

Seismic Interpretation of the Arikaree Creek Field, Denver Basin, Lincoln County, Colorado, Potential New Play Type in the Denver Basin*

Steven Tedesco¹

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Abstract

A fifteen square 3D seismic survey at the Arikaree Creek Field in Townships 5 and 6 South, Range 54 West, Colorado, Denver Basin was evaluated for fault movement direction and displacement within the Paleozoic strata. The field was discovered in 2012, produces primarily from the Mississippian Spergen dolomites formed by secondary low temperature hydrothermal fluids. The survey, done prior to discovery, indicates structural displacement up to 30 millisecond, a high angle reverse fault in a compressional setting, strikes to the north-northeast. Time slices suggest faulting is of Atokan-Morrowan in age, deep seated into the Precambrian, near vertical to high angle, both reverse and normal faulting. Along the main fault, three Riedel shears are propagating near 15 degrees from the fault causing scissor faulting resulting in alternating horst and grabens against the margin. The eastern margin of the fault is a high angle normal fault, up to 20 milliseconds of displacement from the main fault. The overall style of faulting is compressional, right stepping, sinistrial fault with an en echelon forming at the margin. The low temperature hydrothermal secondary dolomitization of the reservoir related to a wrench system indicates a similar trap type to the highly productive brecciated dolomite reservoirs in the Devonian and Ordovician rocks found in the Michigan Basin and Ordovician rocks in the Cincinnati Arch area, Kentucky and Tennessee.

SEISMIC INTERPRETATION OF THE ARIKAREE CREEK FIELD, DENVER BASIN, LINCOLN COUNTY, COLORADO, POTENTIAL NEW PLAY TYPE IN THE DENVER BASIN

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Tulsa, Oklahoma

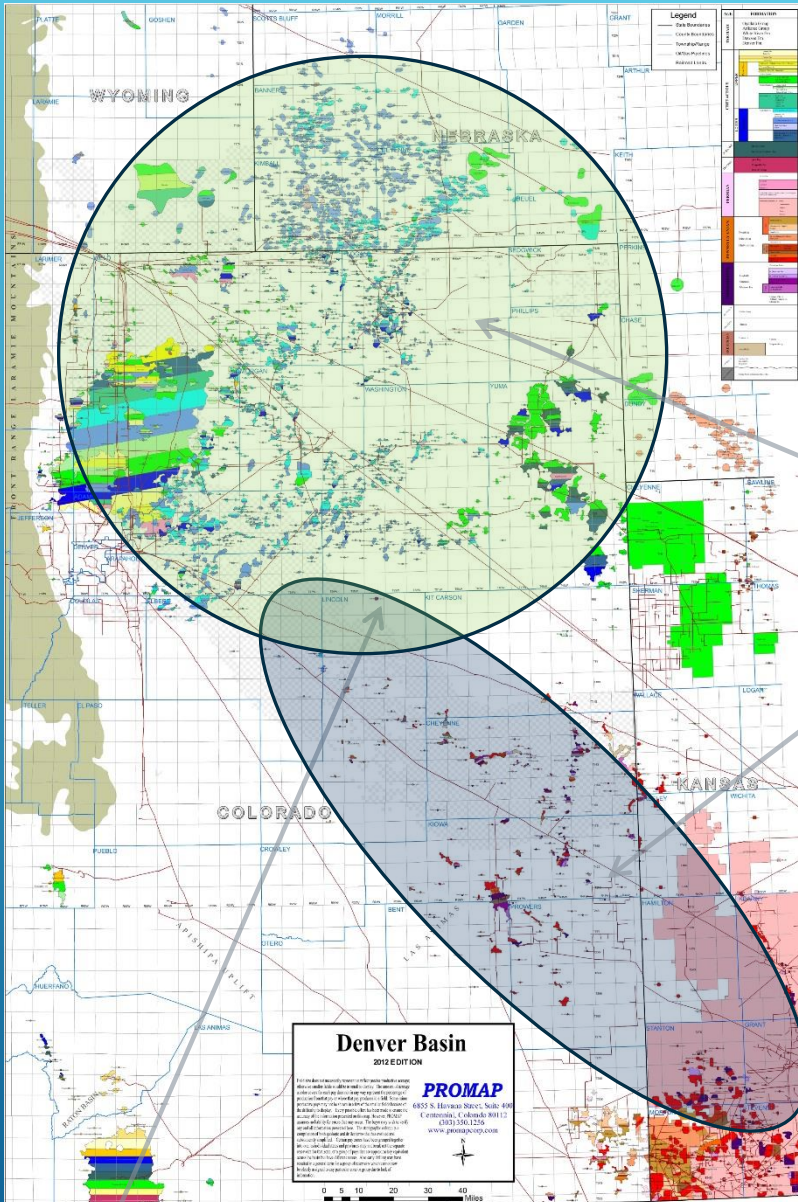


A fifteen square 3D seismic survey at the Arikaree Creek Field in Townships 5 and 6 South, Range 54 West, Colorado, Denver Basin was evaluated for fault movement direction and displacement within the Paleozoic strata. The field was discovered in 2012, produces primarily from the Mississippian Spergen dolomites formed by secondary low temperature hydrothermal fluids. The survey, done prior to discovery, indicates structural displacement up to 30 millisecond, a high angle reverse fault in a compressional setting, strikes to the north-northeast. Time slices suggest faulting is of Atokan-Morrowan in age, deep seated into the Precambrian, near vertical to high angle, both reverse and normal faulting. Along the main fault, three Riedel shears are propagating near 15 degrees from the fault causing scissor faulting resulting in alternating horst and grabens against the margin. The eastern margin of the fault is a high angle normal fault, up to 20 milliseconds of displacement from the main fault. The overall style of faulting is compressional, right stepping, sinistrial fault with an en echelon forming at the margin. The low temperature hydrothermal secondary dolomitization of the reservoir related to a wrench system indicates a similar trap type to the highly productive brecciated dolomite reservoirs in the Devonian and Ordovician rocks found in the Michigan Basin and Ordovician rocks in the Cincinnati Arch area, Kentucky and Tennessee.

ABSTRACT



THE ART OF DISCOVERY



Denver Basin – Colorado, Mid-Continent USA Foreland Basin

Reservoir Types:

Cretaceous: D and J channel sandstones
Niobrara, Codell, Greenhorn and Carlisle chinks
Permian: Lyons sandstones

Paleozoic:

Depths - 1,606 – 3,500 meters;
Mississippian carbonates – 3 to 20 meters thick;
Morrow sandstone channels – 2 to 20 meters thick;
Cherokee A and C shoals or secondary dolomite features
- 0.5 to 3 meters thick;
Marmaton B carbonate shoal – 1 to 3 meters thick.

Arikaree Creek Field (Discovered by Running Foxes Petroleum)

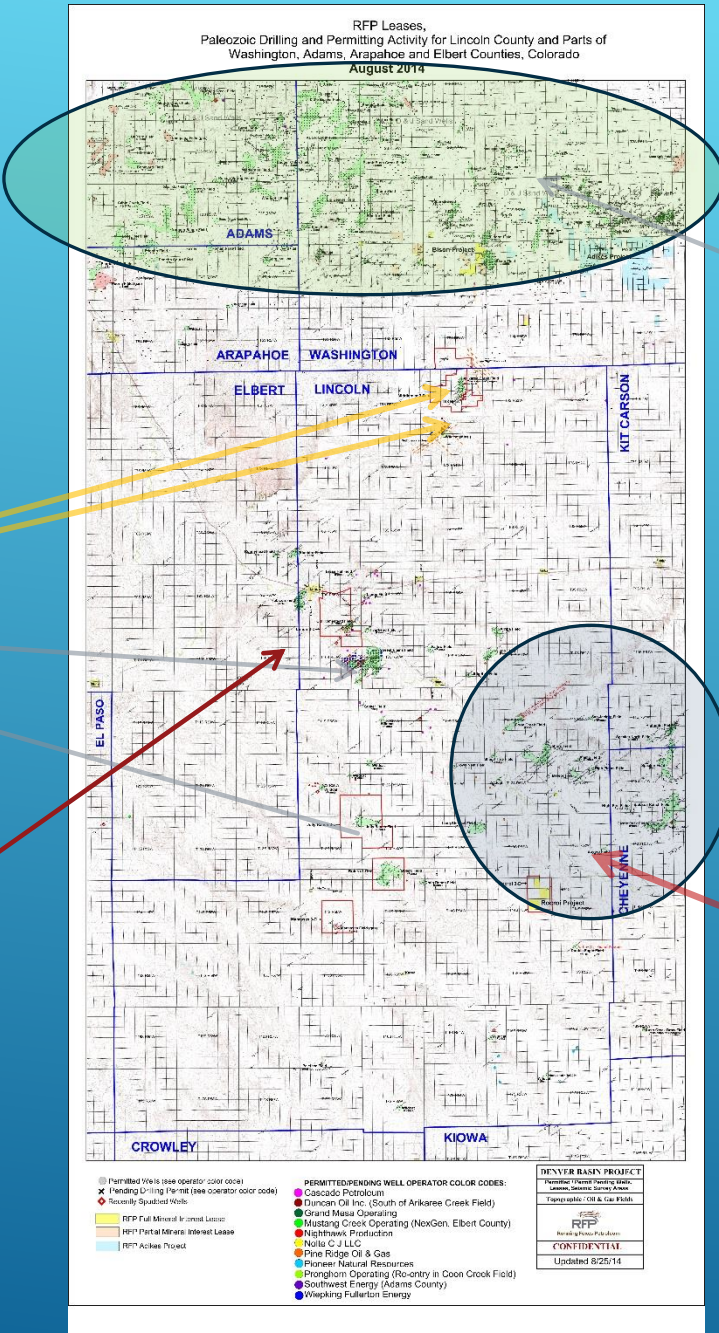


THE ART OF DISCOVERY

SOUTHEAST DENVER BASIN – Lincoln and Washington Counties

Cretaceous Fields – pre-1980

- ▶ Generally unexplored prior to 2009 for over 20 years;
- ▶ No productive Cretaceous sands present;
- ▶ Paleozoic reservoirs are discrete;
- ▶ Low oil prices



New Paleozoic Fields Post 2010

Large area significantly under explored

Limited Seismic Data

Paleozoic Fields – pre-1985



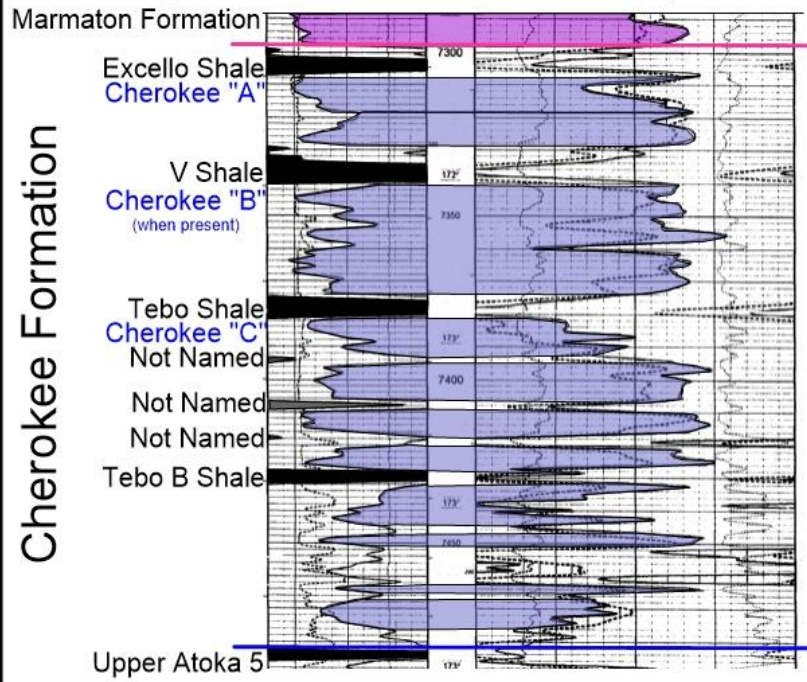
THE ART OF DISCOVERY

- ▶ Defined by Running Foxes Petroleum Inc. with seismic and surface geochemistry;
- ▶ Drilled in 2012 by Running Foxes Petroleum Inc. former partner;
- ▶ Field:
 - ▶ Complex Wrench Fault System trending northeast-southwest;
 - ▶ Spergen (Mississippian) reservoir low temperature hydrothermal dolomites
 - ▶ Three main horst blocks

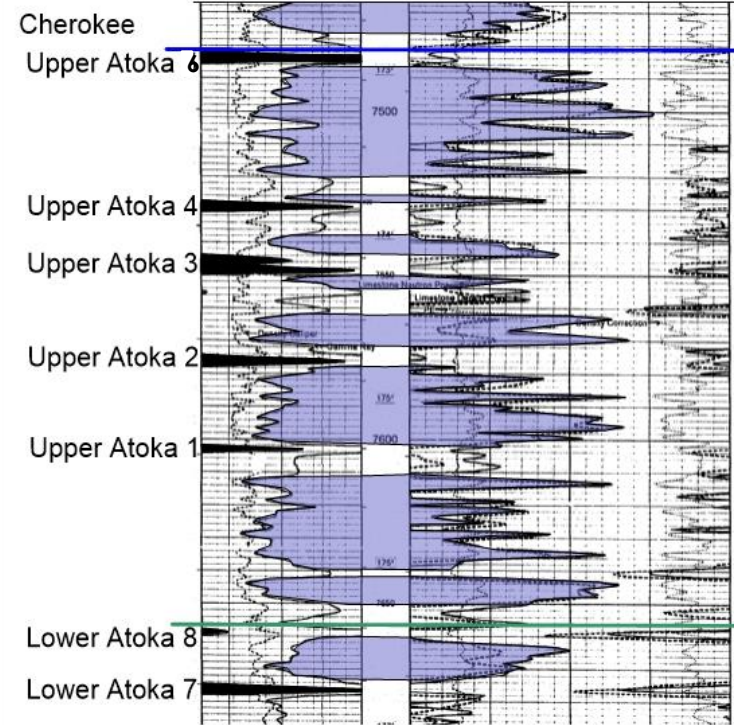
ARIKAREE CREEK OIL FIELD



Craig 7-2 Section 2 T10S R56W Lincoln Co., Colorado

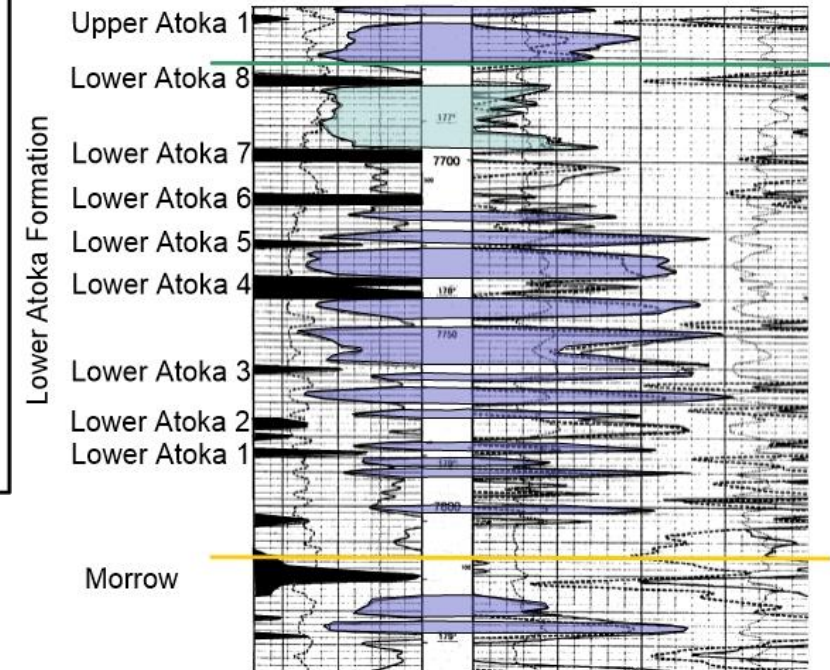


Craig 7-2 Section 2 T10S R56W Lincoln Co., Colorado



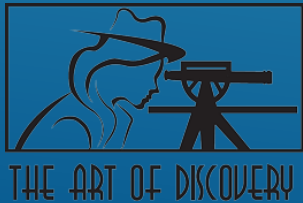
The Cherokee and Atoka Formations can be subdivided in intervals or cyclothems. The missing component is coal so the boundaries are the tops and bottoms of carbonaceous mudstones

