Implementing Discriminative Water Saturation Criteria to Determine Prime Production Remnants in Morrow County*

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Abstract

The Morrow Consolidated Oil Field was analyzed as a part of a project examining the technical and economic feasibility of CO_2 utilization and storage in Ohio. The Morrow Field produces from the Copper Ridge Dolomite, also known as the Trempealeau Formation. After deposition of the Trempealeau, the area underwent large scale erosion, leaving behind remnants that become encased in the Wells Creek Shale. These remnants are irregular in size and distribution and serve as the primary reservoir for the field. Historically, these remnants have been difficult to identify. We present a method for identifying remnants including those with high production potential.

In total, 74 wells from the northeast portion of the field were analyzed for net to gross, porosity, and water saturation using Gamma Ray, Resistivity, Neutron Porosity, and Bulk Density wireline logs. Many of the wells in the study area did not penetrate the entire Trempealeau Formation; instead drilling was terminated between 50 and 100 feet from the top.

As such, a water saturation (Sw) cutoff criterion was identified to establish the bottom of the reservoir for uniform calculation purposes. When applied to the cross sections created for the field, the Sw cutoff helped distinguish between “elevated” remnants and non-remnants in study area. Additionally, good correlation exists between remnants identified with the water saturation cutoff and production data. Mapping the wells that met the water saturation cut off yielded a remnant map for the study area without the use of field wide seismic data.

Reference Cited

Dolly, E.D., and D.A. Busch, 1972, Stratigraphic, Structural, and Geomorphologic Factors Controlling Oil Accumulation in Upper Cambrian Strata of Central Ohio: American Association of Petroleum Geologists Bulletin, v. 56/12, p. 2335-2369.

Selected Website

http://www.scotese.com/ Website accessed March 2016.

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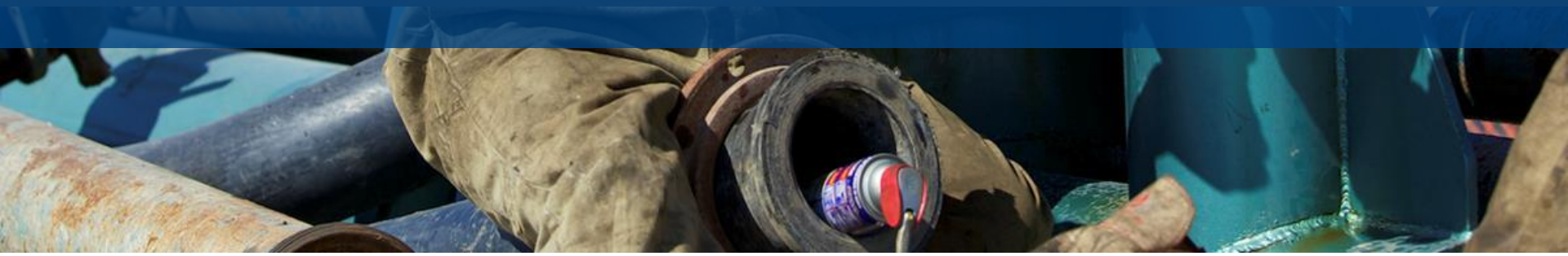
American Association of Petroleum Geologists

Eastern Regional Meeting, Fall 2015



NETL

Ohio Development Services Agency

MRCSP MIDWEST REGIONAL CARBON SEQUESTRATION PARTNERSHIP

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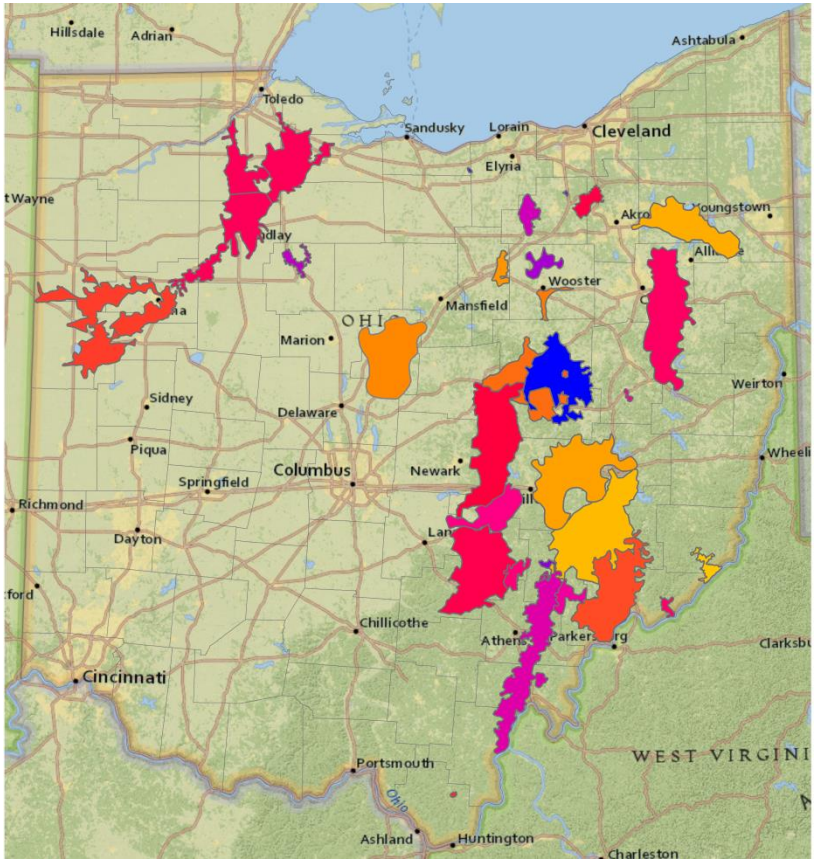
CO2 Utilization for Enhanced Oil Recovery and Geologic Storage in Ohio

- Funded by Ohio Coal Development Office (MRSCP cost share)
  - Phase 1 - April 2014 to September 2015
  - Phase 2 - October 2015 to December 2017
- Research Goals
  - Develop process understanding and evaluate technical and economic feasibility of CO2 utilization and storage in Ohio's depleted oil fields
  - Focus on Clinton sandstone and Knox dolomite formations (under-pressured, low permeability reservoirs with poor primary production)
  - Provide systematic assessment of EOR and geologic storage potential in these reservoirs



