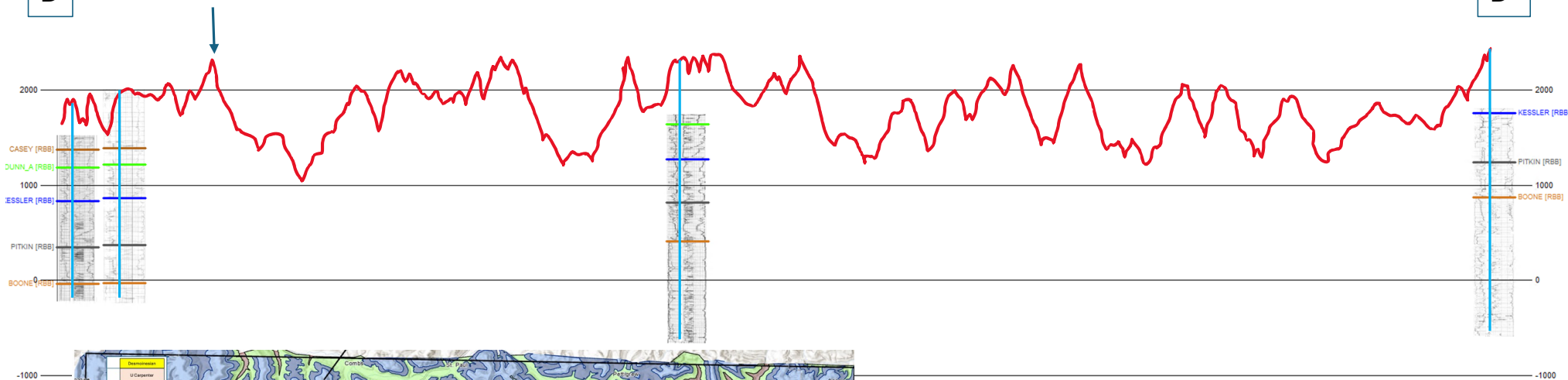
West

D

White Rock Mnt

East

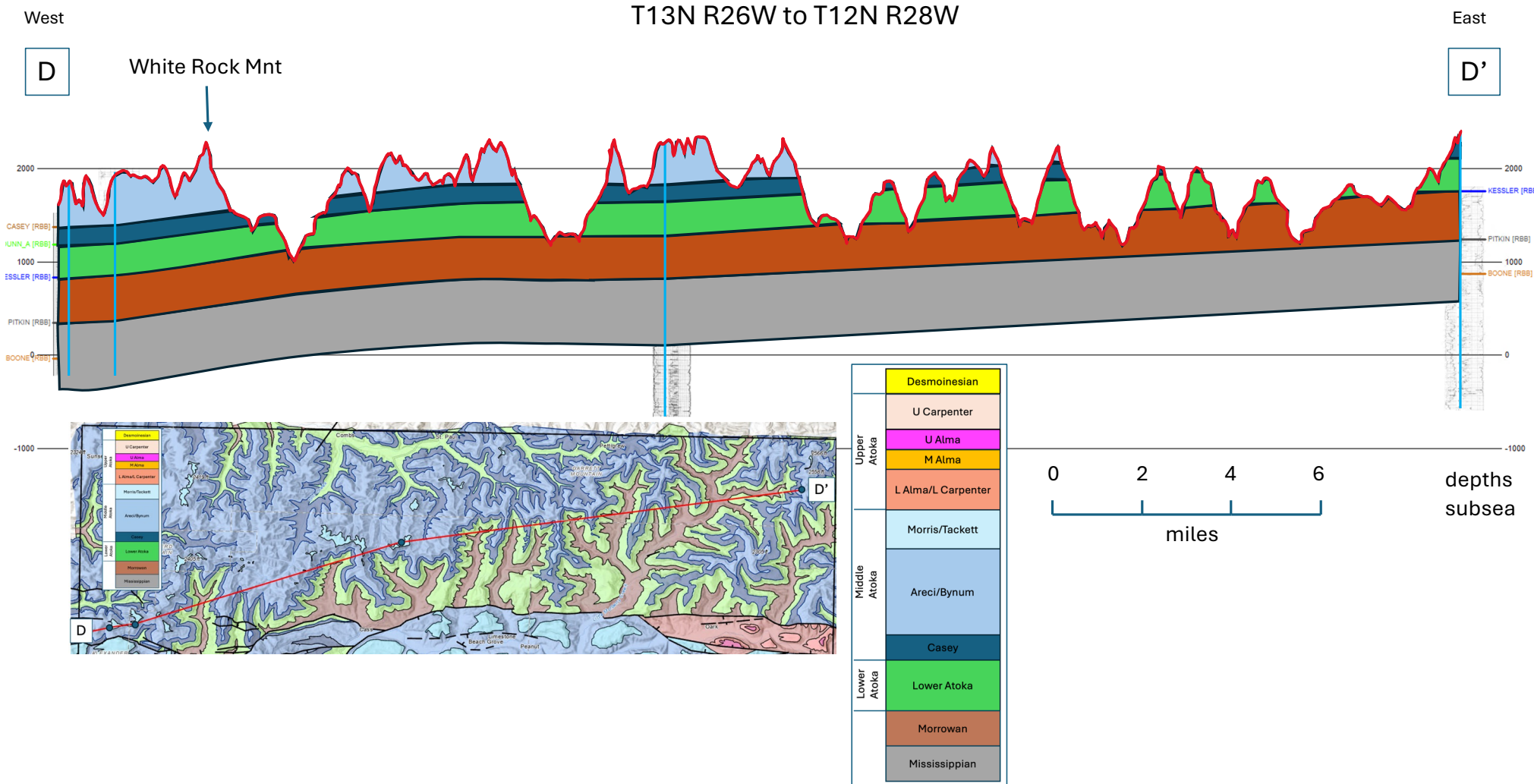
D'