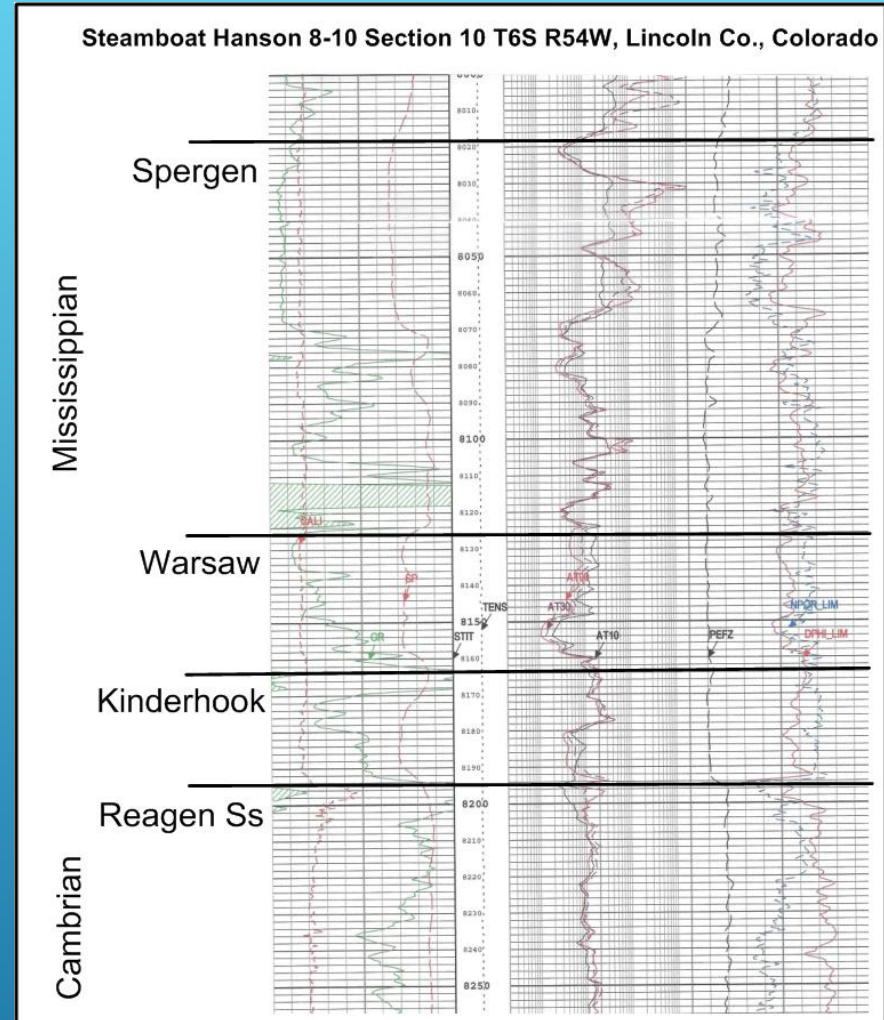
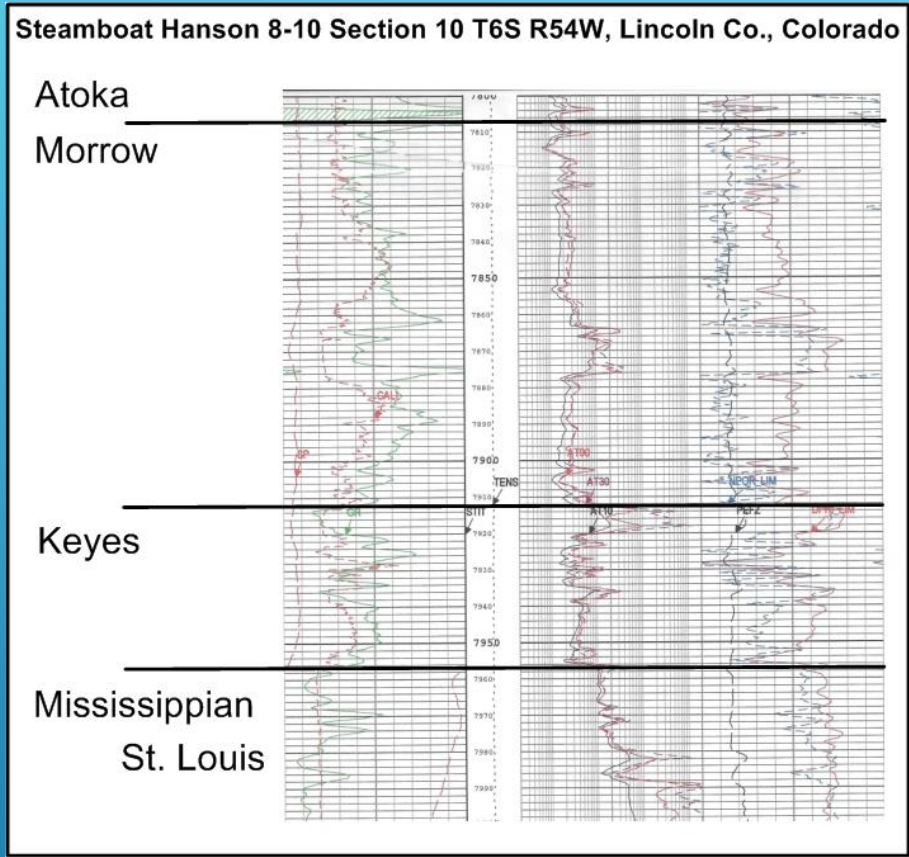
Craig 7-2 Section 2 T10S R56W Lincoln Co., Colorado



STRATIGRAPHIC COLUMN (DESMOINESIAN AND

ATOKAN)





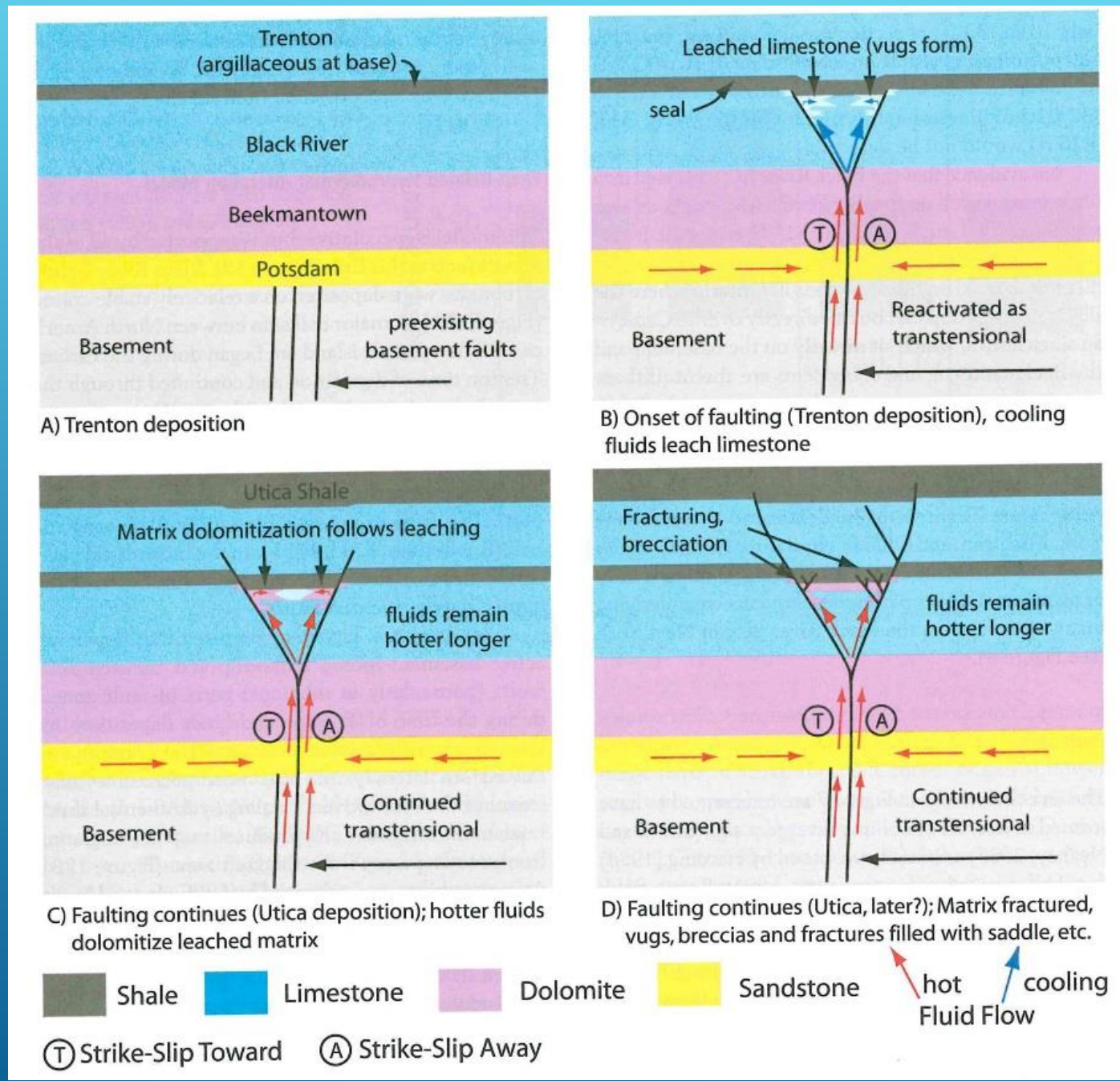
STRATIGRAPHIC COLUMN (MORROWAN AND MISSISSIPPIAN)



Development of a wrench fault system in the Ordovician rocks in the Michigan and Appalachian basins;

During formation and into post deformation low temperature hydrothermal fluids migrate up along faults and fractures until stopped by a dense caprock that has not been faulted or fractured (brecciated)

Usually the limestone is replaced by dolomite increasing porosity, permeability and reducing rock volume

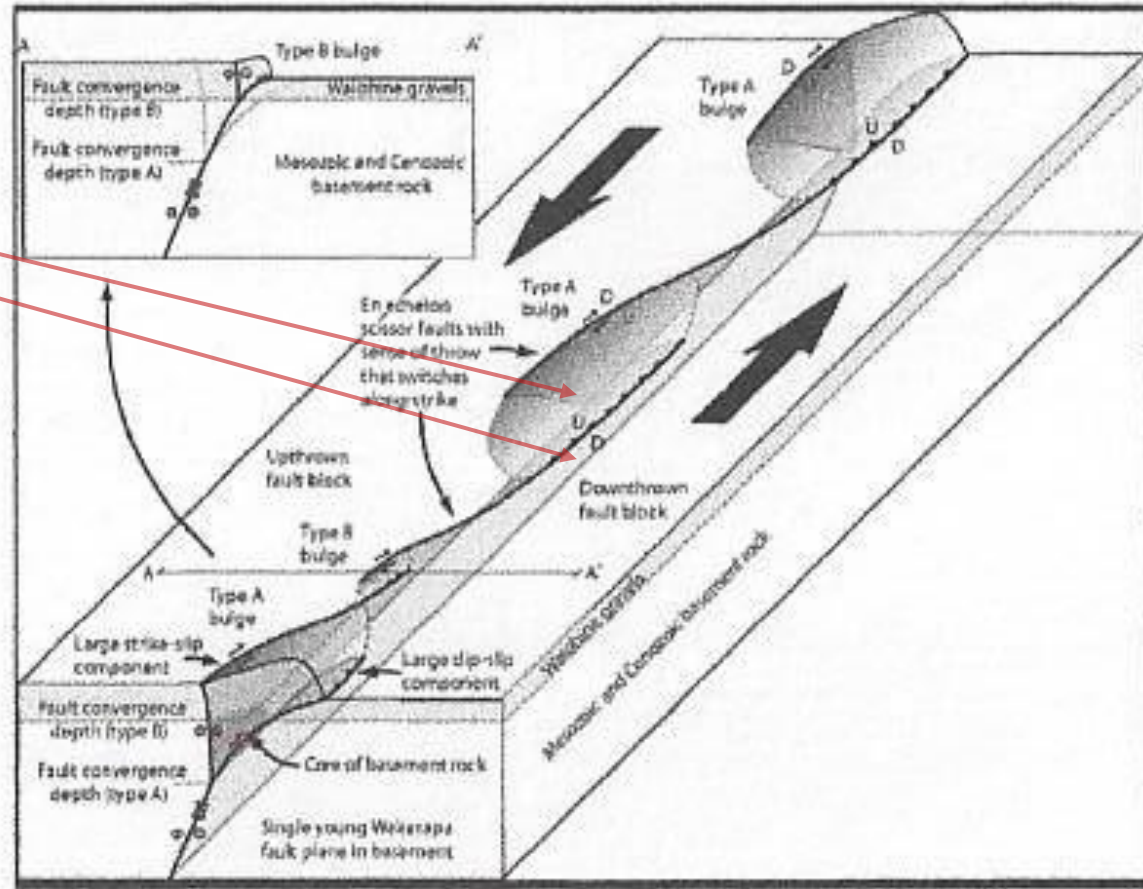


THE ART OF DISCOVERY



RFP

Areas where traps can form both in the up and down block position.



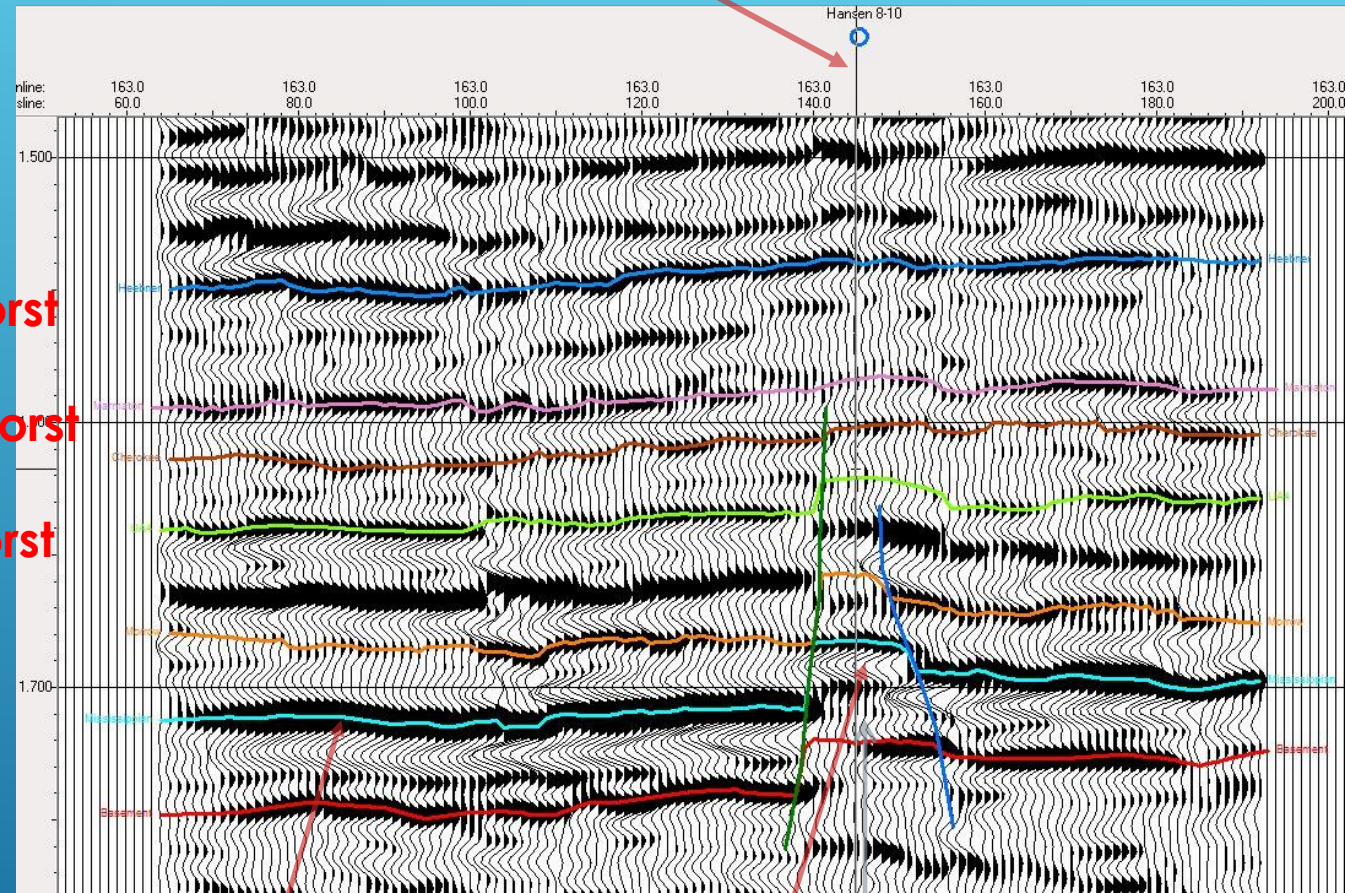
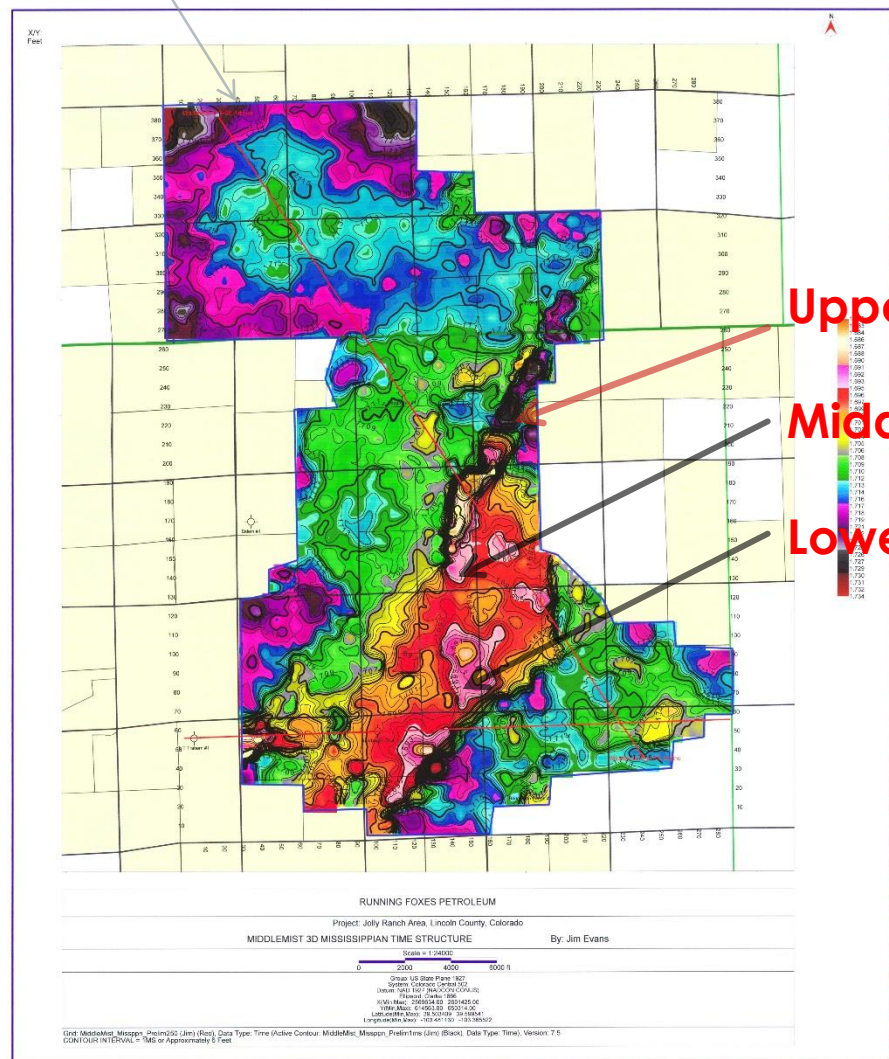
STRIKE SLIP MODEL