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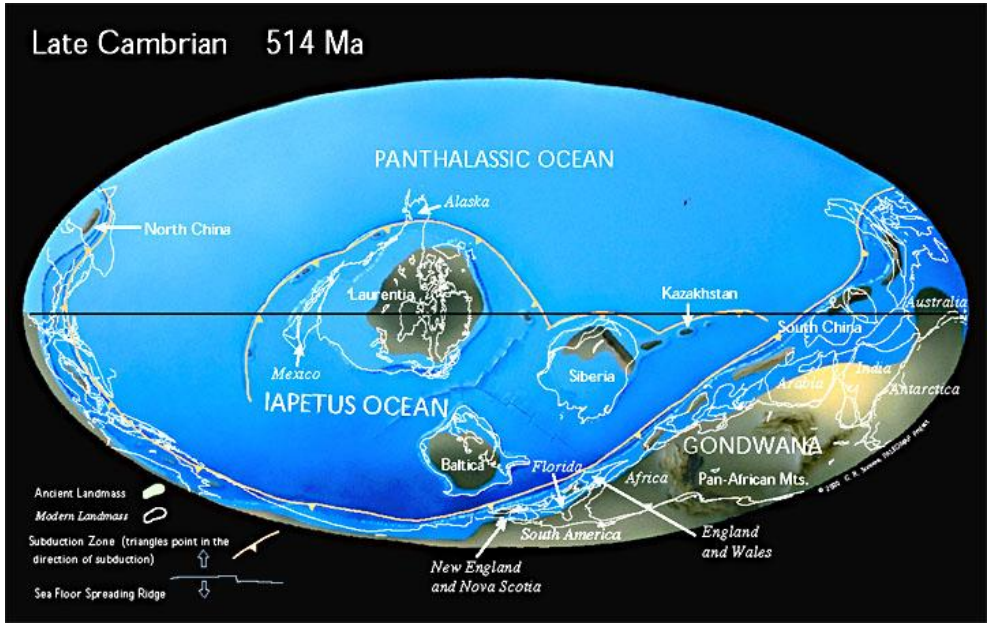
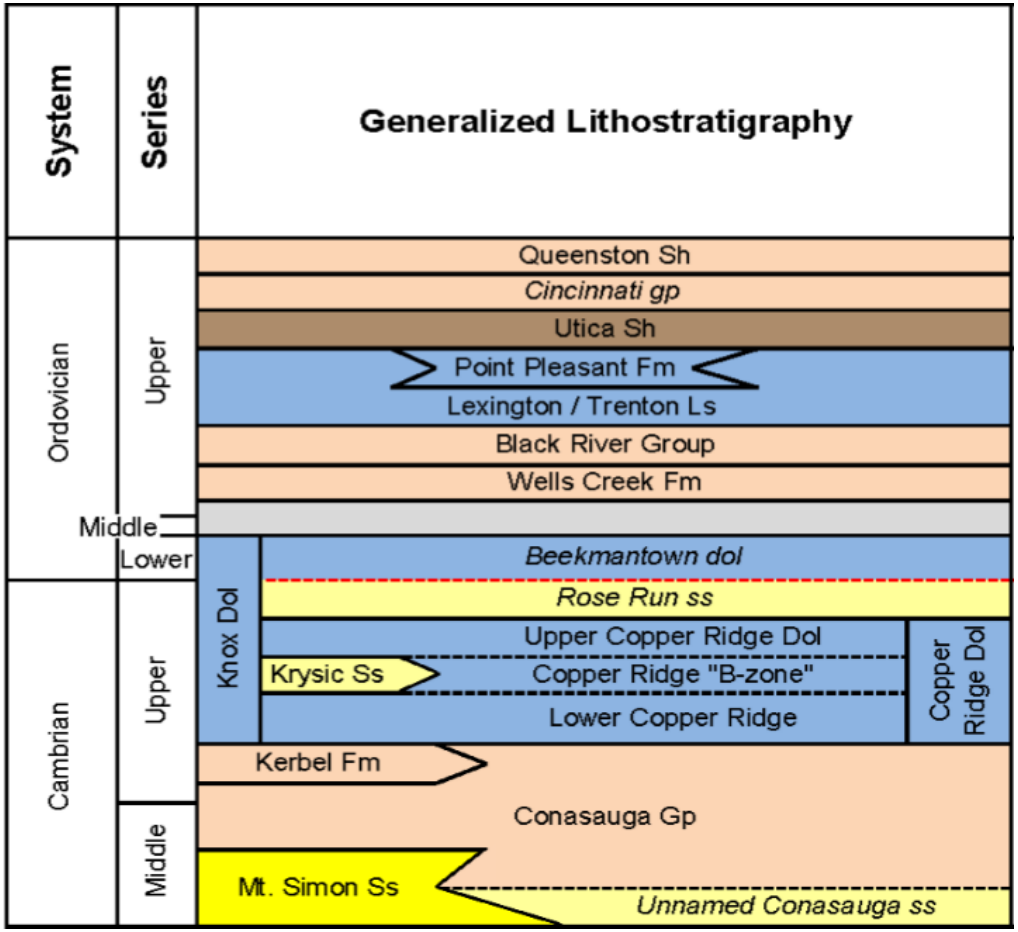
OCDO EOR: Morrow Consolidated Oil Field Analysis

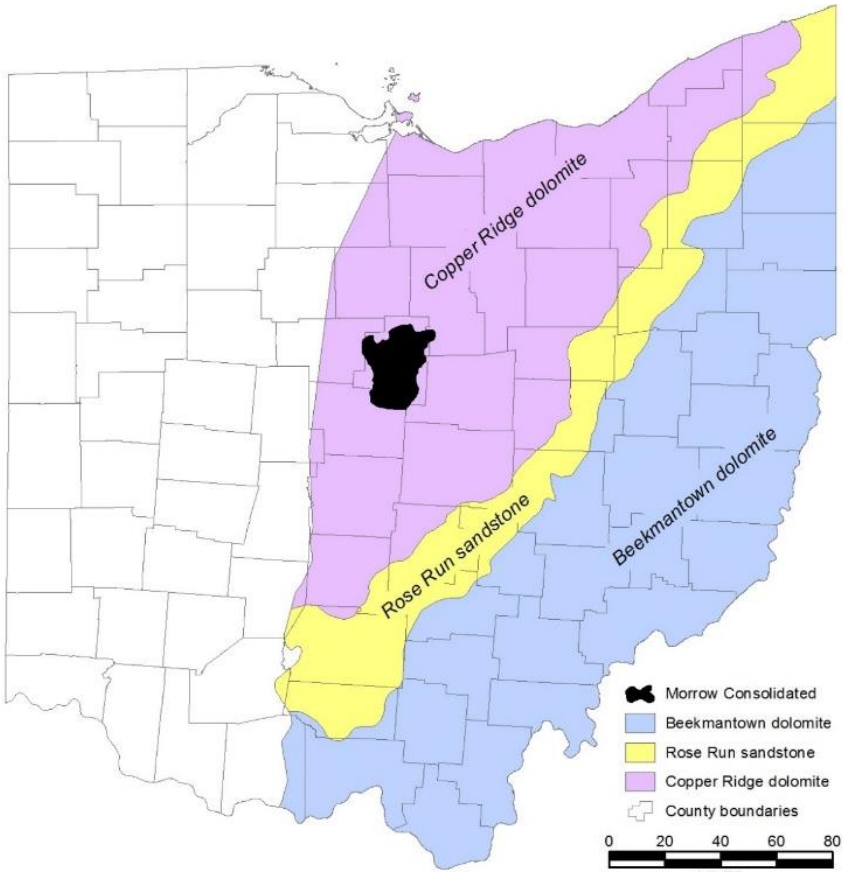


http://www.scotese.com/

- Knox Formation: Morrow Consolidated Oil Field
- Age: Cambrian
- Rock Type: Dolomite
- Play Type: Erosional Remnant
- Modern Analog: Ha Long Bay, Vietnam