A horizontal number line with tick marks at 0, 2, 4, and 6. The word "miles" is written below the line.

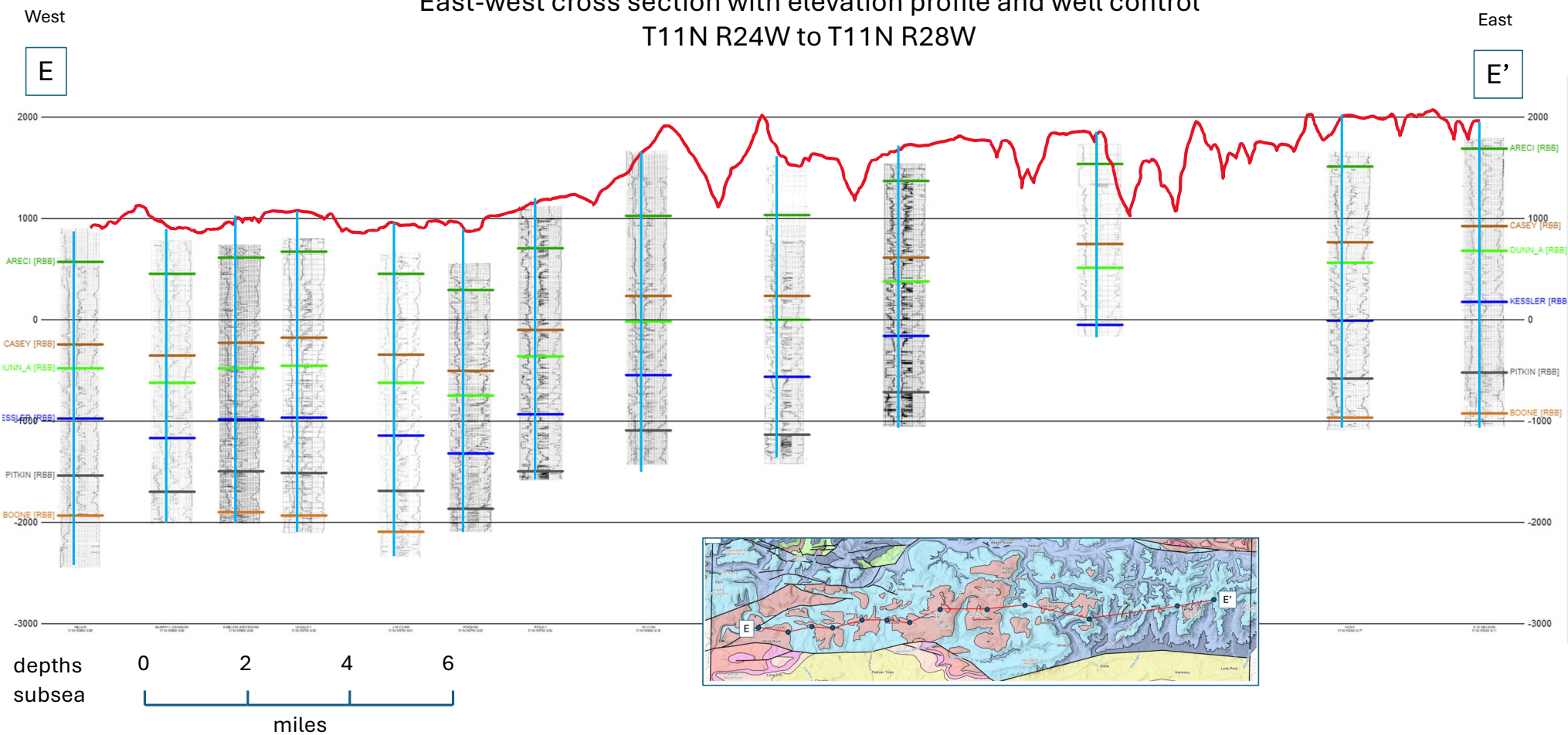
depths
subsea

East-west cross section with elevation profile and well control T13N R26W to T12N R28W