PRE-DRILLING 3D MISSISSIPPIAN TIME STRUCTURE



3D Outline

Discovery Well

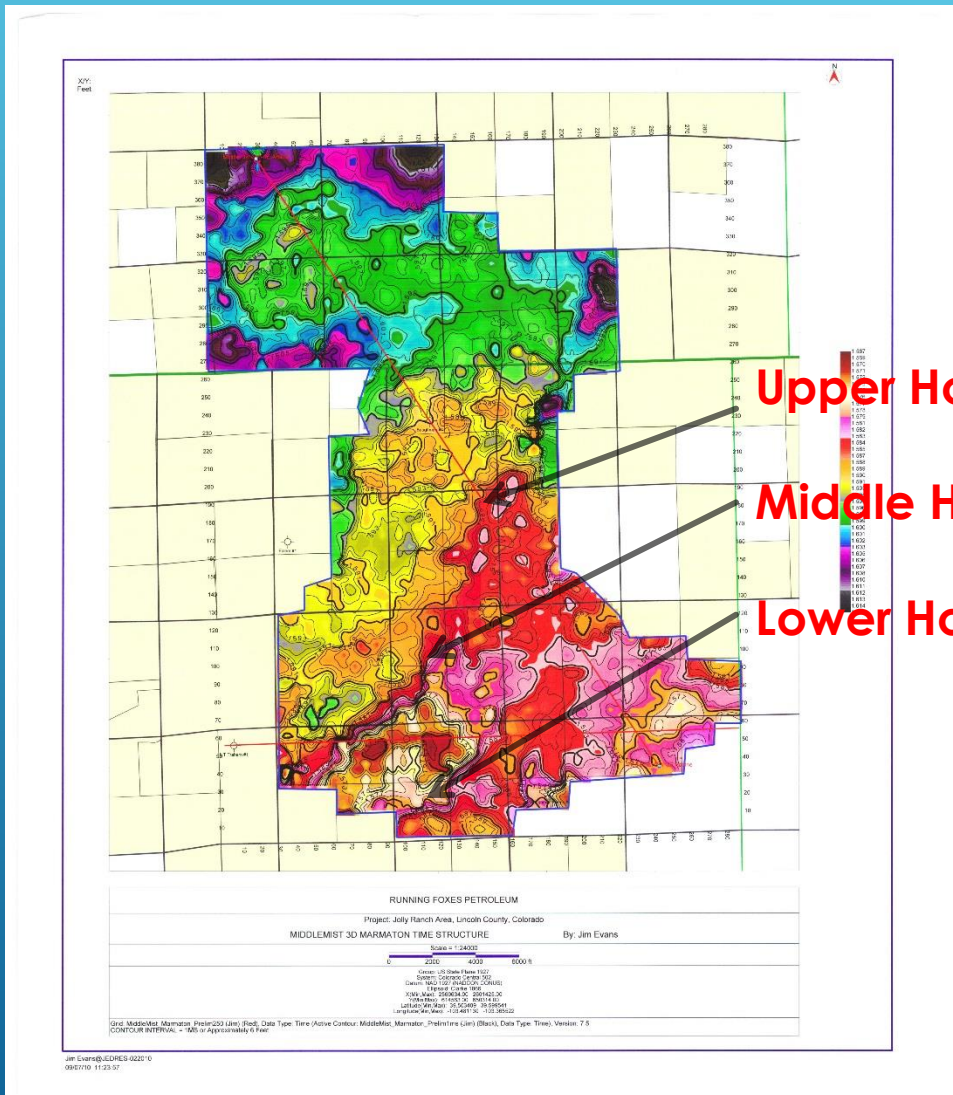


Mississippian

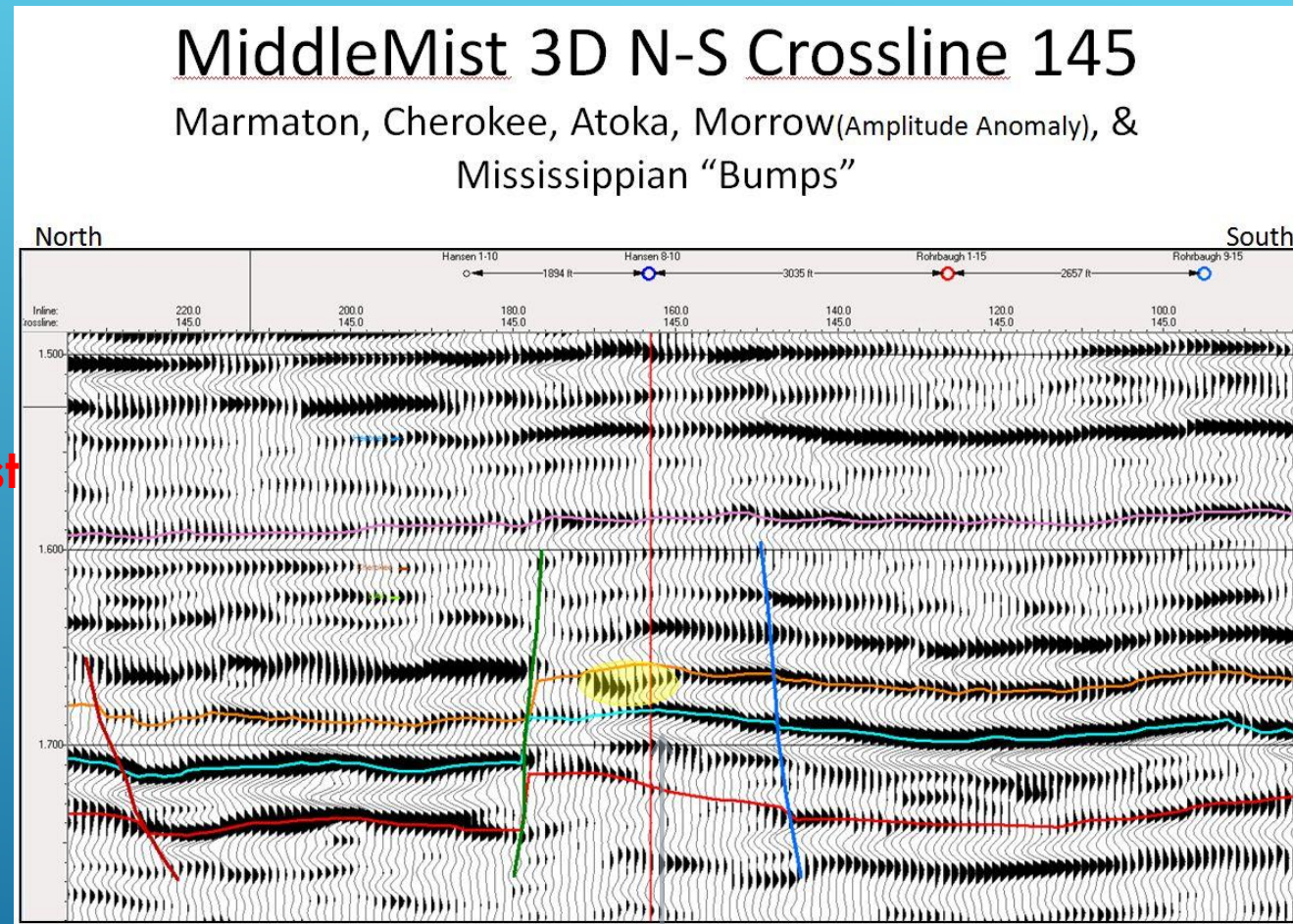
Pop up structure



PRE-DRILLING 3D SEISMIC SURVEY



Note the diminishing relief



Top of the Marmaton

Pop up structure – different view from previous slide

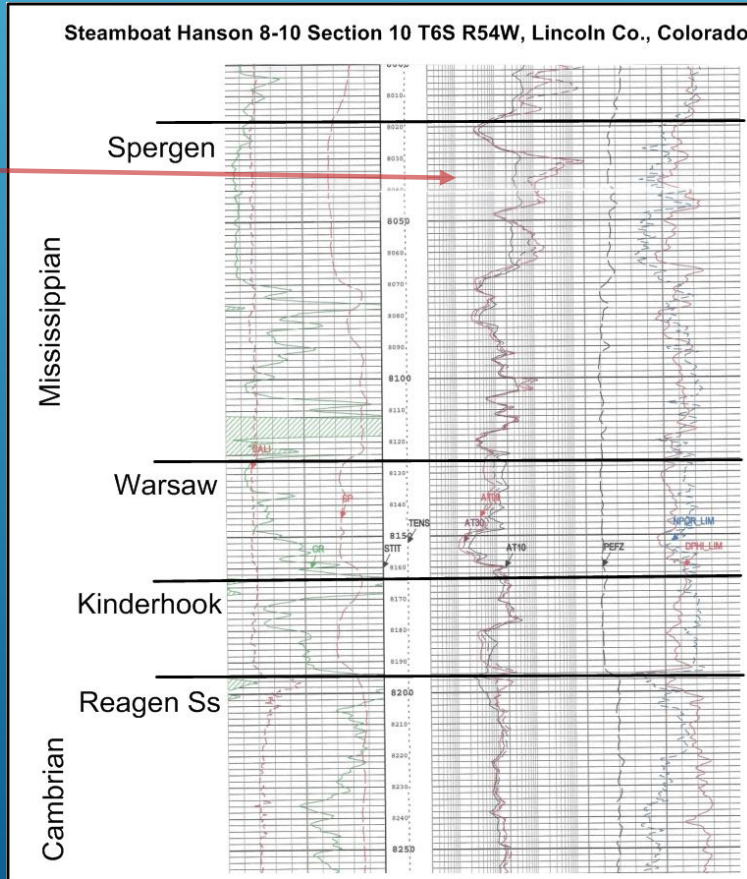




Completed in the Mississippian Spergen;
 Upper Horst;
 400+ BOPD;
 Reservoir is low temperature hydrothermal dolomites;
 High pour point oil;
 Atokan oil;
 No water.

Upper Horst Well

Pay

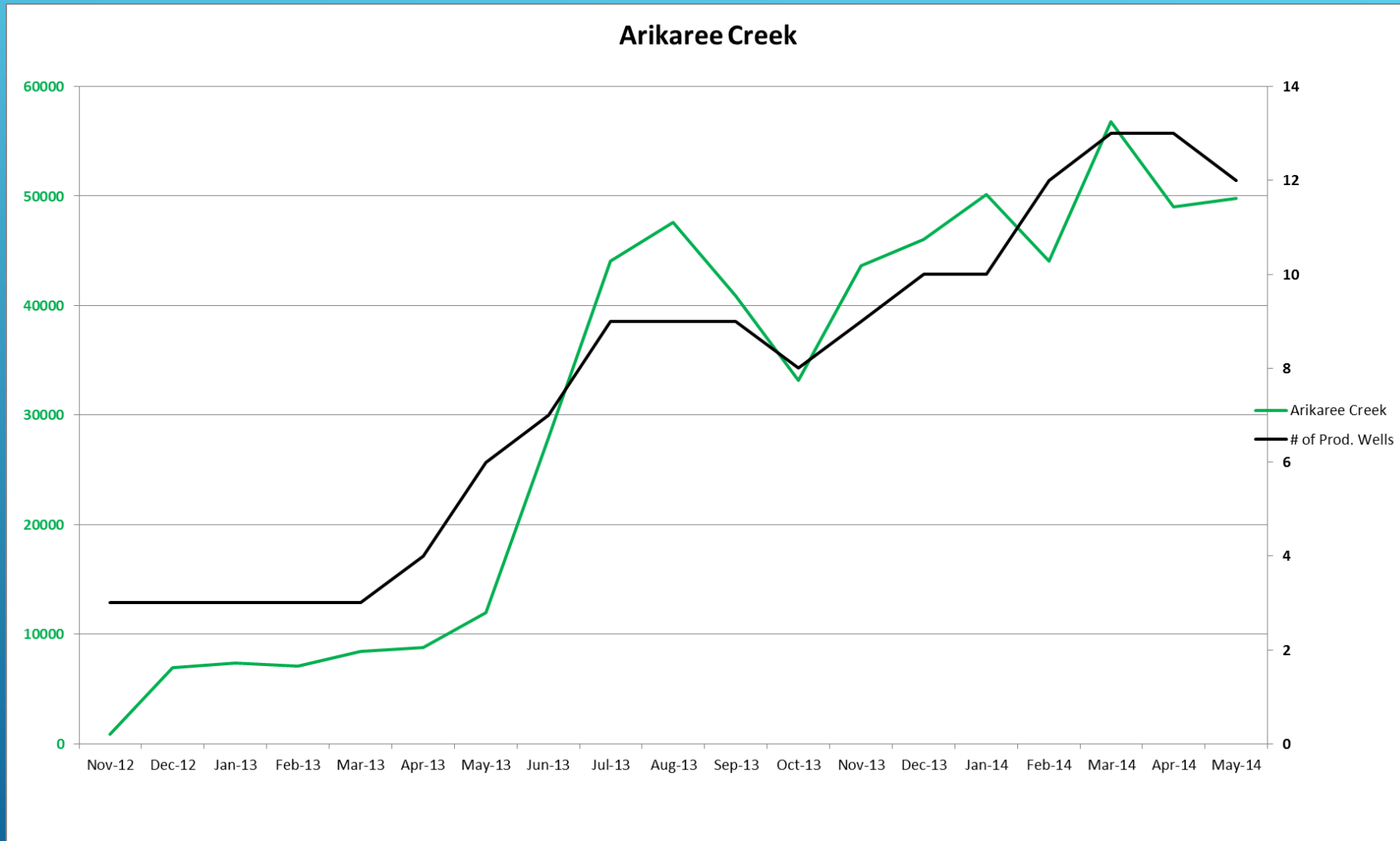


Middle Horst
 oil and water zone
 Erratic pay;
 No predictability.