Morrow County Stratigraphy





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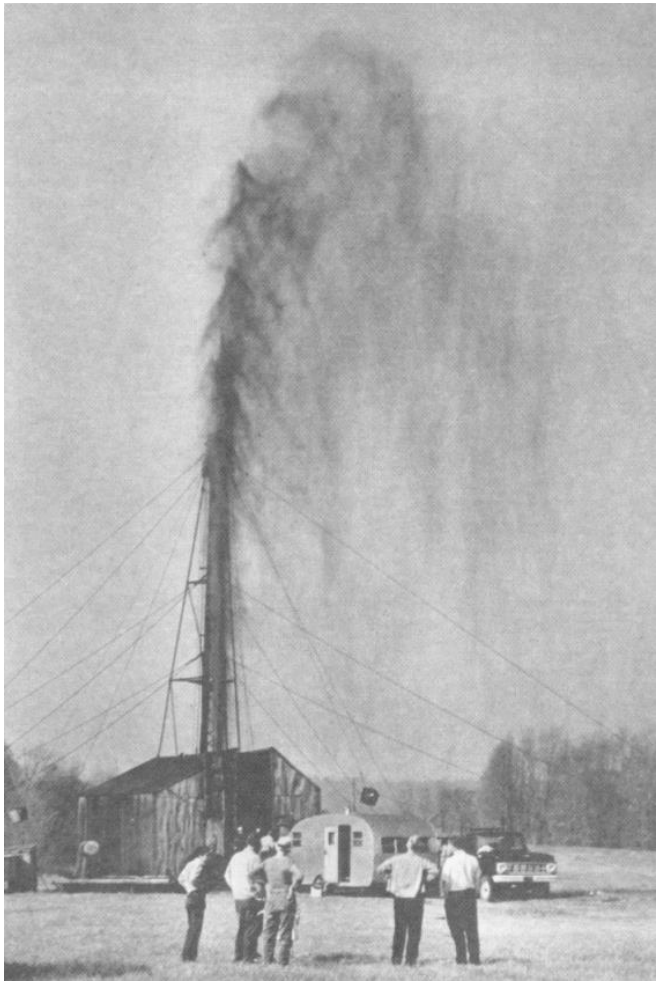
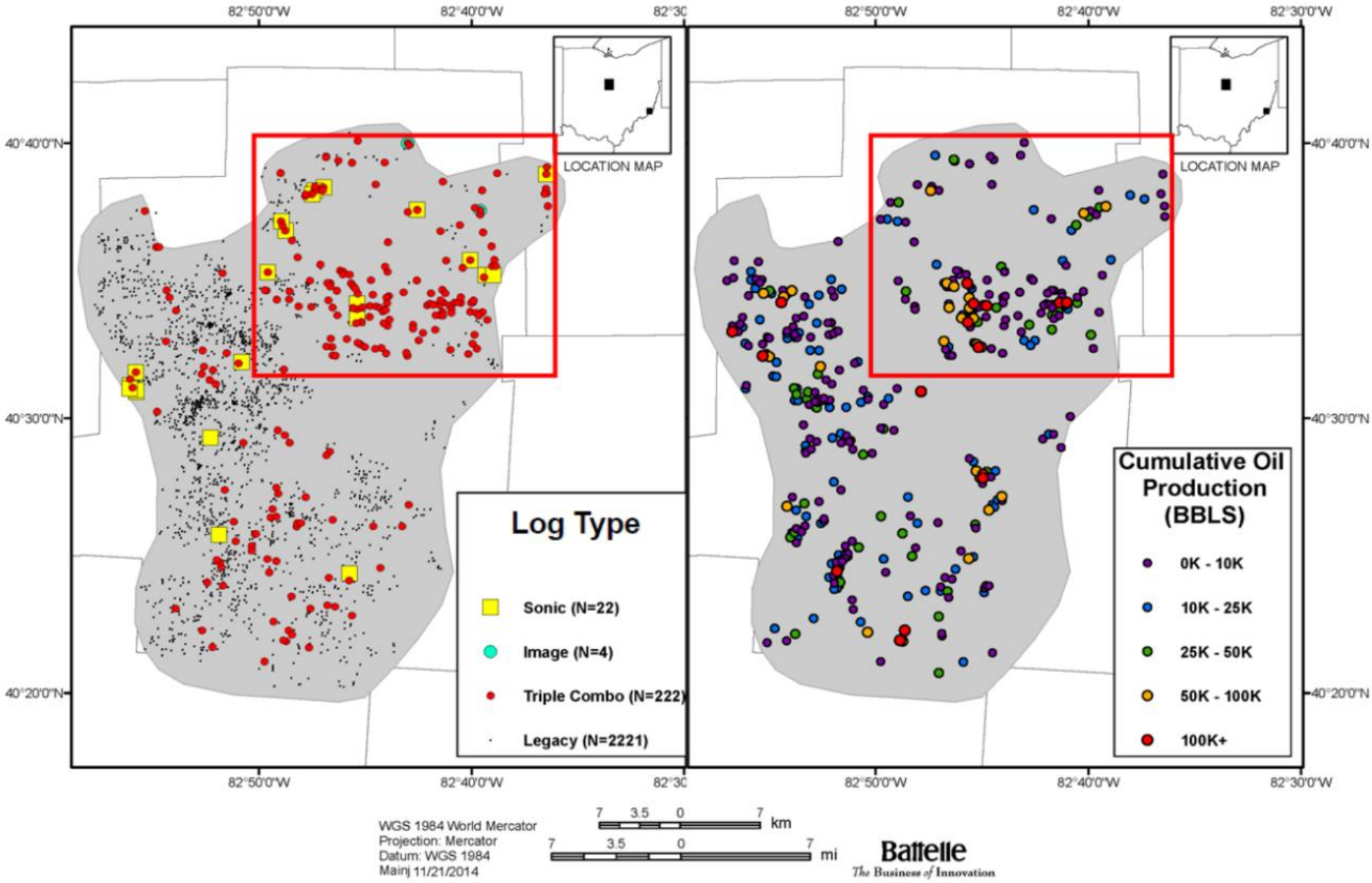
Morrow County Production History



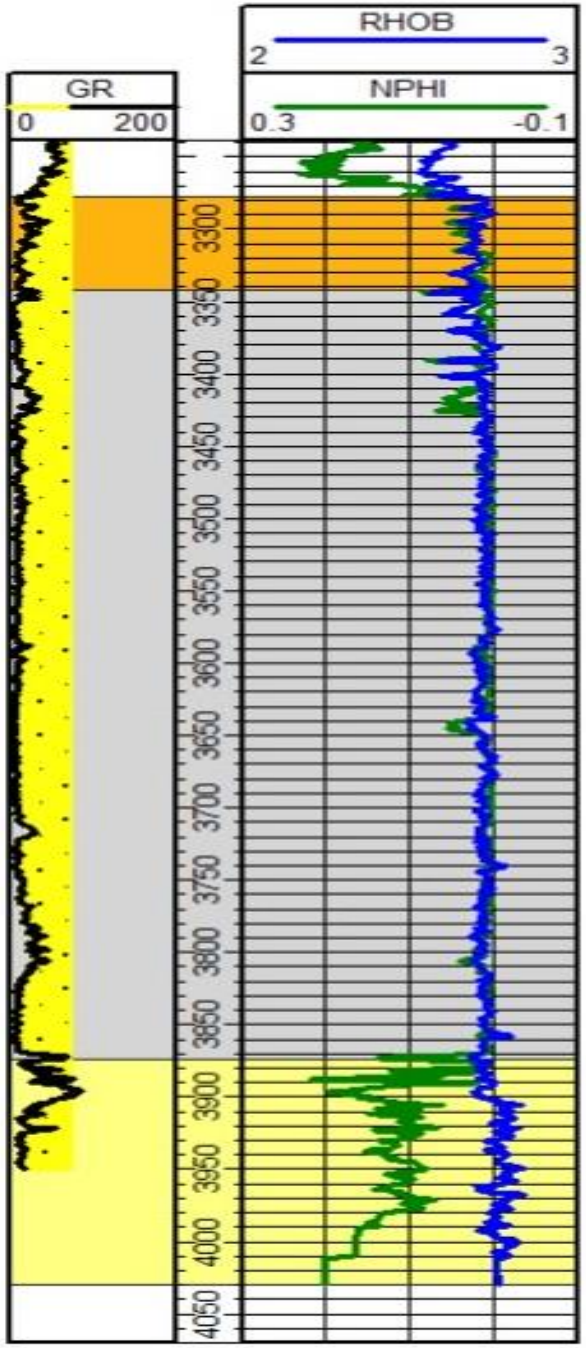
http://www.ohgeosoc.org/publications/017.pdf