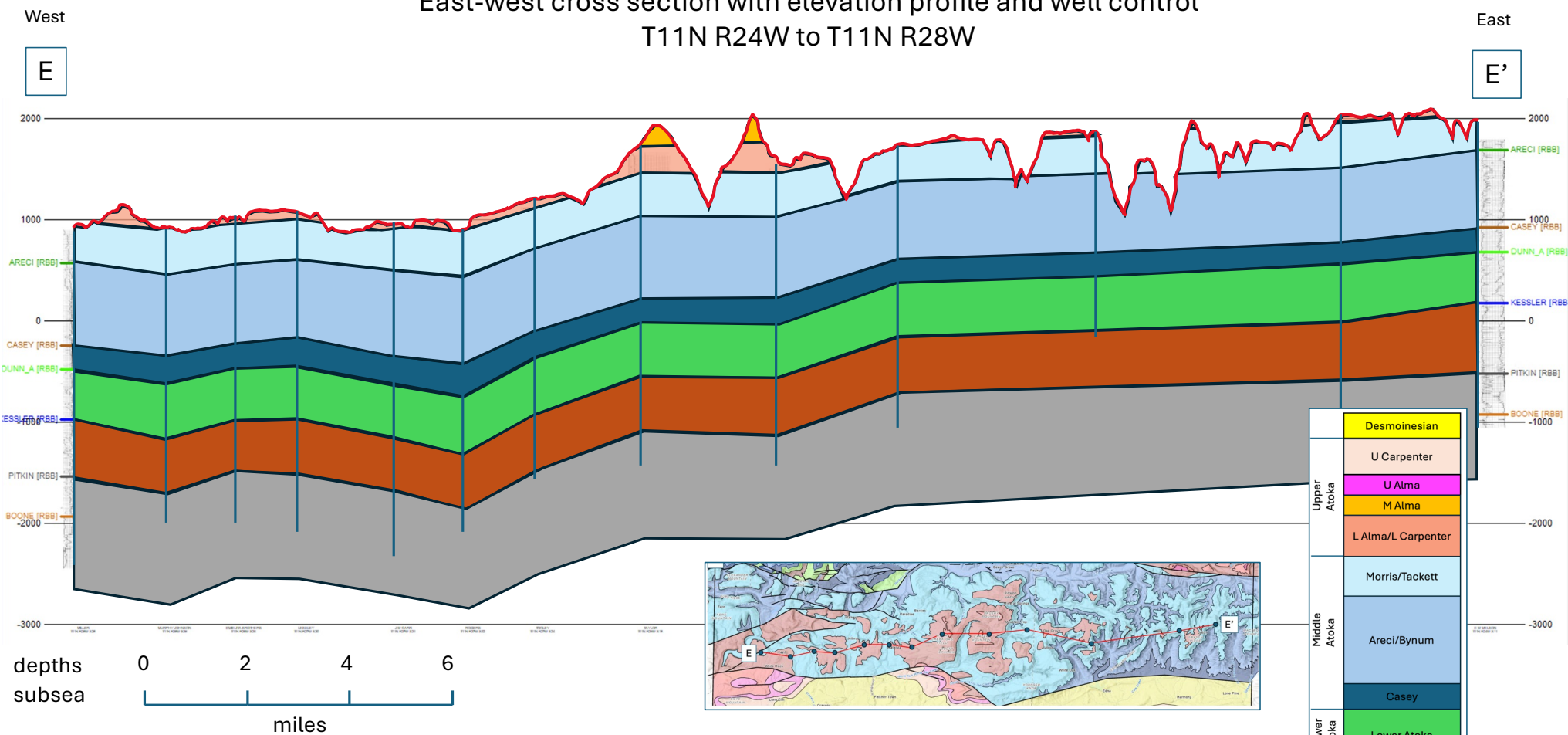


East-west cross section with elevation profile and well control

T11N R24W to T11N R28W



East-west cross section with elevation profile and well control T11N R24W to T11N R28W



	Desmoinesian
Upper Atoka	U Carpenter
	U Alma
	M Alma
	L Alma/L Carpenter
Middle Atoka	Morris/Tackett
	Areci/Bynum
	Casey
Lower Atoka	Lower Atoka
	Morrowan
	Mississippian



Answer:

The cliffs surrounding White Rock Mountain are the Atoka
Areci Formation on the upthrown side of the Cass Fault



White Rock Mountain © 2025



Acknowledgments



Dr. T. A. “Mac” McGilvery

Olivia Smith

Jamie Woolsey

Christopher Moyer

Amy and Shiner

White Rock Mountain © 2025

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