Lower Horst
 Well: Whistler 16-21

33 meters
 lower then
 upper block

PRODUCTION



Field has made over 1.1 MMBO

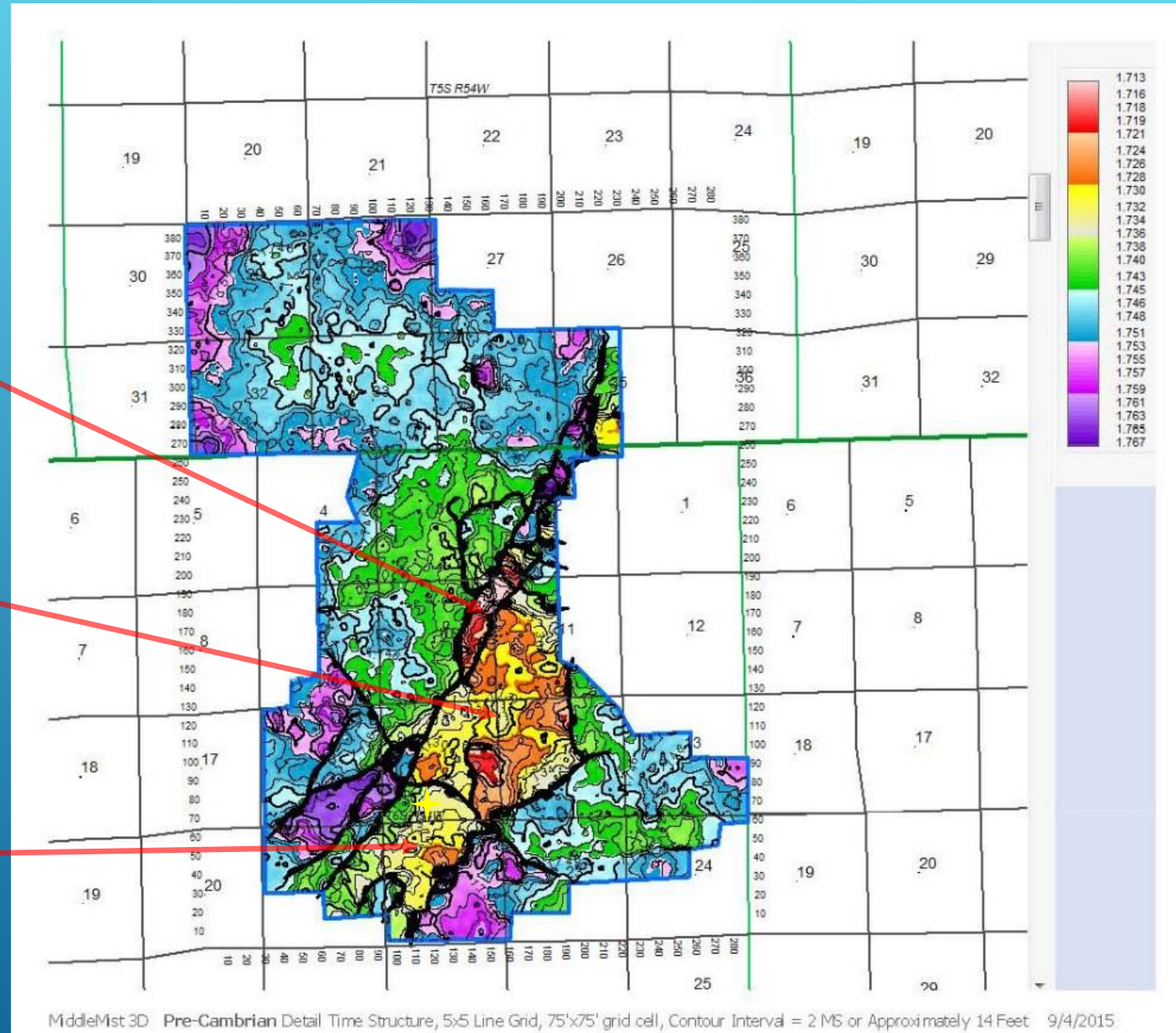


PRECAMBRIAN TIME STRUCTURE

Upper Block

Middle Block

Lower Block

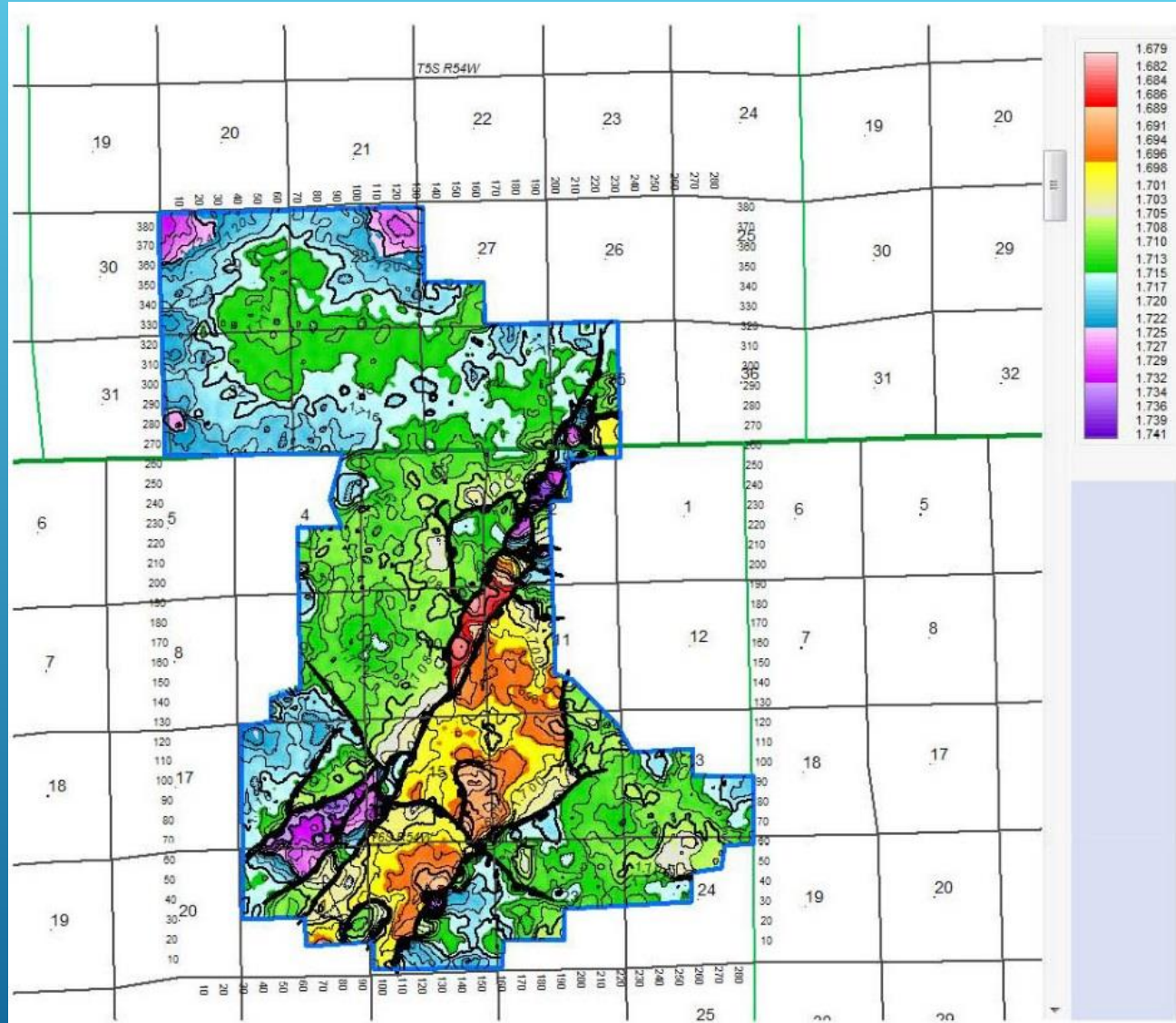
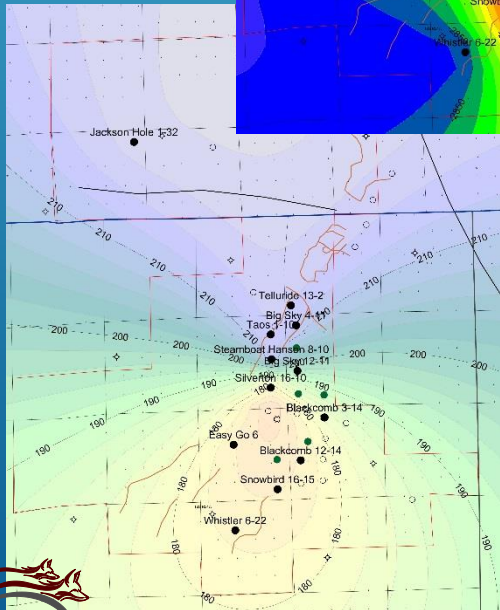
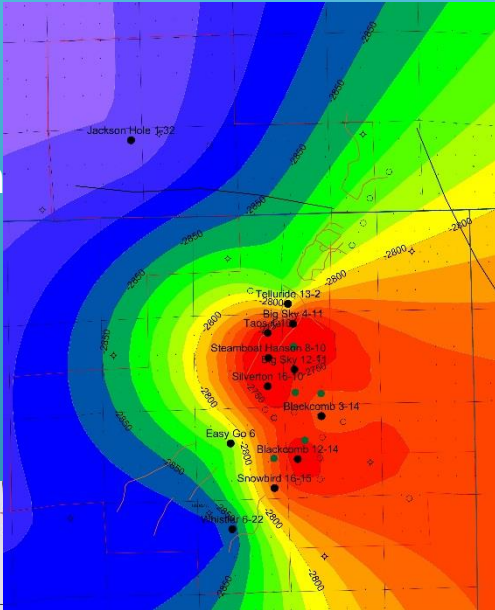


MISSISSIPPIAN TIME STRUCTURE



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Mississippian
Structure



MiddleMist3D Mississippian Detail Time Structure, 5x5 Line Grid, 75x75' grid cell, Contour Interval = 2 MS or Approximately 14 Feet 9/3/2015

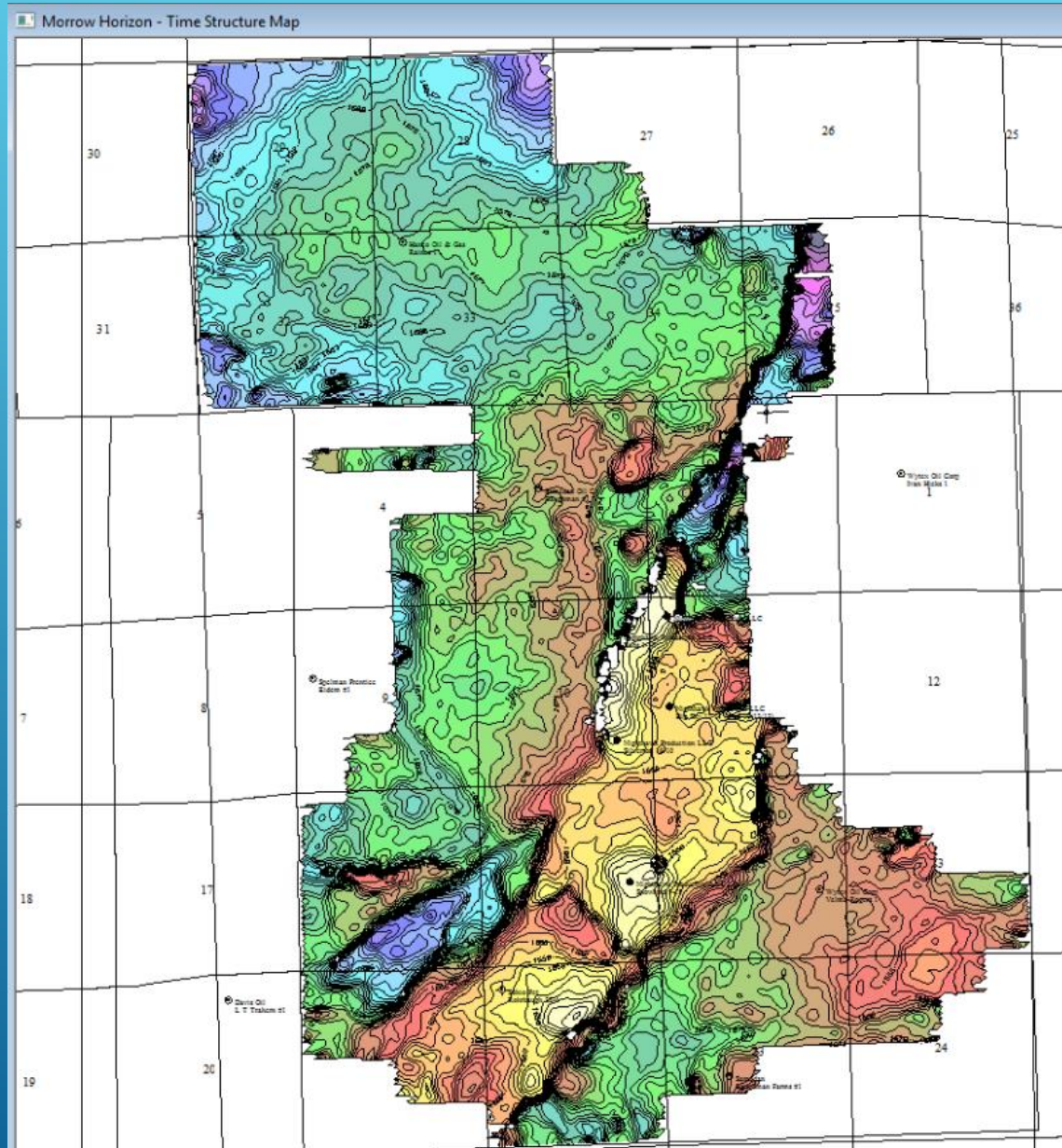
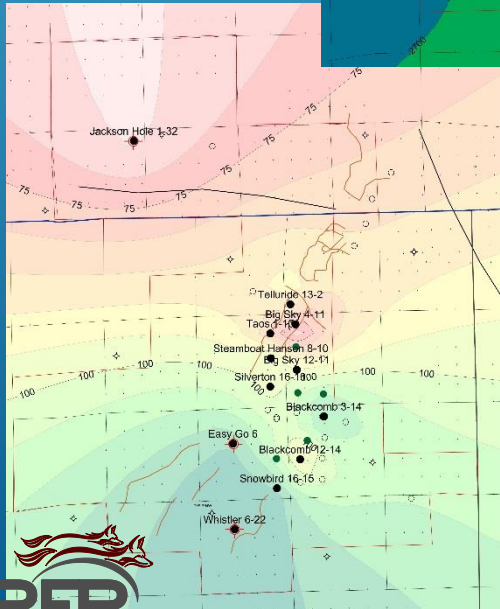
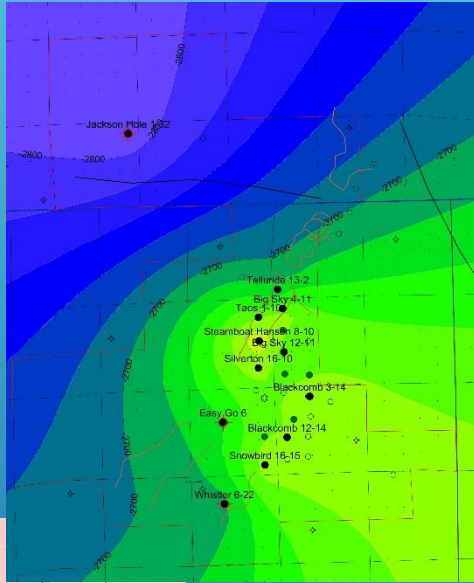


MORROW TIME STRUCTURE



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Morrow
Structure

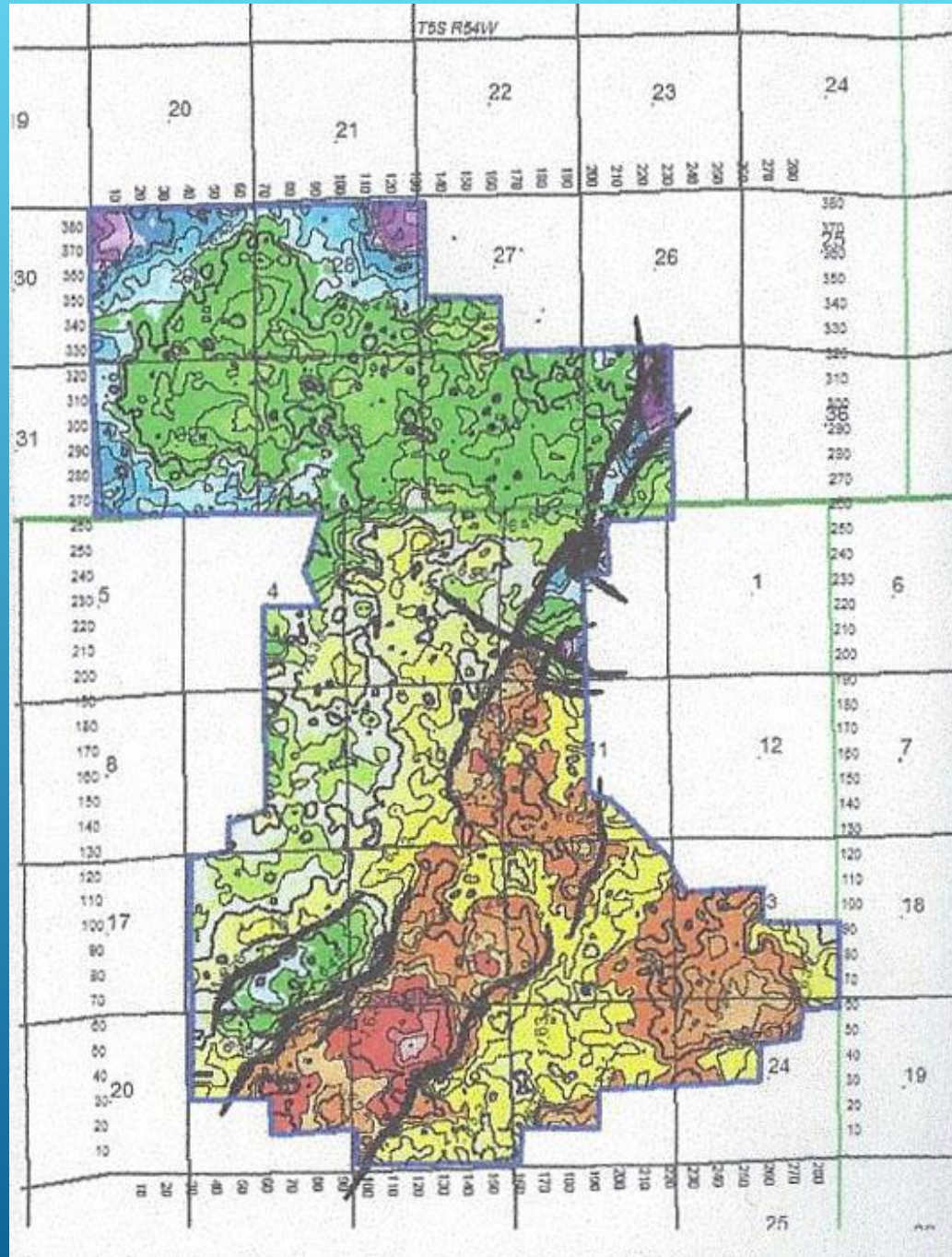
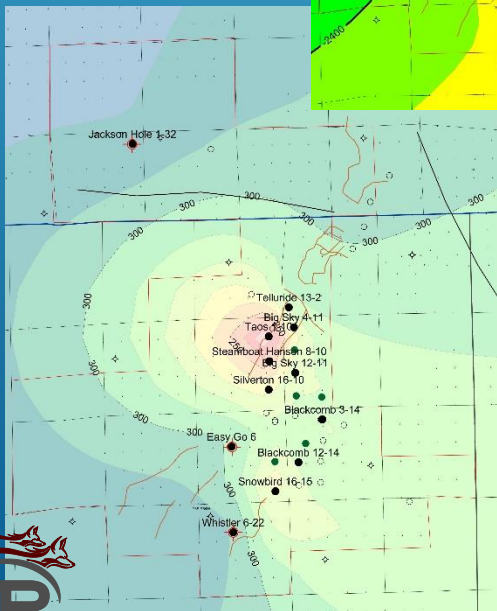
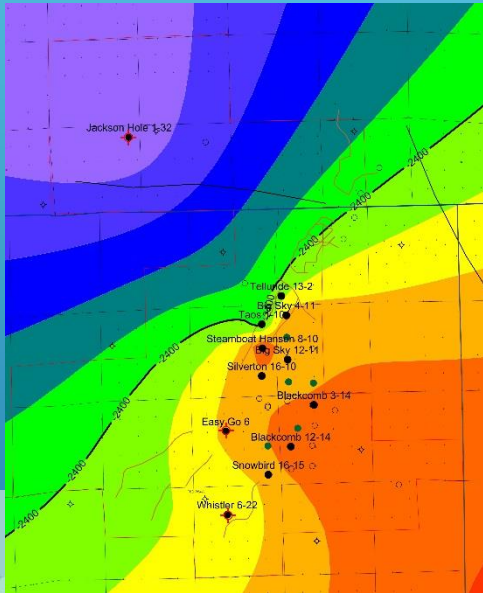