- Originally discovered in 1959
- 177 MMBbls OOIP
- 46.3 MMBbls recovered
- 2,469 wells drilled

Log Coverage



Type Log



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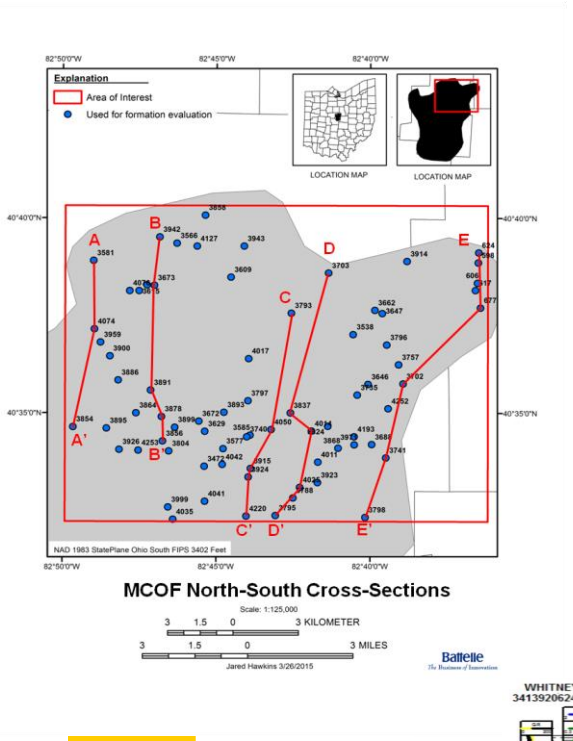
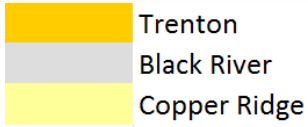
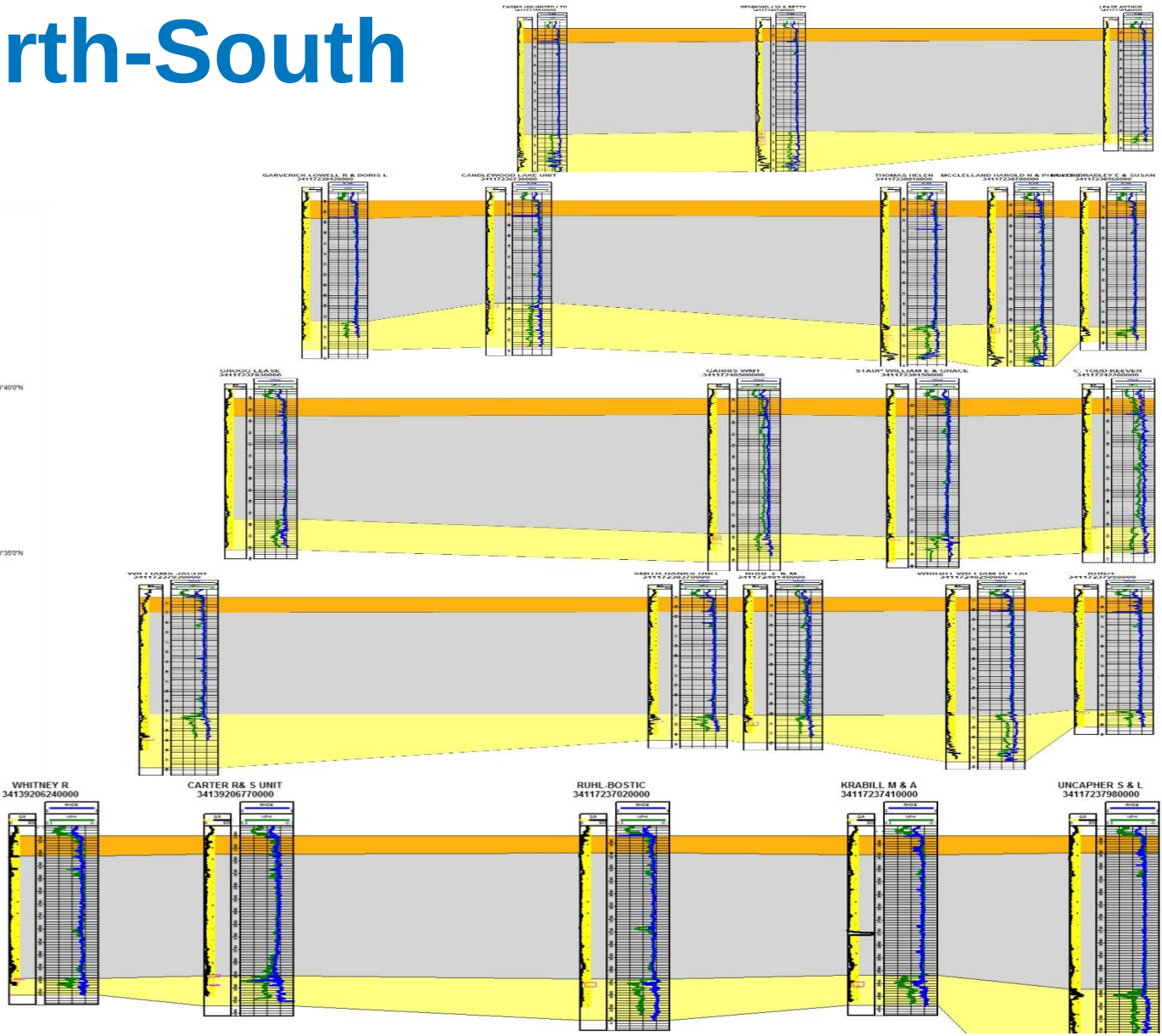
Black River