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ATOKA TIME STRUCTURE

Atoka
Structure

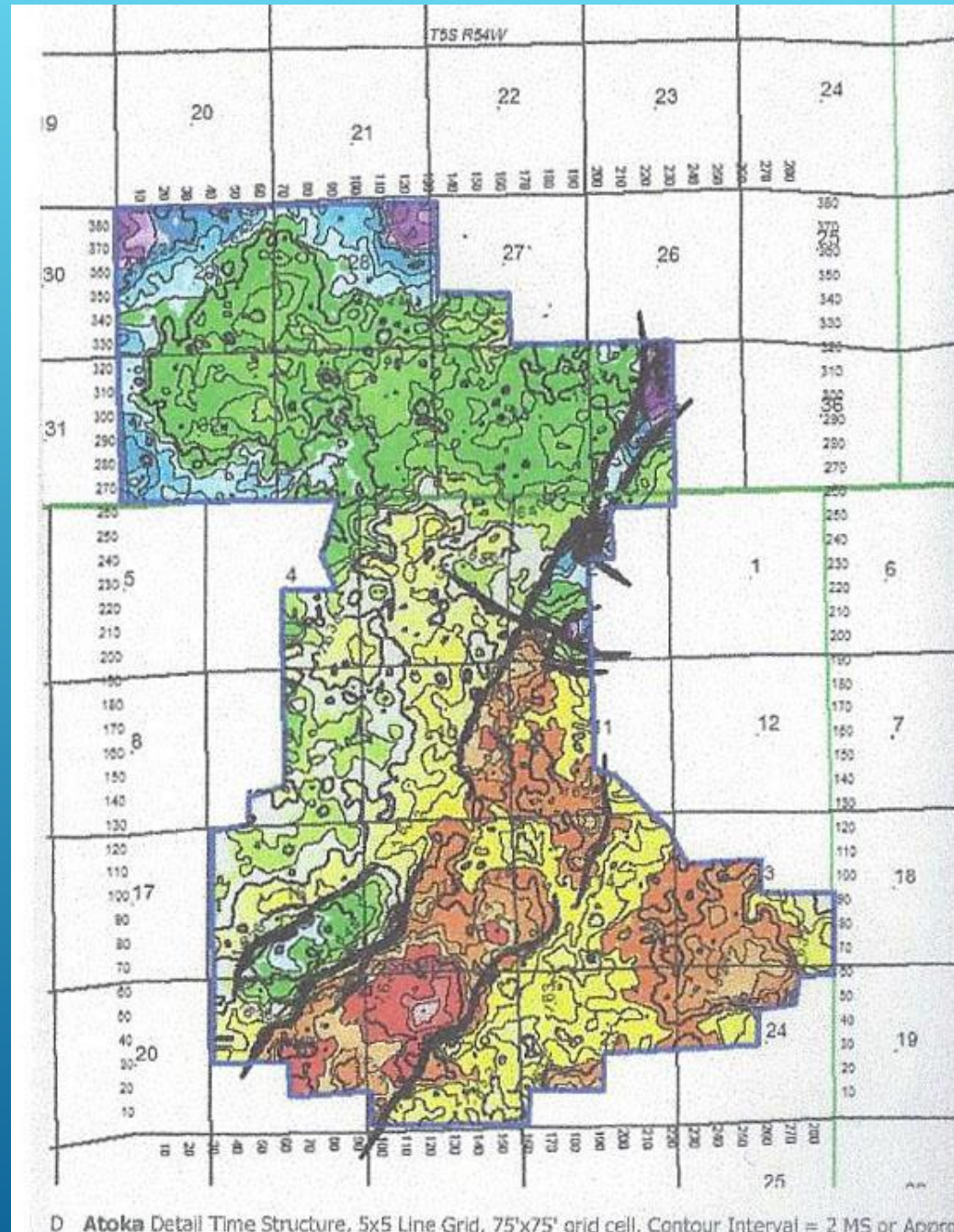
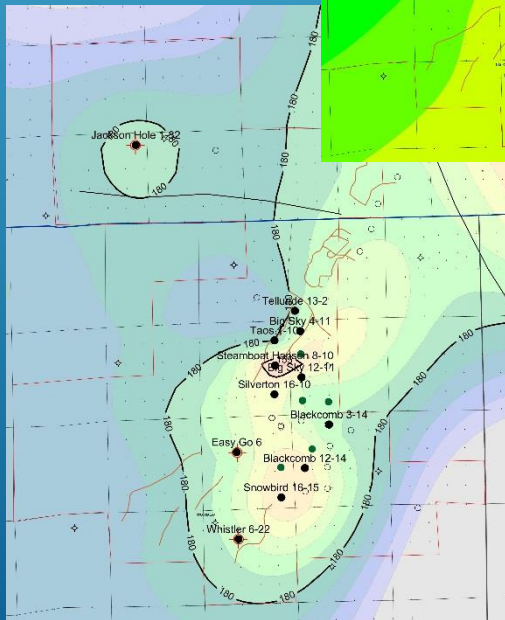
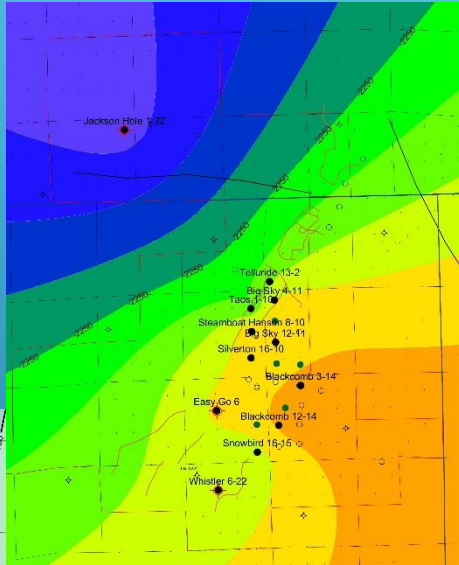




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CHEROKEE TIME STRUCTURE

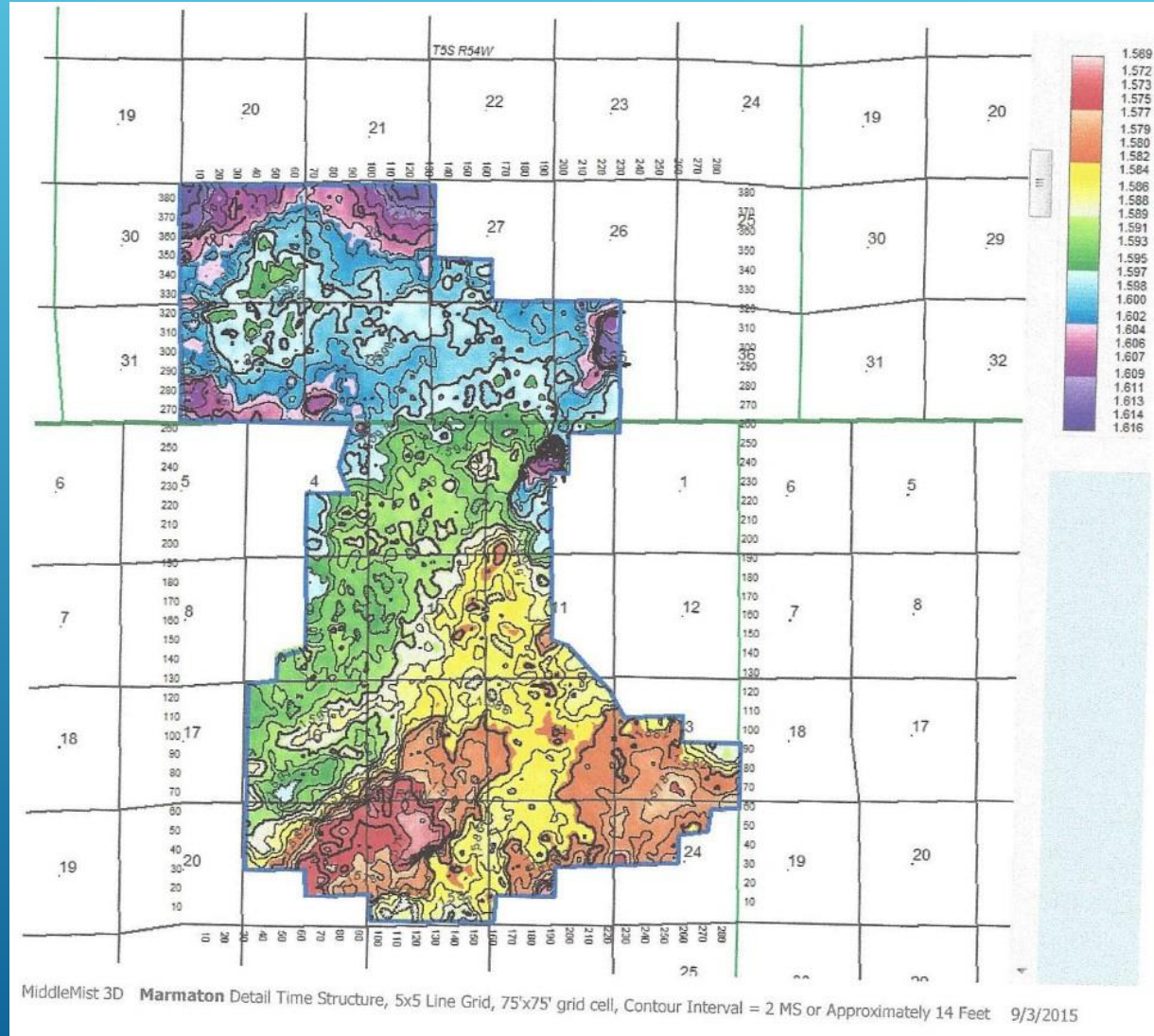
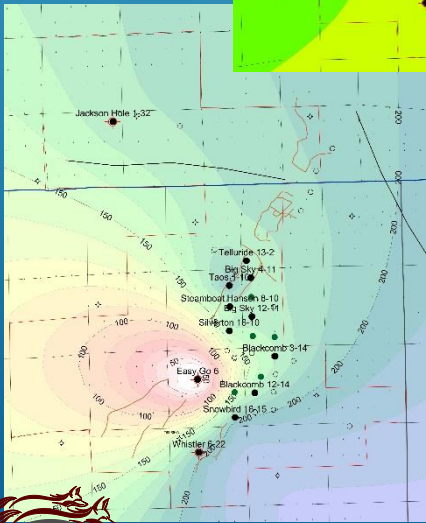
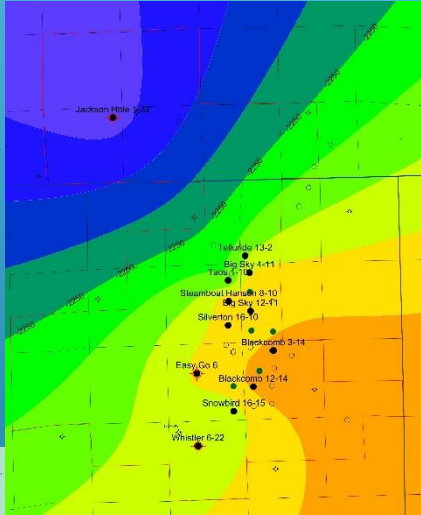
Cherokee
Structure



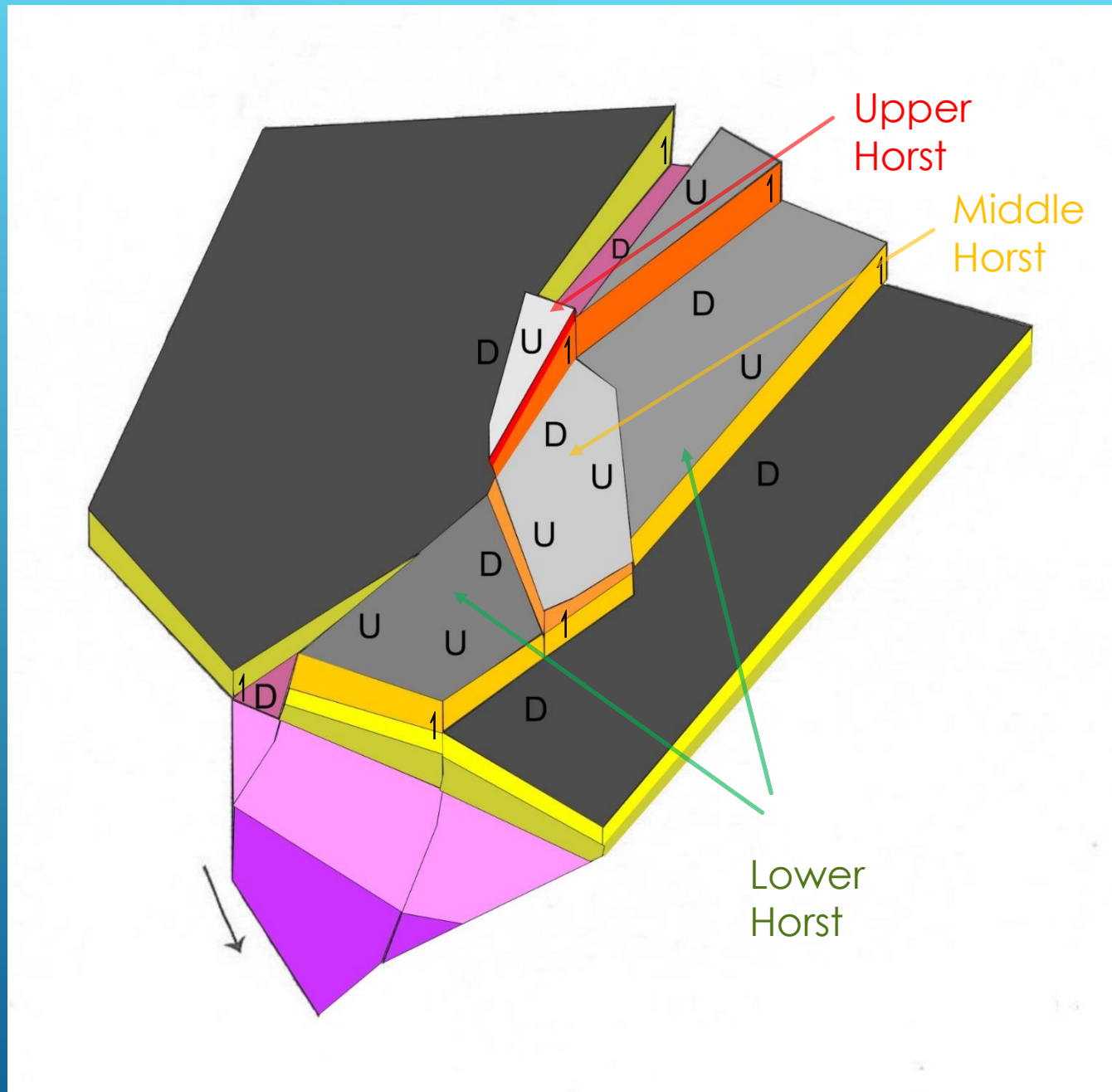
D. Atoka Detail Time Structure, 5x5 Line Grid, 75'x75' grid cell, Contour Interval = 2 MS or Approx

MARMATON TIME STRUCTURE

Marmaton Structure



GENERAL FAULT BLOCK MODEL



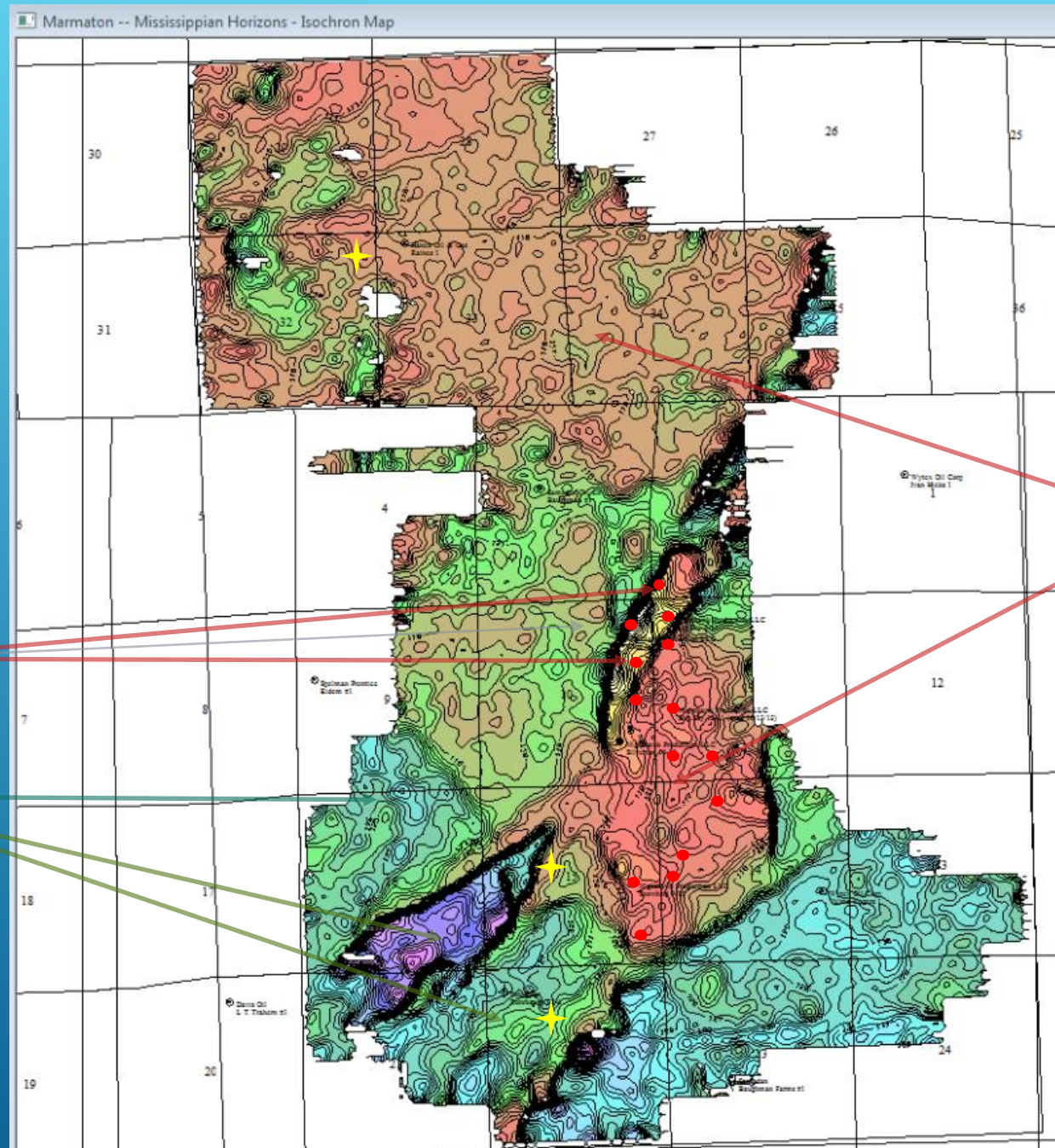
MISSISSIPPIAN – MARMATON ISOCHRON

Areas of thinning are associated with the Arikaree Creek structure but other areas to the north as well.