Copper Ridge

MCOF North-South







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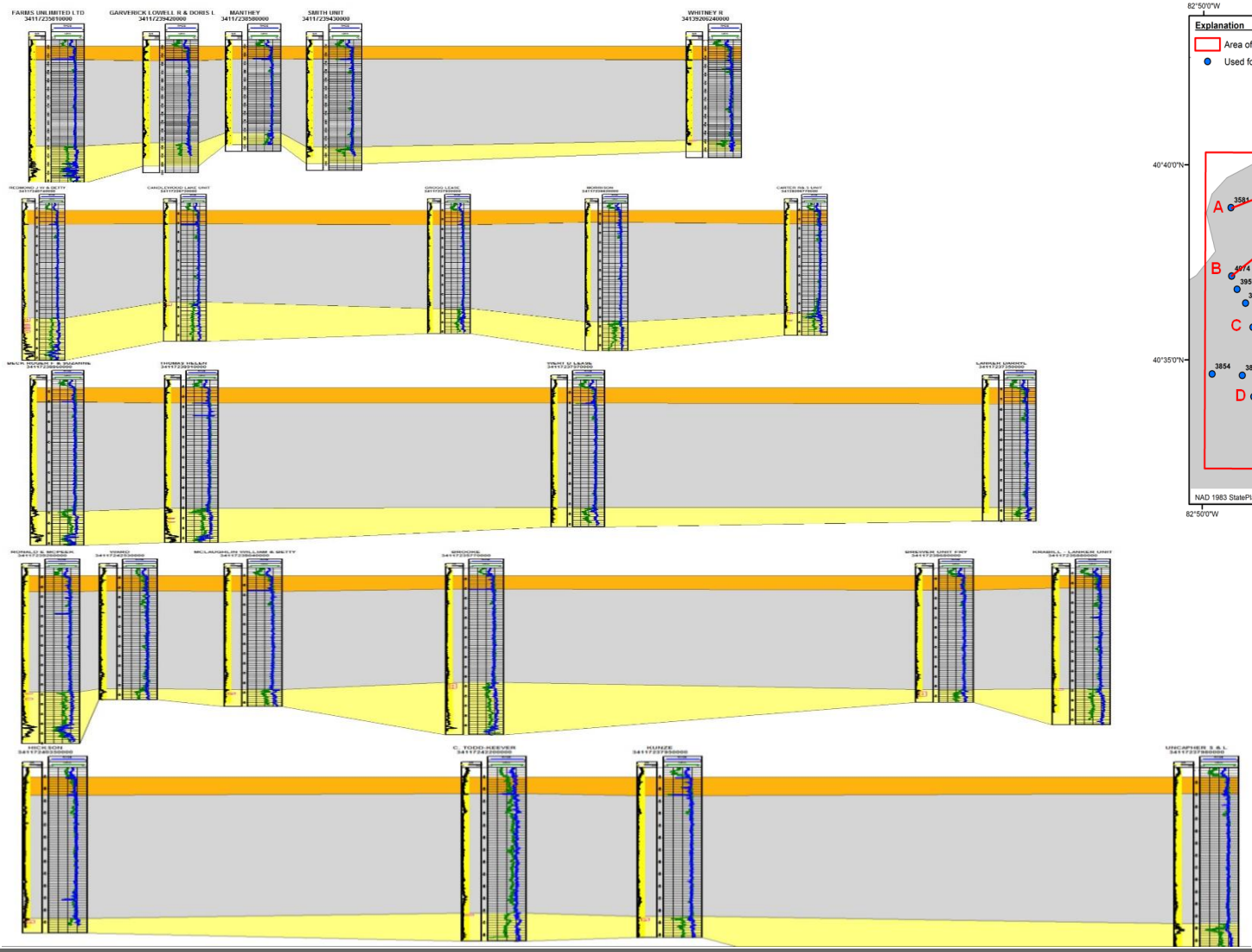
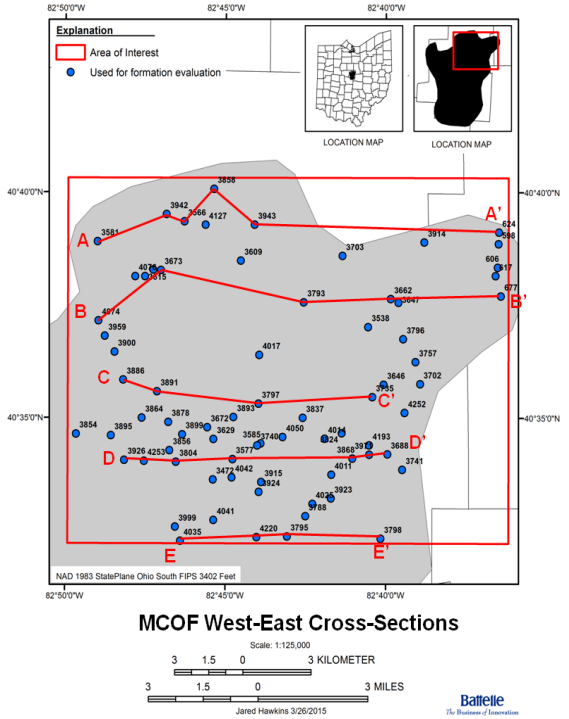
MCOF West-East





MCOF West-East Cross-Sections

Scale: 1:125,000

3 1.5 0 3 KILOMETER

3 1.5 0 3 MILES

Jared Hawkins 3/26/2015

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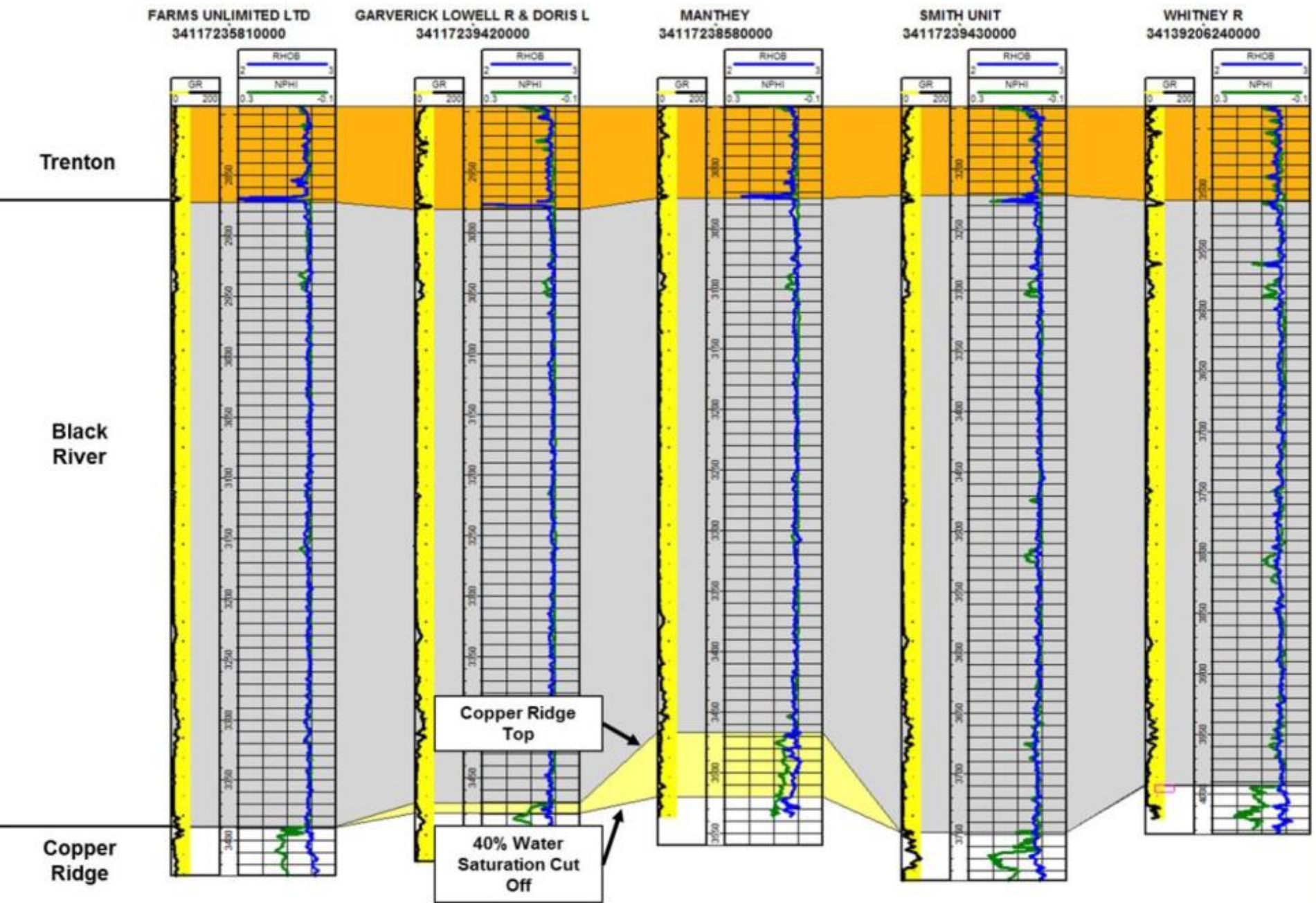
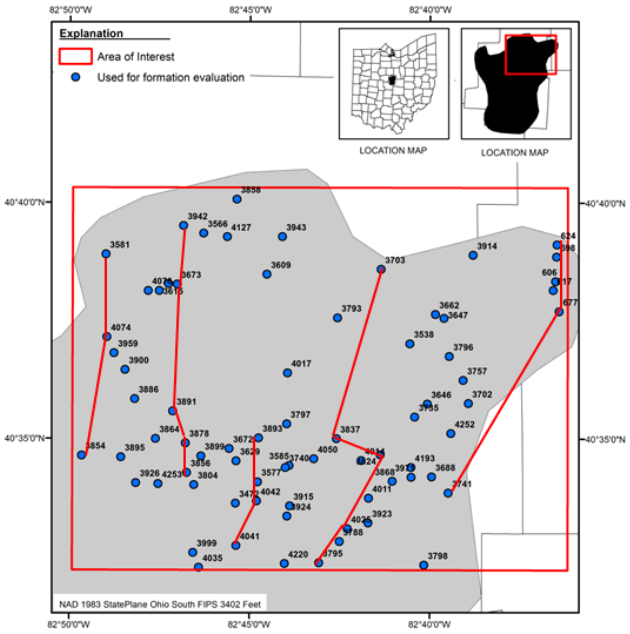
Problem: Most wells did not penetrate the full Copper Ridge Section