Wells

Thick

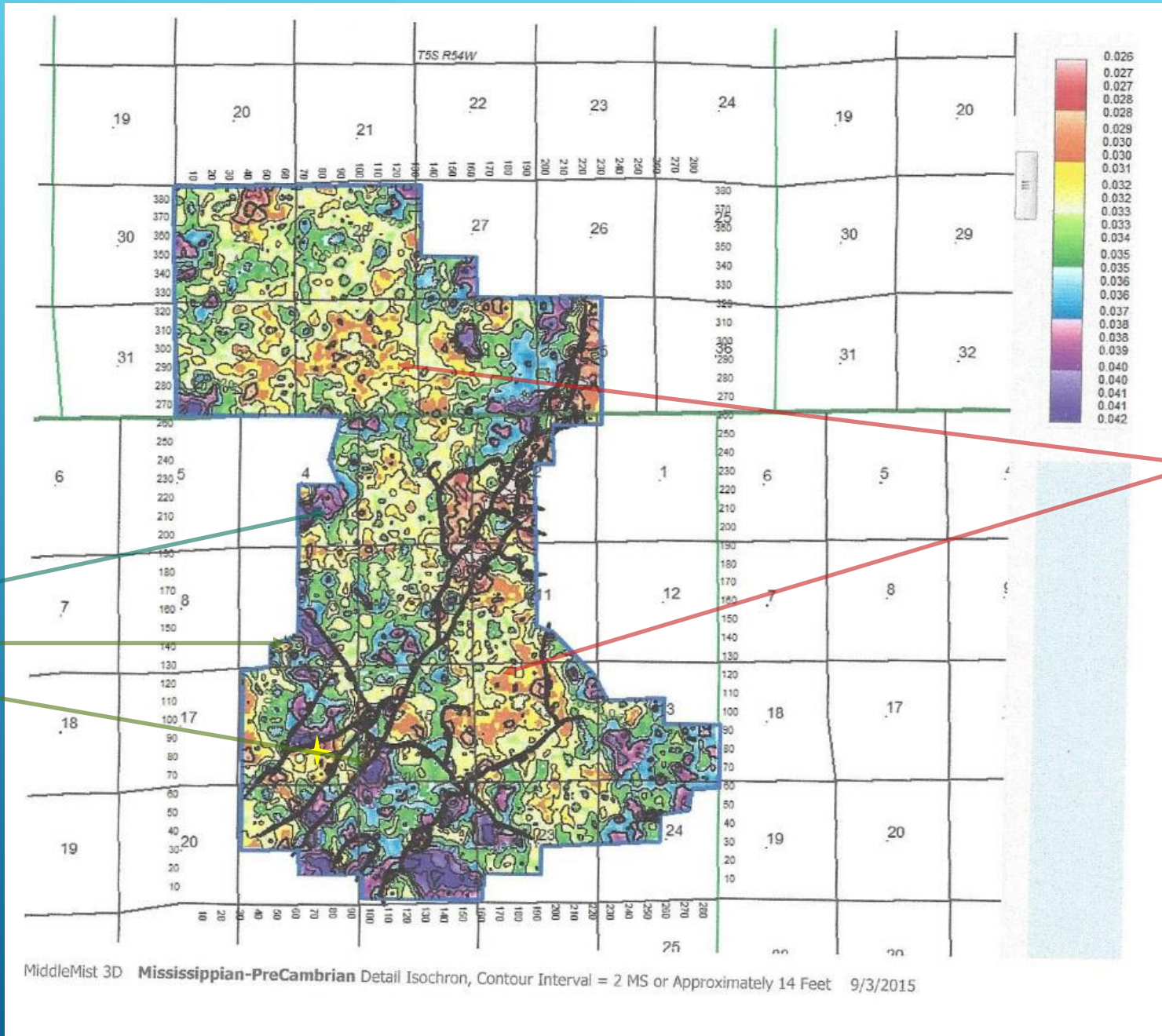
Thin



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Areas of thick are localized and the area is relative uniform thickness across the survey. The localized areas of thicks may indicate the presence of preserved Ordovician rocks. This is supported by some of the drilling. Structural activity was not present at this time.

Thick MISSISSIPPIAN- PRECAMBRIAN ISOCHRON



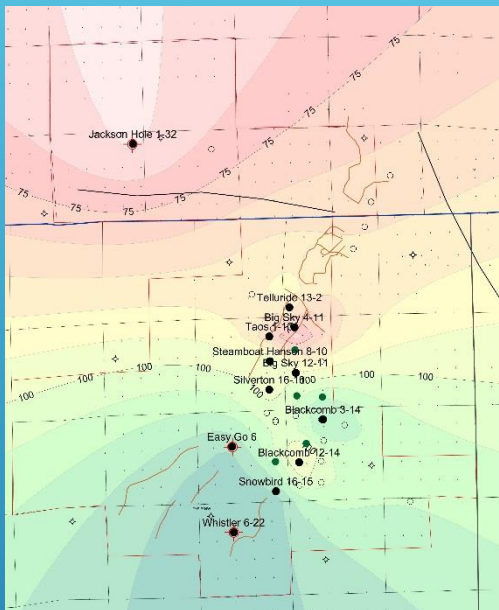
THE ART OF DISCOVERY

Thin

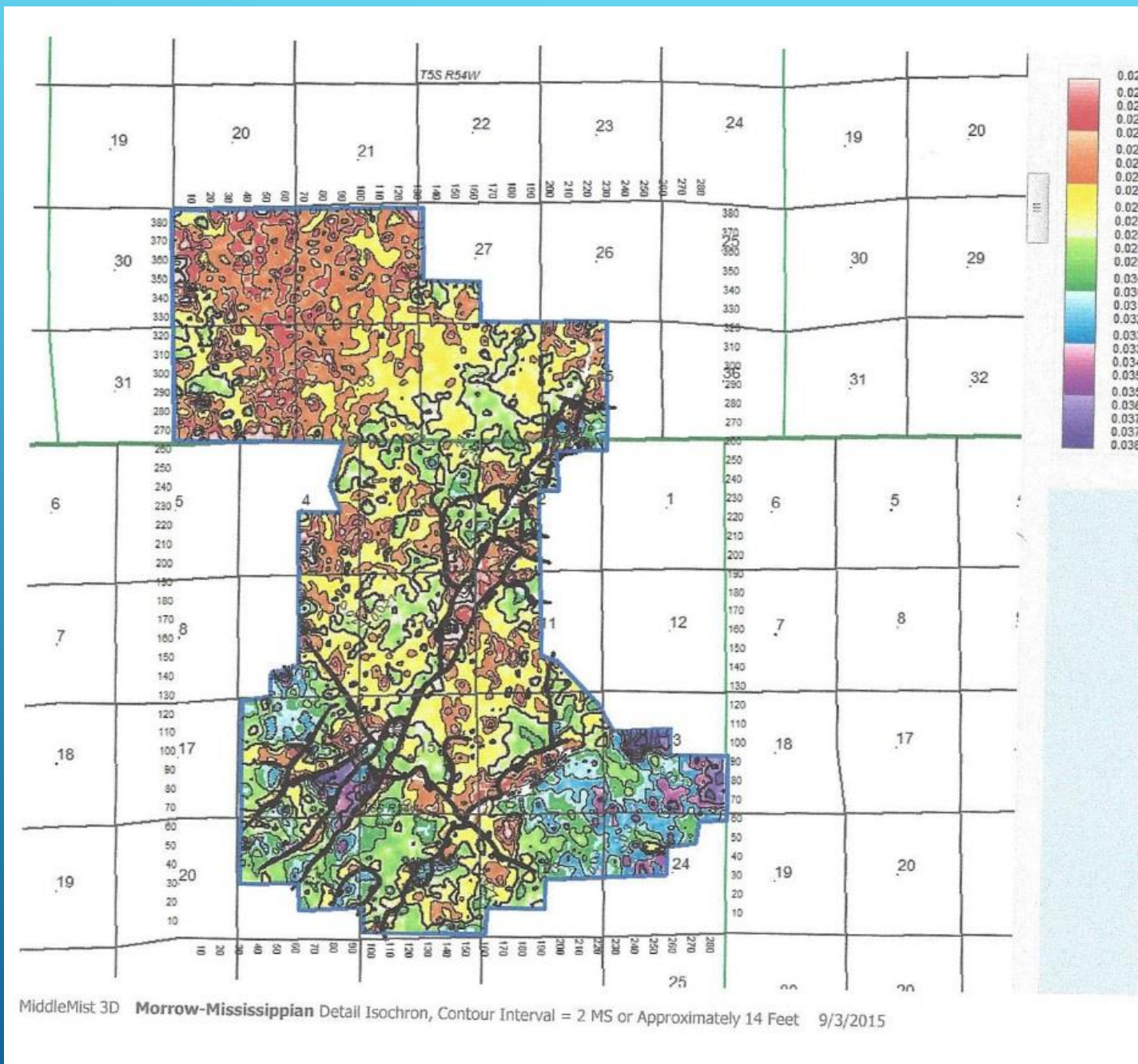


RFP

Morrow- Mississippian Isopach

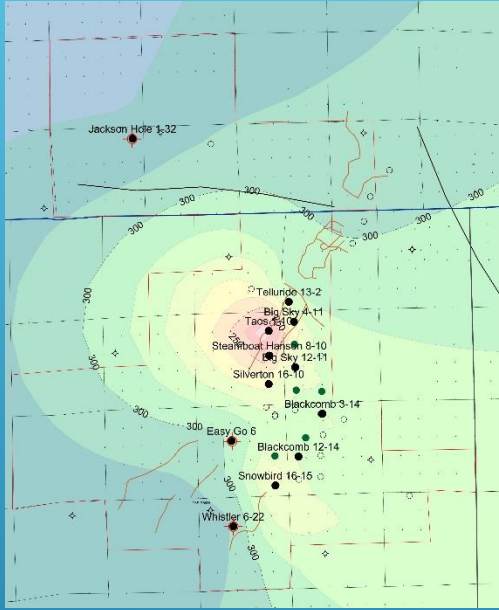


MORROW- MISSISSIPPIAN ISOCHRON



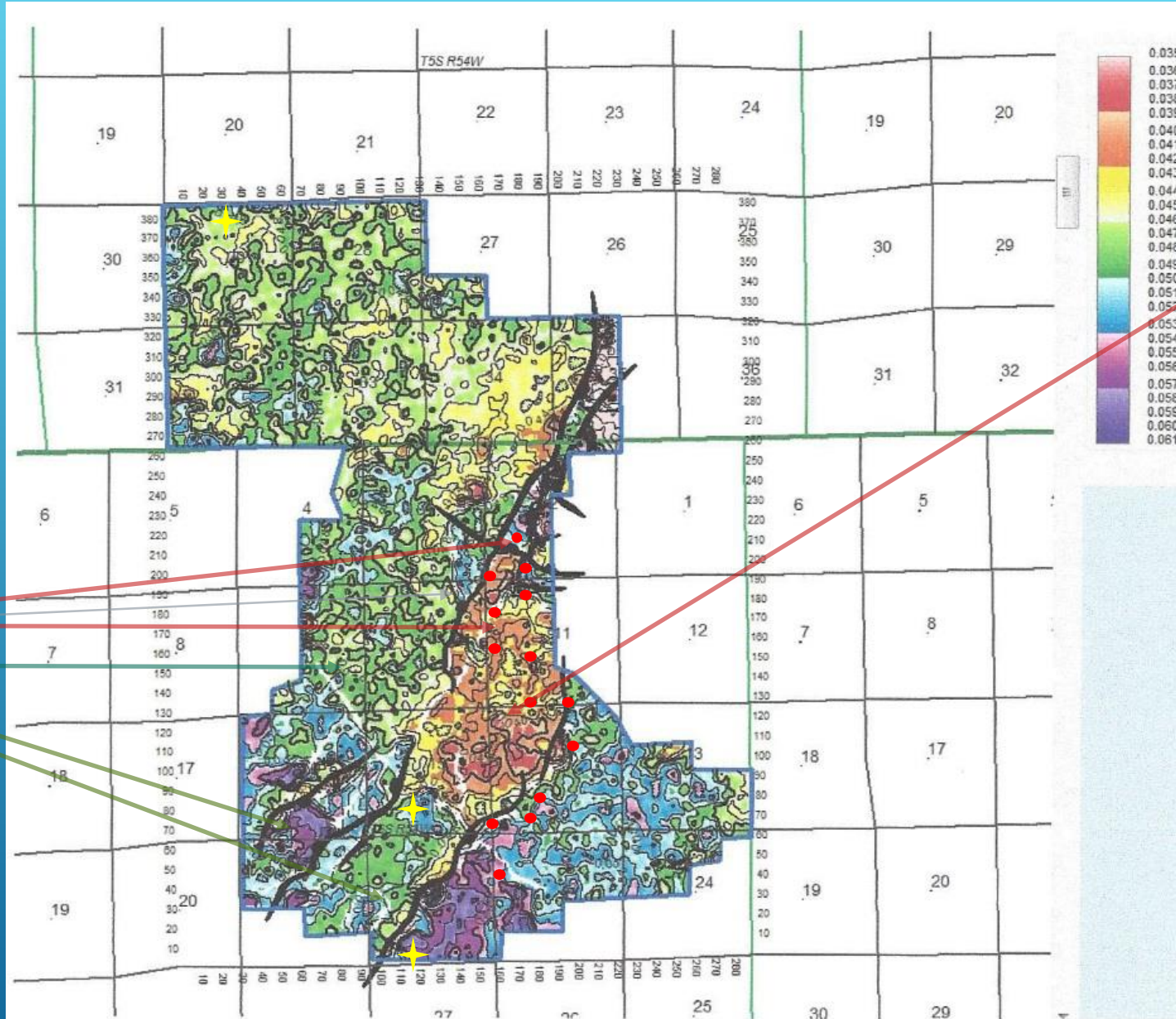
Results similar to
the previous
slide

Atoka-Morrow Isopach



Wells
Thick

ATOKA-MORROW ISOCHRON



MiddleMist 3D Atoka-Morrow Detail Isochron, Contour Interval = 2 MS or Approximately 14 Feet 9/3/2015



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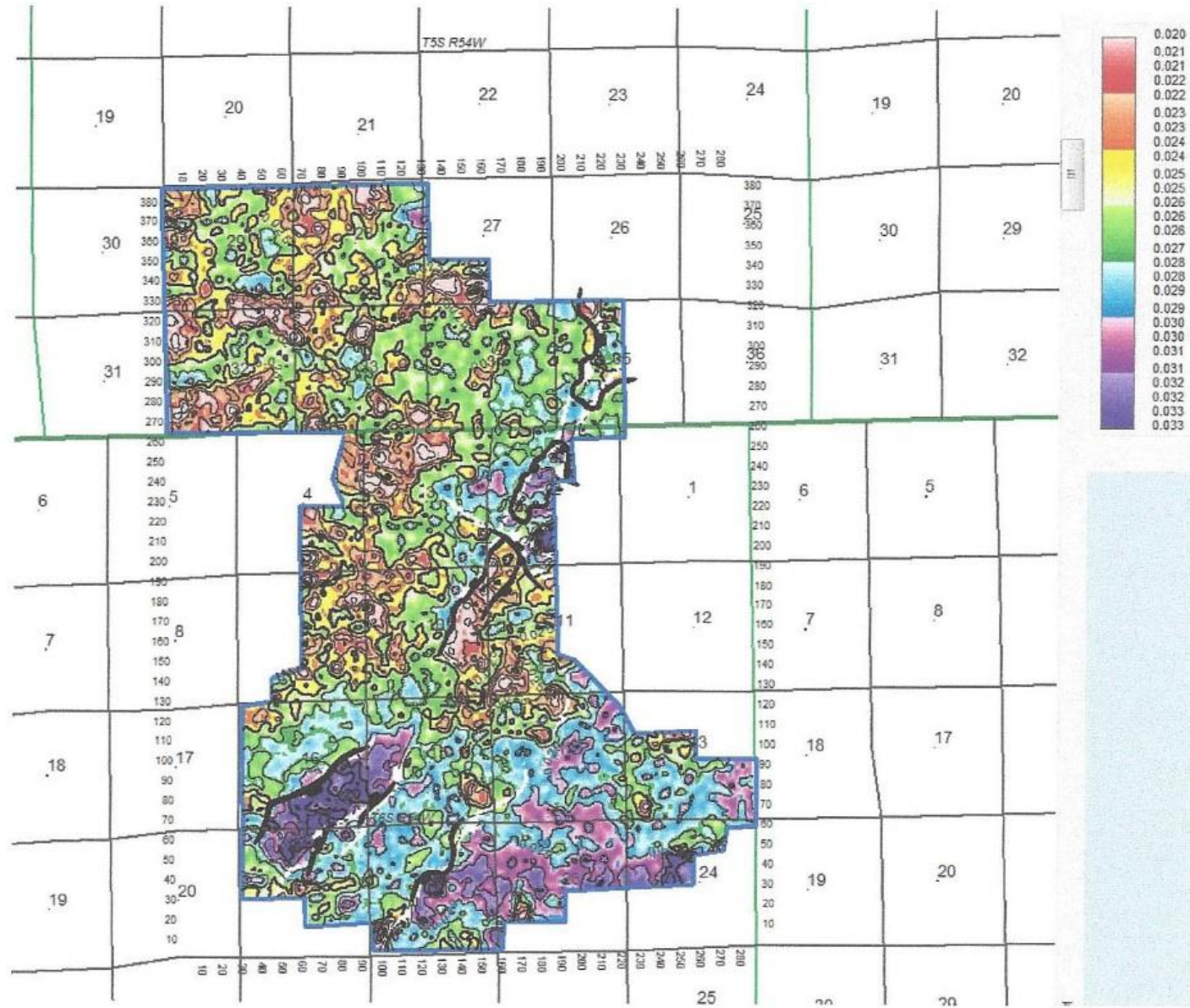
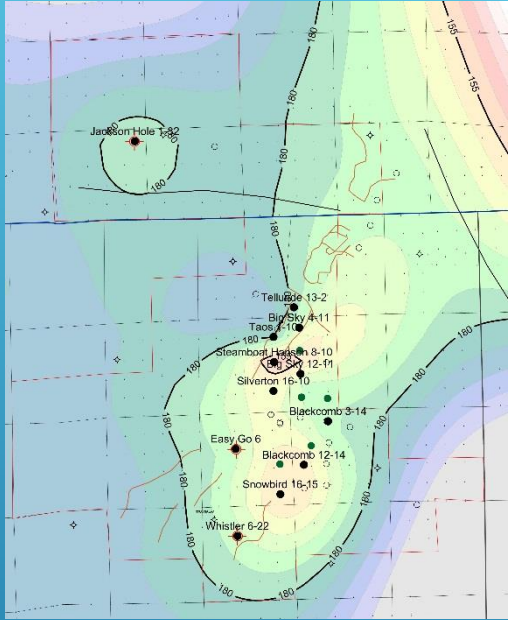
Thin

Structural activity began in Morrow and Atokan time.

This consistent with tectonic activity in the Anadarko Basin.



Cherokee - Atoka Isopach



MiddleMist 3D Cherokee-Atoka Detail Isochron, Contour Interval = 2 MS or Approximately 14 Feet 8/30/2015



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Even though geologic mapping suggests a thin the seismic is not definitive.

CHEROKEE- ATOKA ISOCHRON



RFP

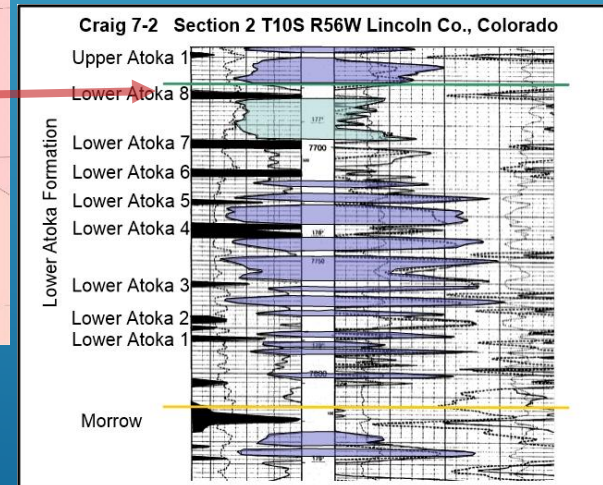
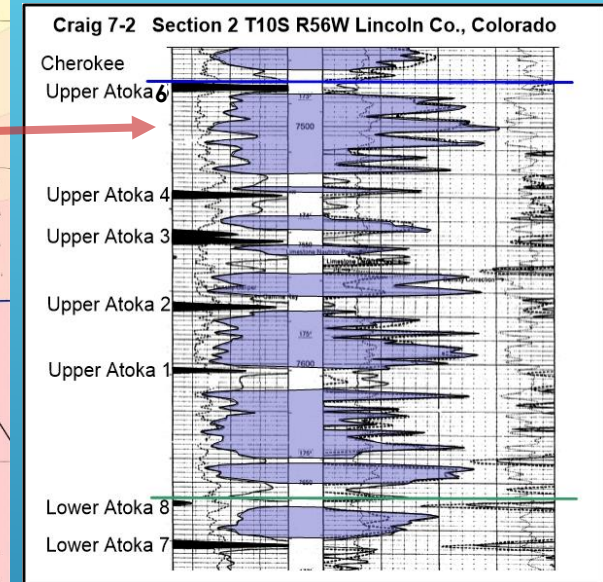
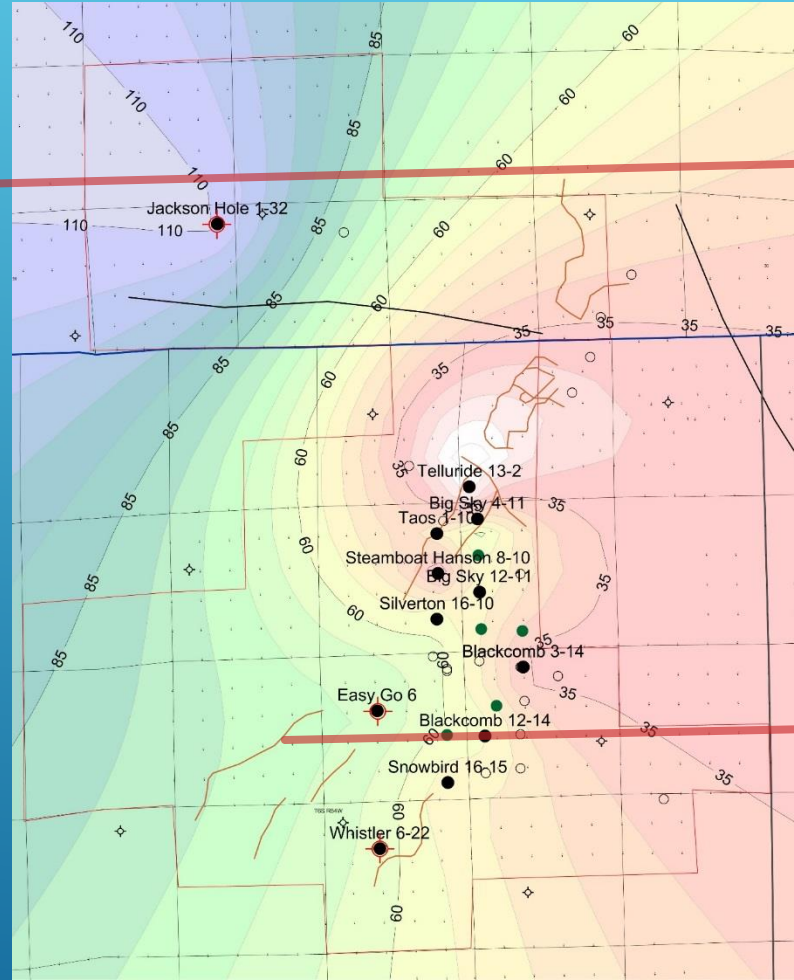
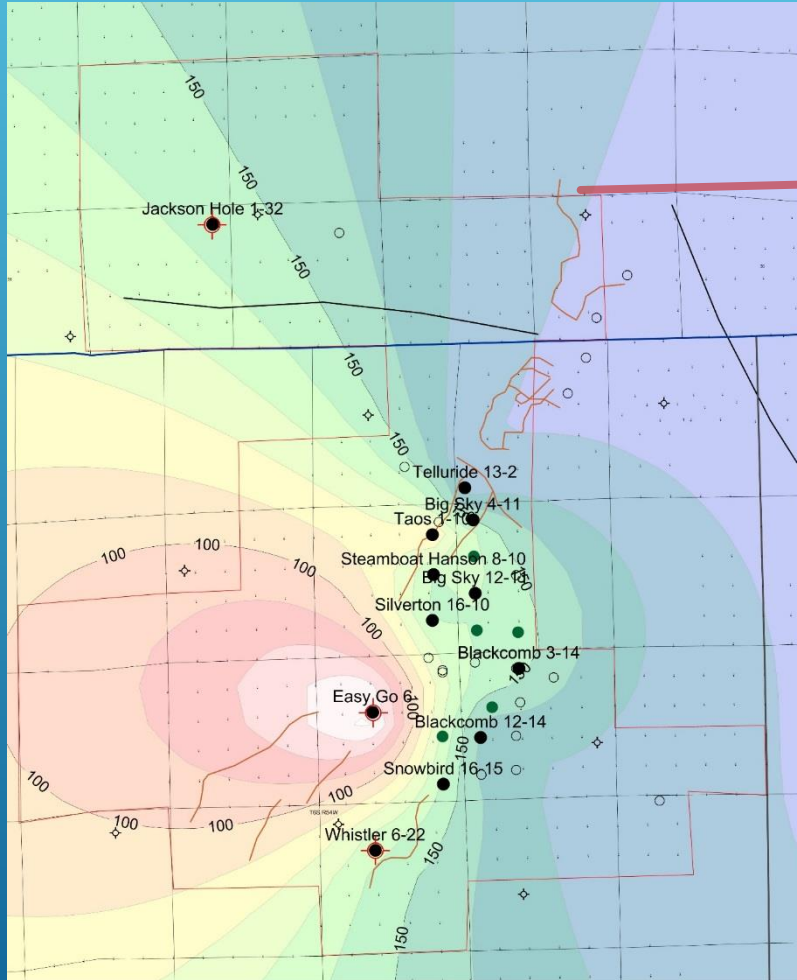
LOWER ATOKA ISOPACHS

Upper

Lower



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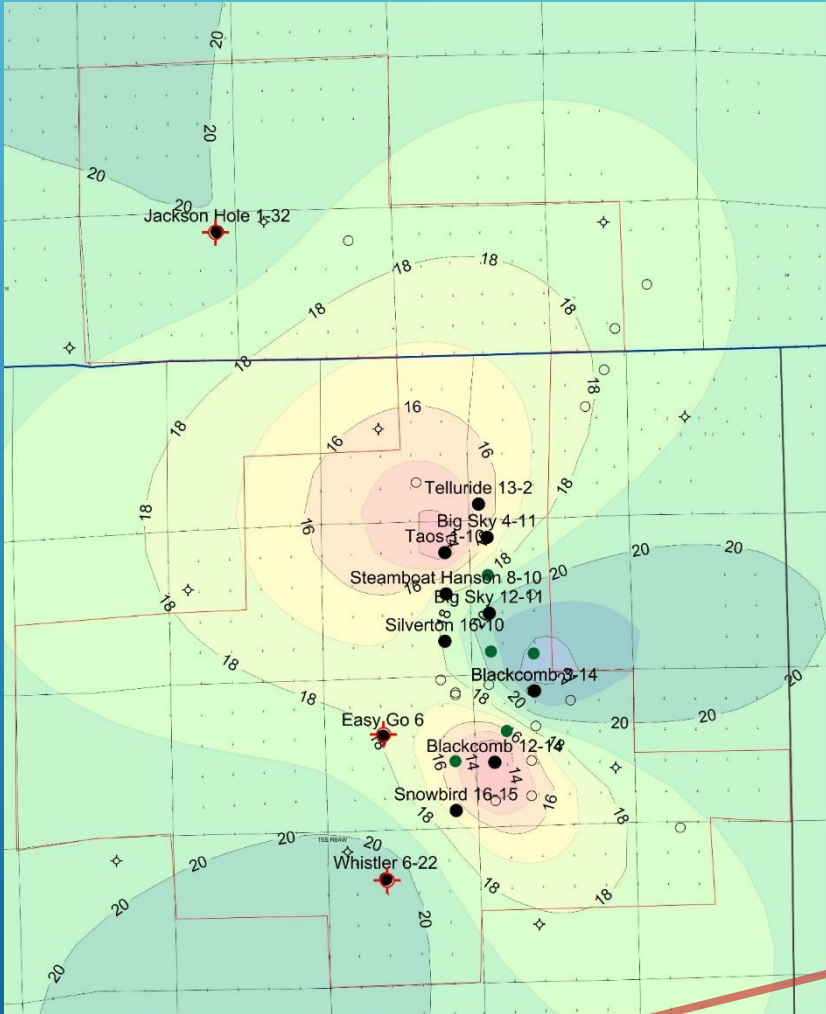
Dividing the Atoka in to the upper and lower indicates the thinning is more prominent in the Lower Atoka.

INDIVIDUAL INTERVAL THICKNESS - ATOKA

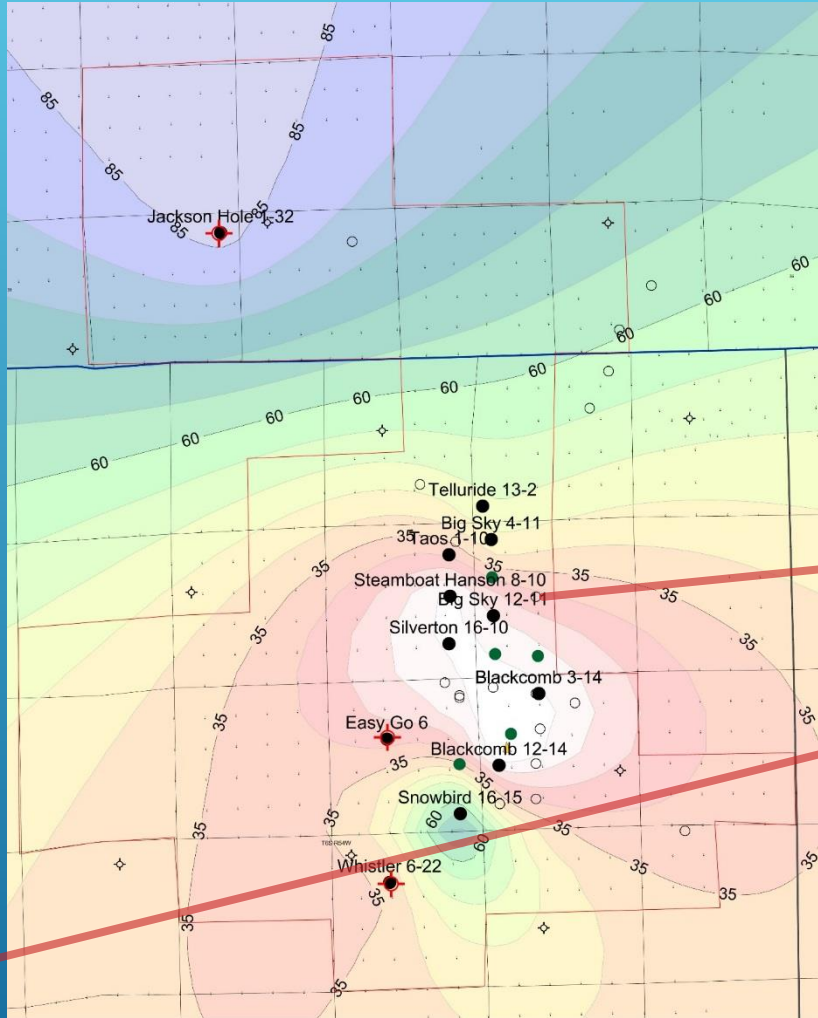


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LA3 interval has thin areas but is not as definitive as LA7 (younger) interval.

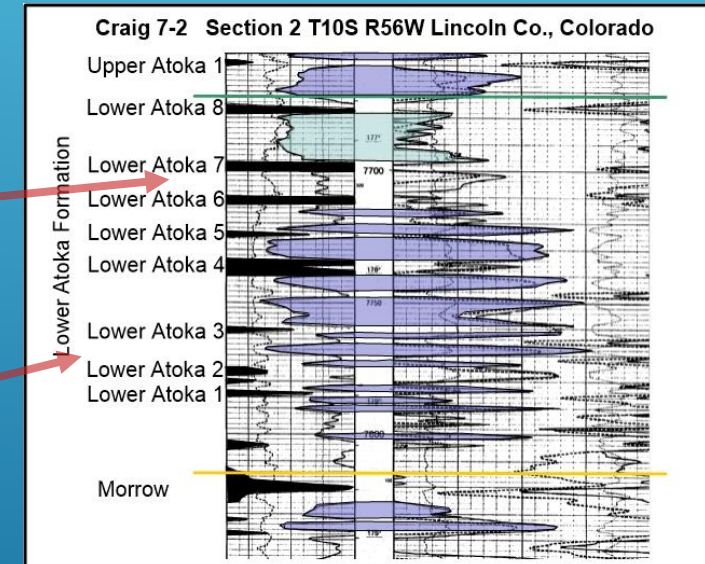


LA 3 Interval



LA 7 Interval

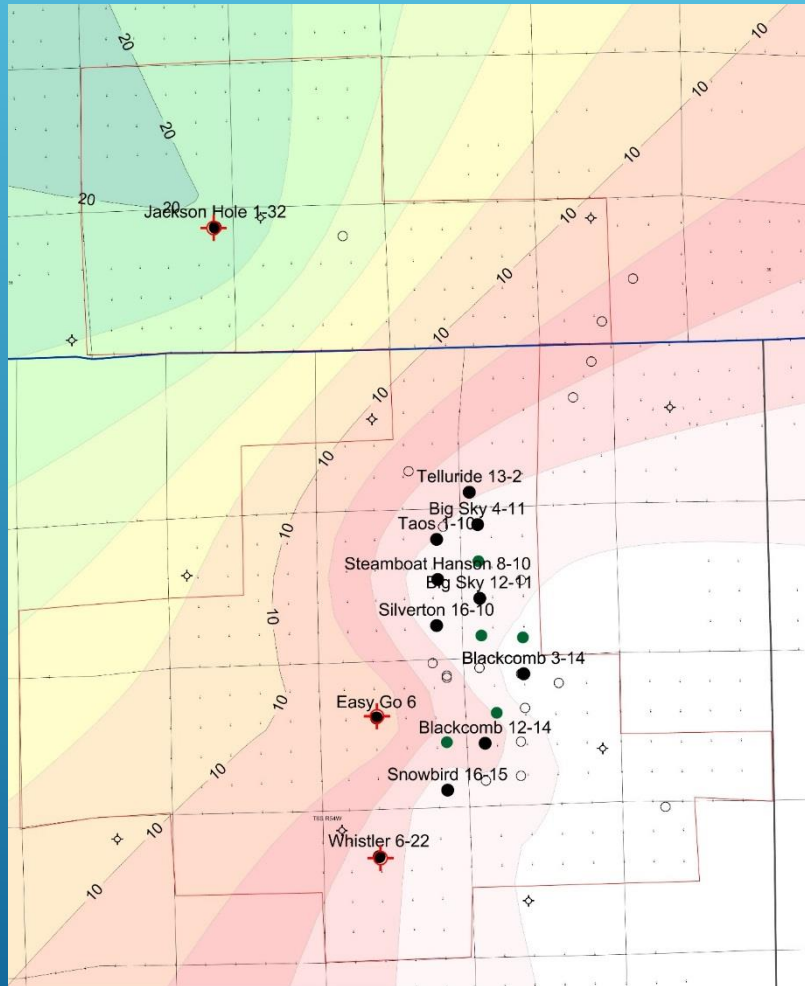
LA 1 and 2 are absent in the area; LA 3 rests directly on the Morrow.