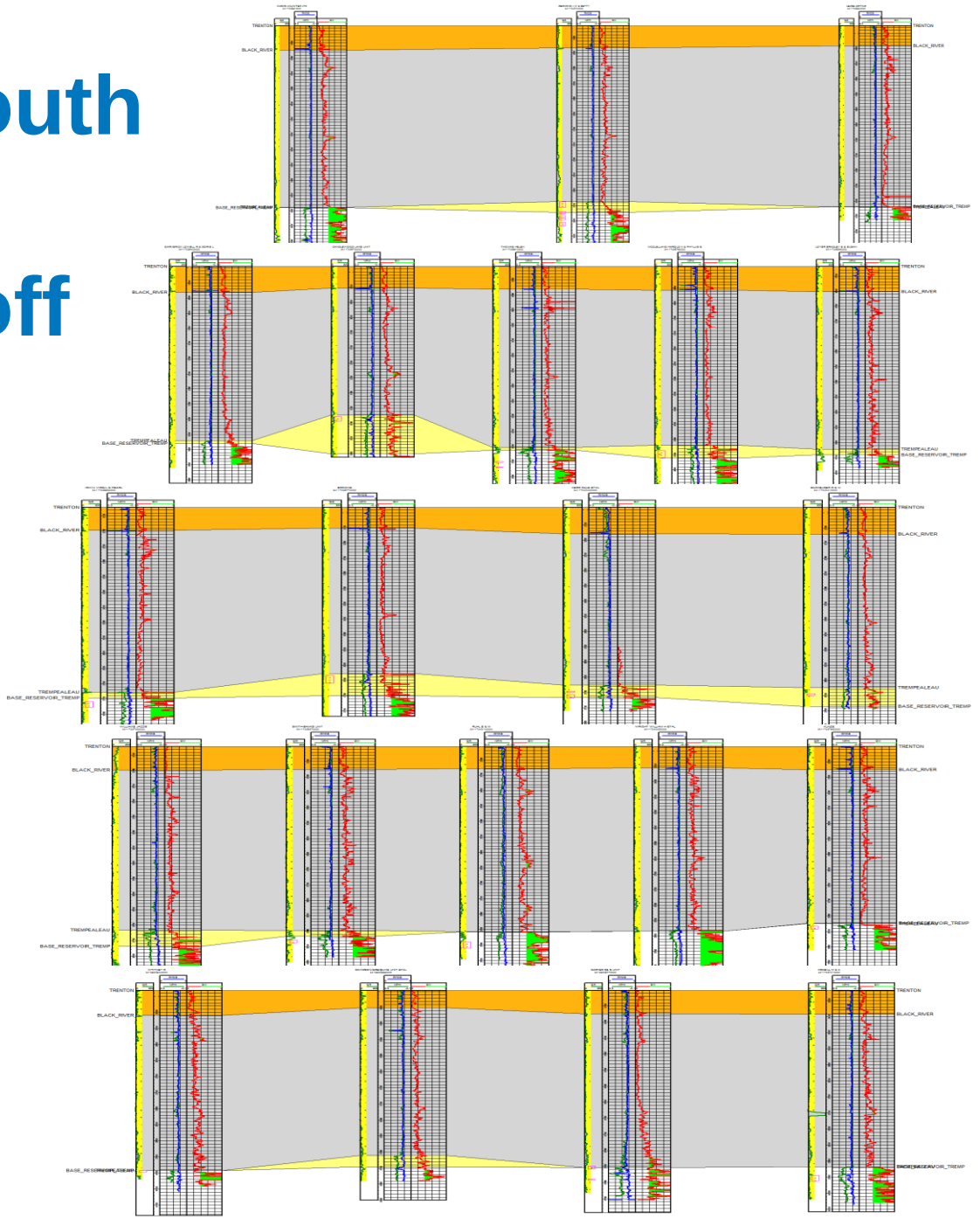
Solution: Utilize a Water Saturation Cutoff to delineate reservoir remnants