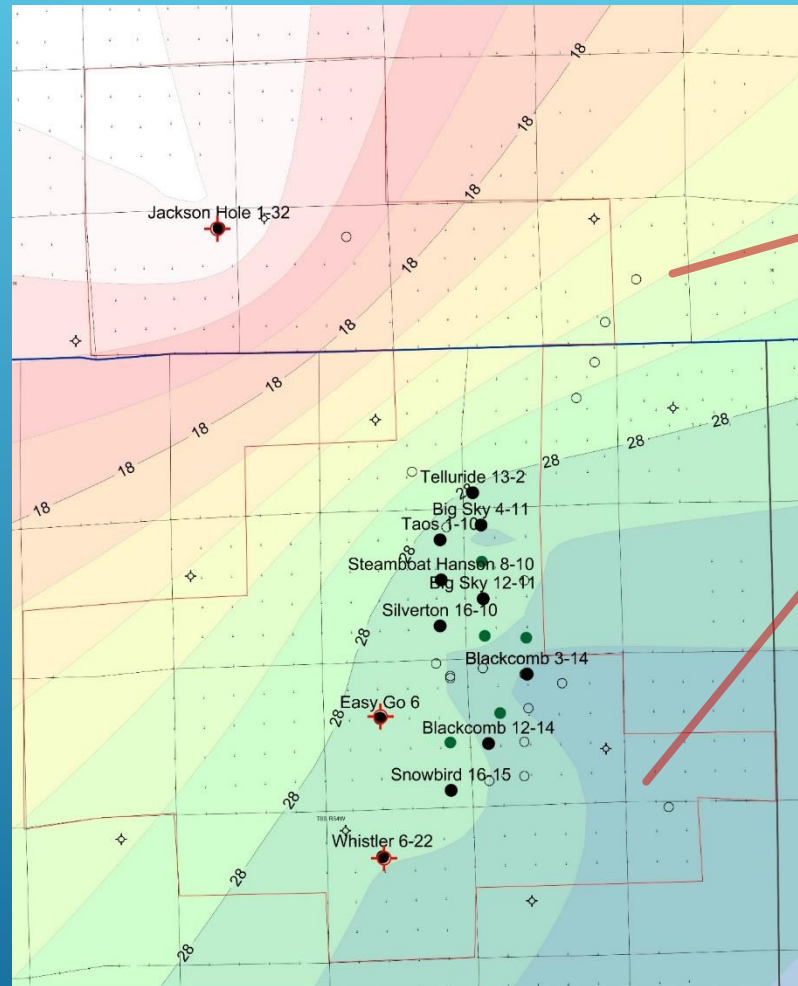
UPPER ATOKA ISOPACHS



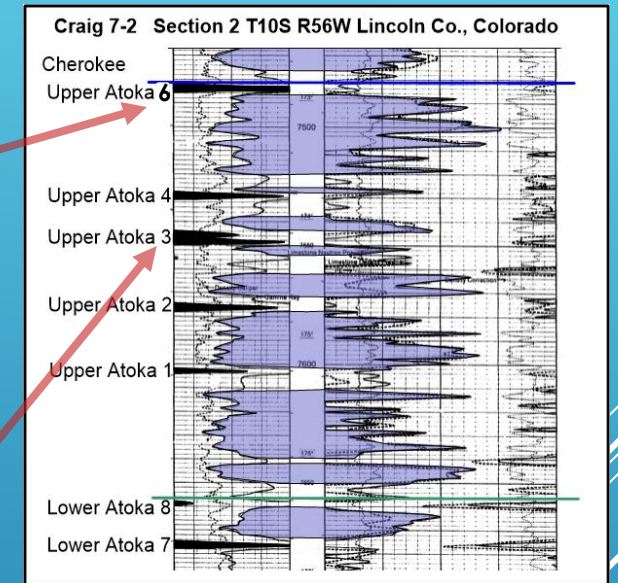
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UA 4 Interval



UA 6 Interval



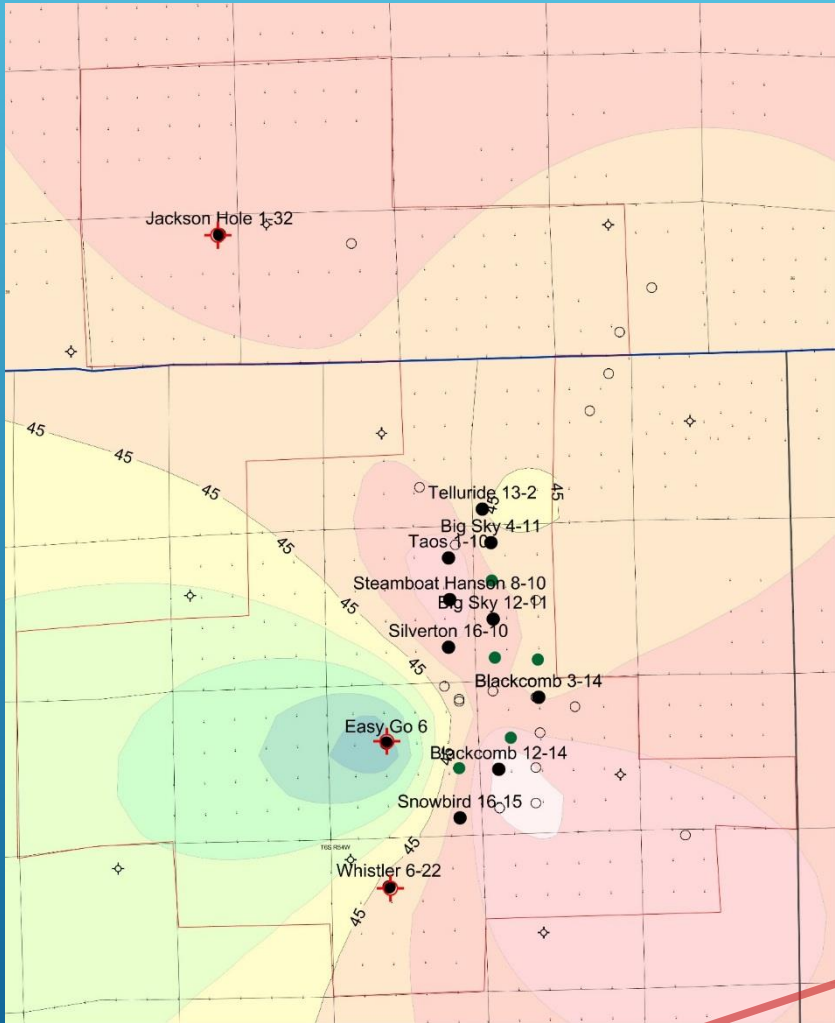
The thin is more definitive in the UA 4 (older) than the younger UA 6.



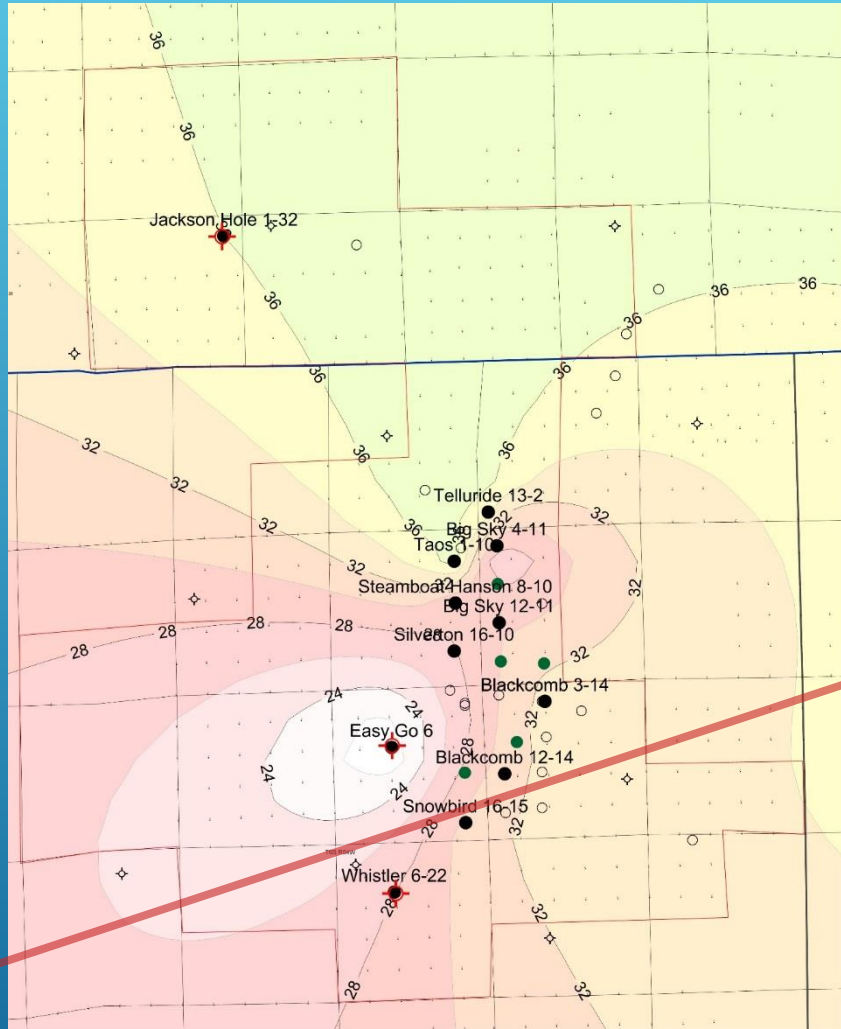


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CHEROKEE INTERVAL ISOPACHS

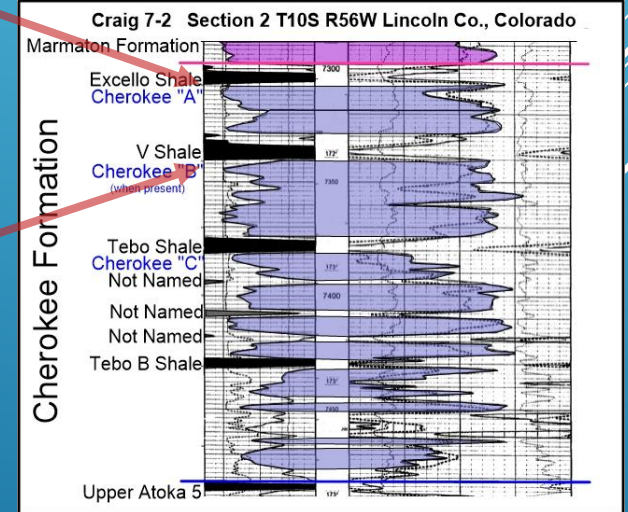


Tebo Interval



Excello Interval

Thinning is present in the Tebo and Excello intervals but this could be due to presence of or structural activity or the marine setting of topographic high creating an area of marine non-deposition.

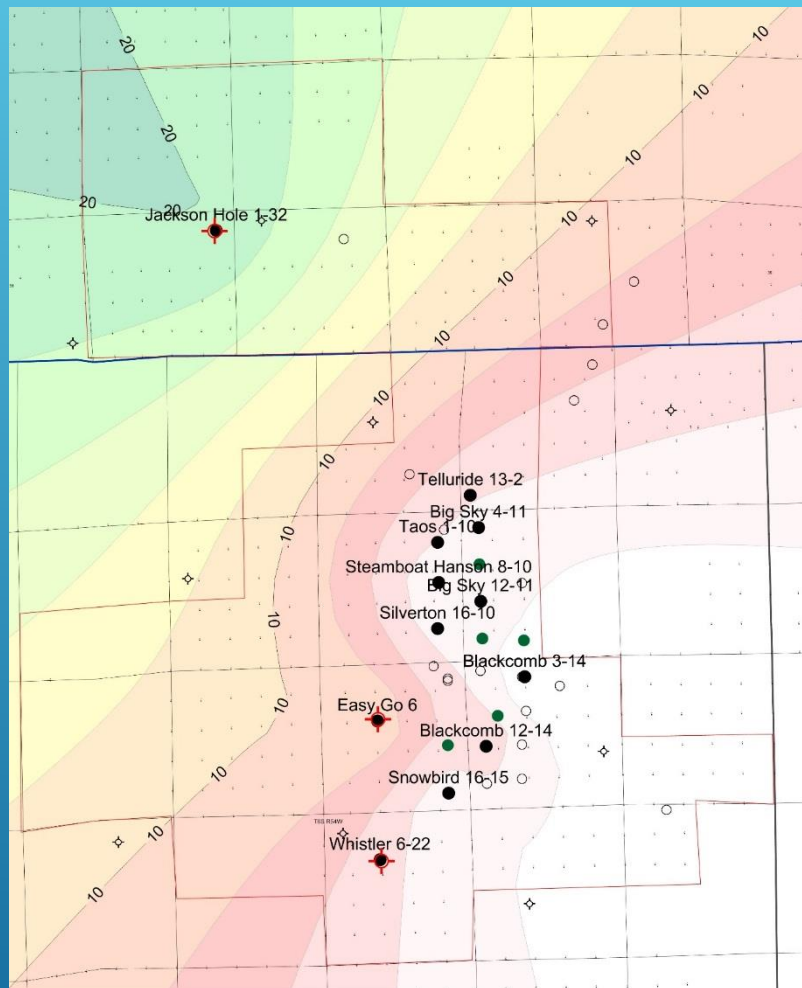


RFP

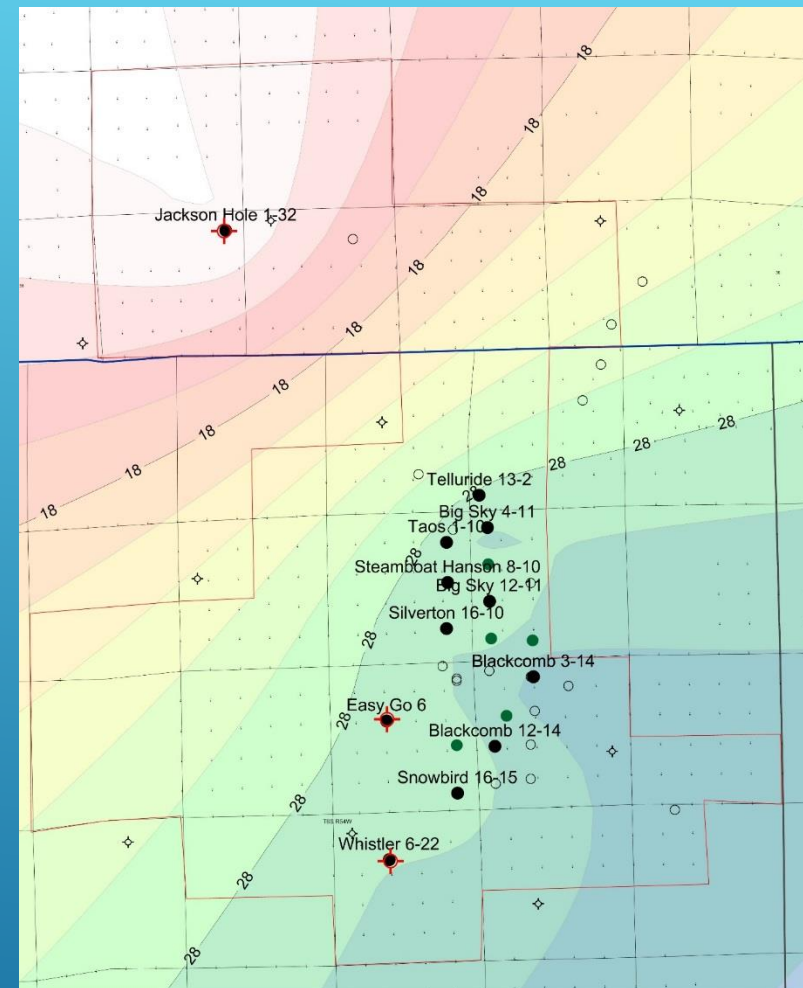
UPPER MARMATON ISOPACHS



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M1 Intervals



M2 Intervals

The Marmaton is also a carbonate dominated formation. The thins could be related to a topographic feature or structural activity. The seismic does not support structural movement at this time.



SUMMARY



- The Arikaree Creek Field is a wrench fault system trending to the northwest-southwest;
- Time of movement occurred from Morrowan to Atoka time. But more specifically from late Lower Atokan to early Upper Atokan time;
- Minor movement may have occurred in Cherokee and Marmaton but no significant faulting seen;
- Thinning in Cherokee and Marmaton time may be related to a positive topographic high. This is seen in other basins such as the Illinois, Michigan, Cherokee, Sedgwick, etc.

A red fox is captured in mid-stride, running across a snowy beach. The fox's fur is a vibrant orange-red, with white underparts and a bushy tail. The background shows a dark blue ocean under a clear sky. The overall scene is bright and dynamic.

The End

Thank You For
Coming