Remnant Mapping with Water Saturation



MCOF North-South with Water Saturation Cutoff





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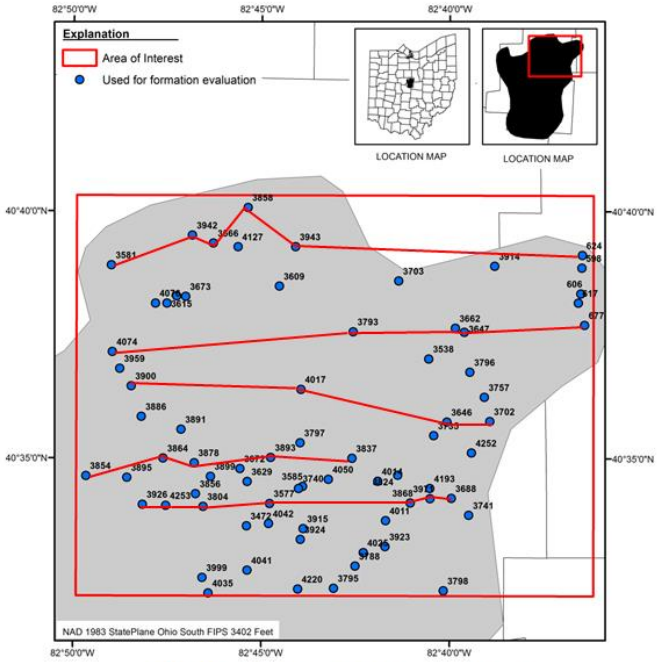
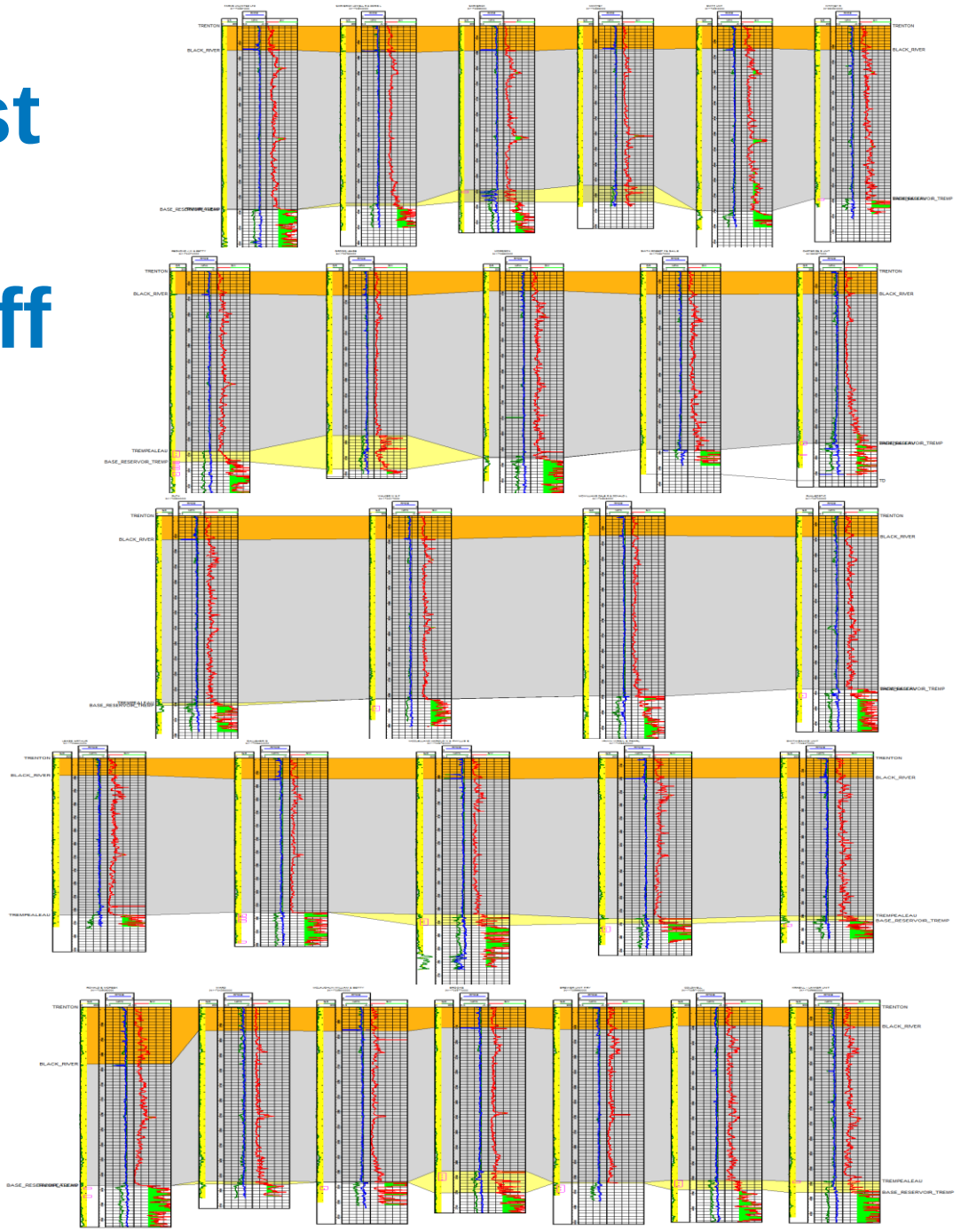
MCOF West-East with Water Saturation Cutoff





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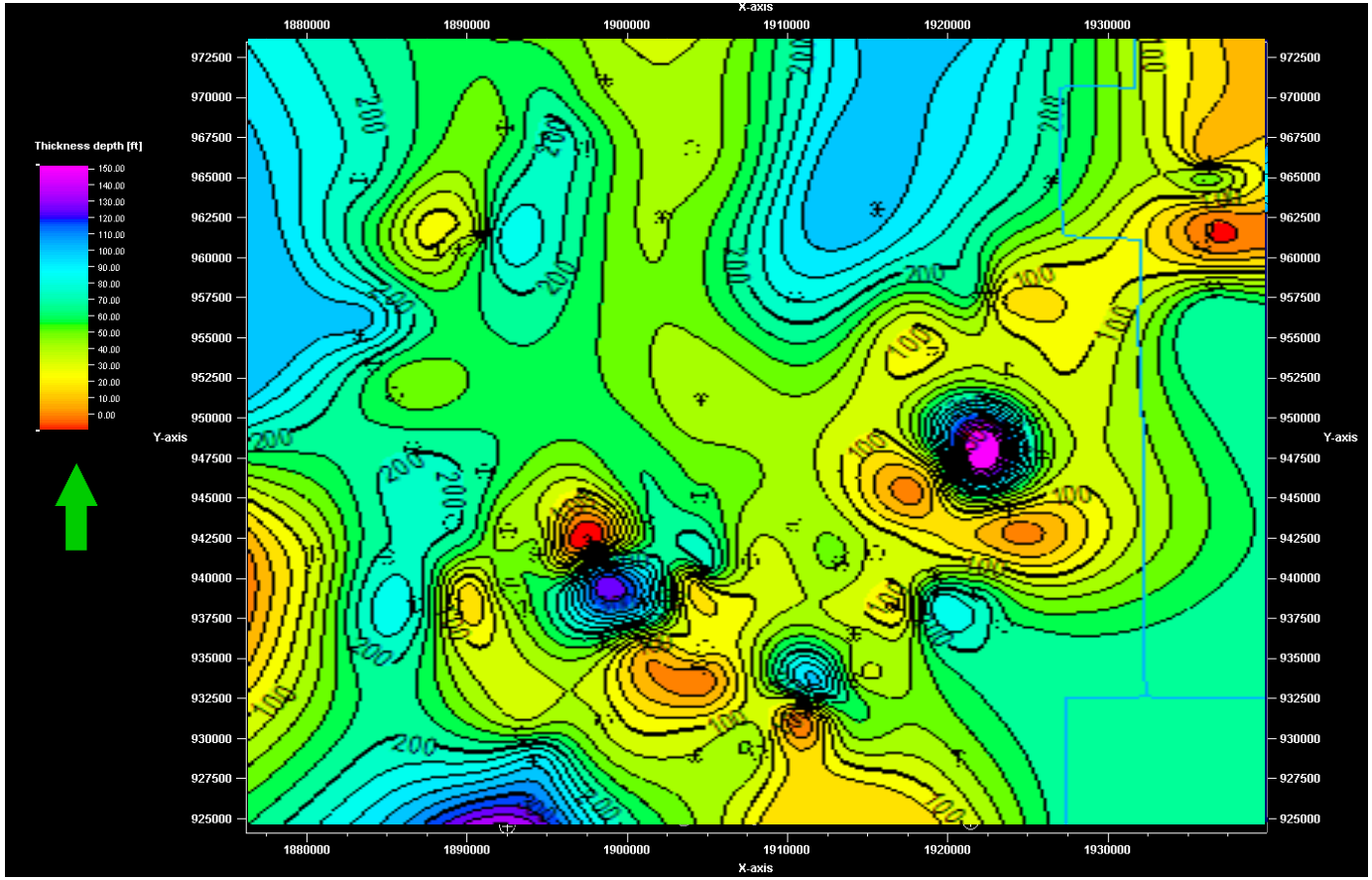
Copper Ridge

MCOF Copper Ridge Total Isopach



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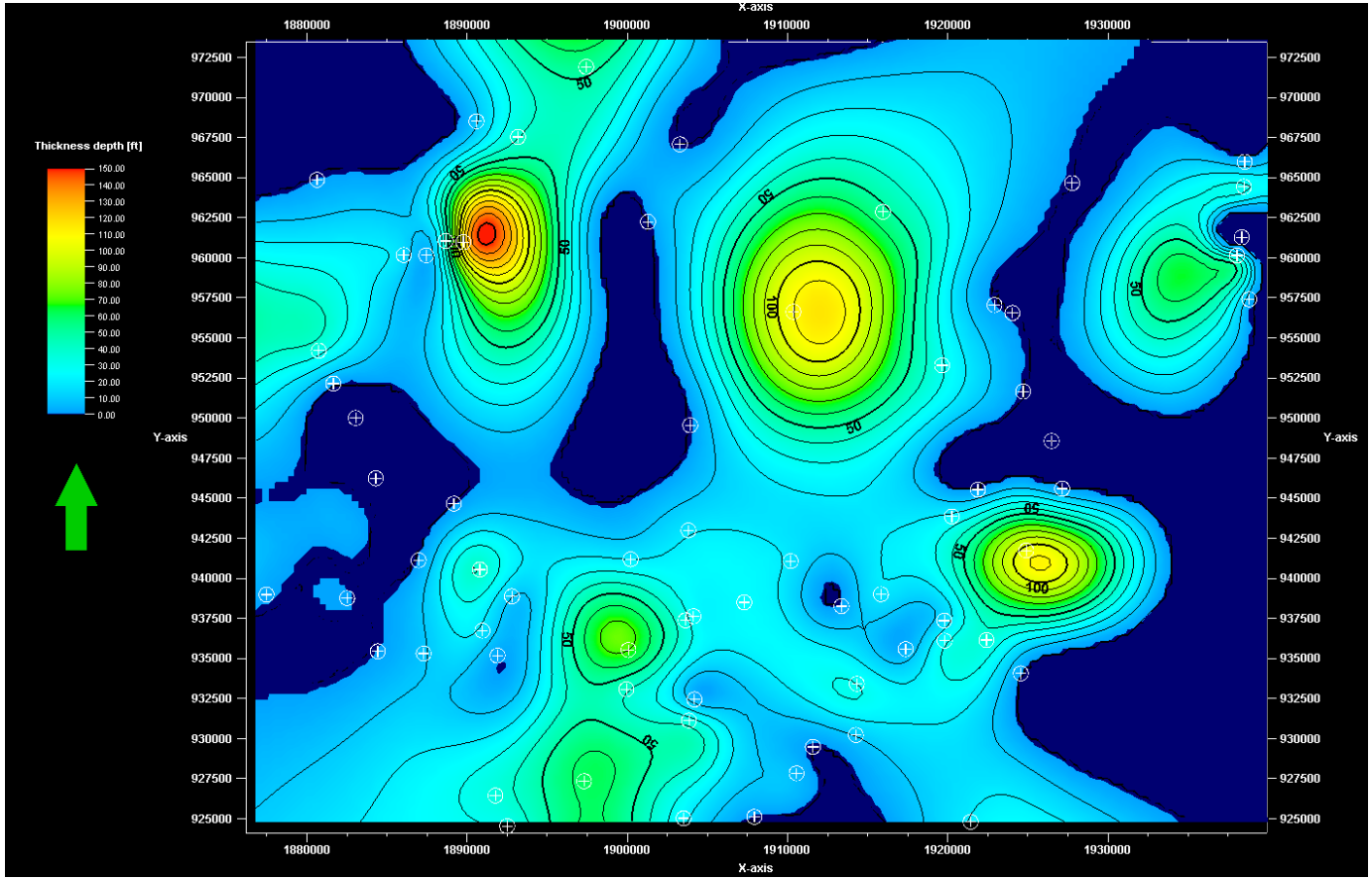
MCOF Copper Ridge Reservoir Isopach



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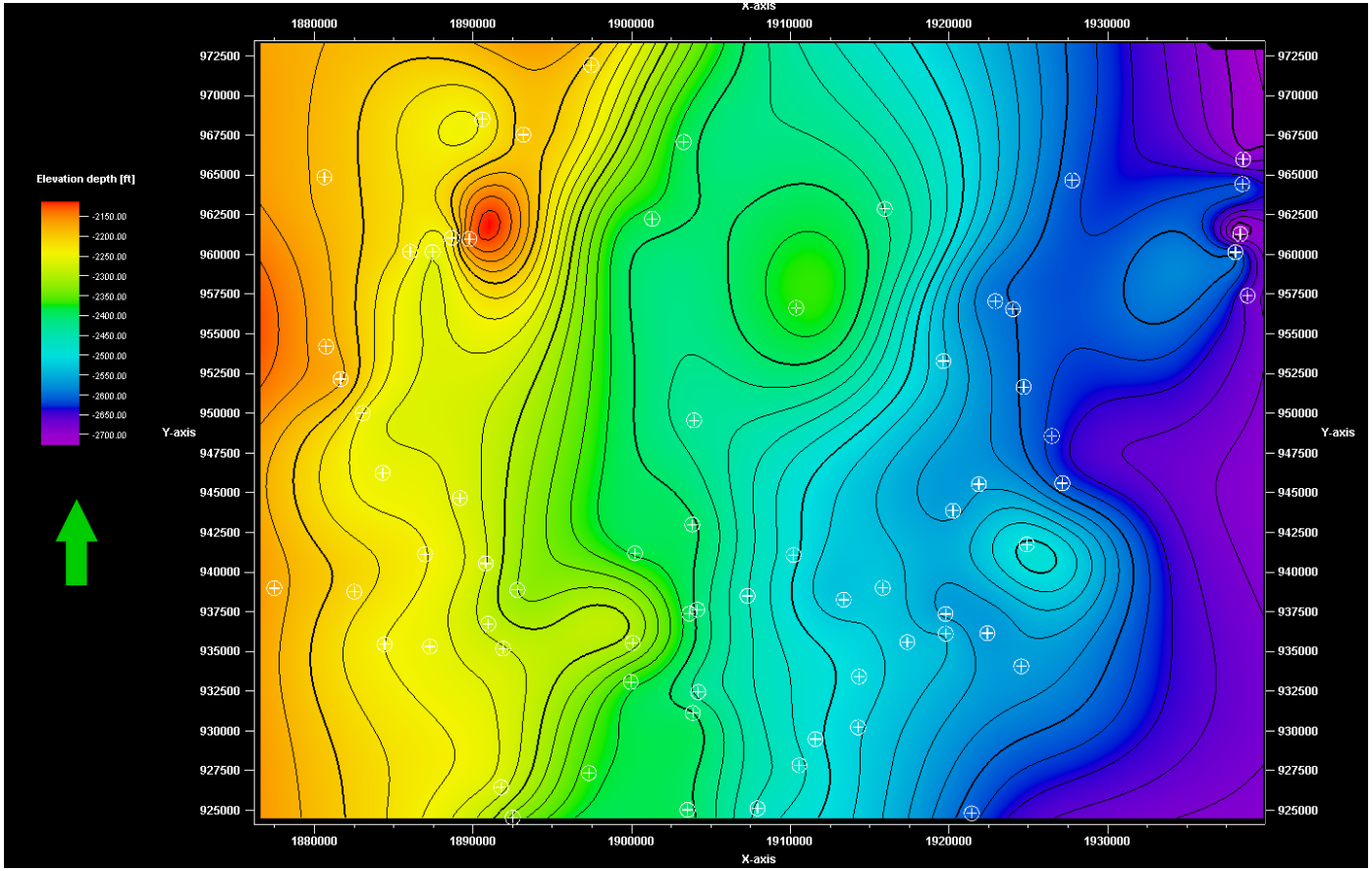
Copper Ridge Petrophysical Averages

	Gross	Net	Net to Gross	Average Porosity	Porosity Feet
Average	113	82	76%	6%	5
Range	3-545	3- 248	30%-100%	3-9%	0-17

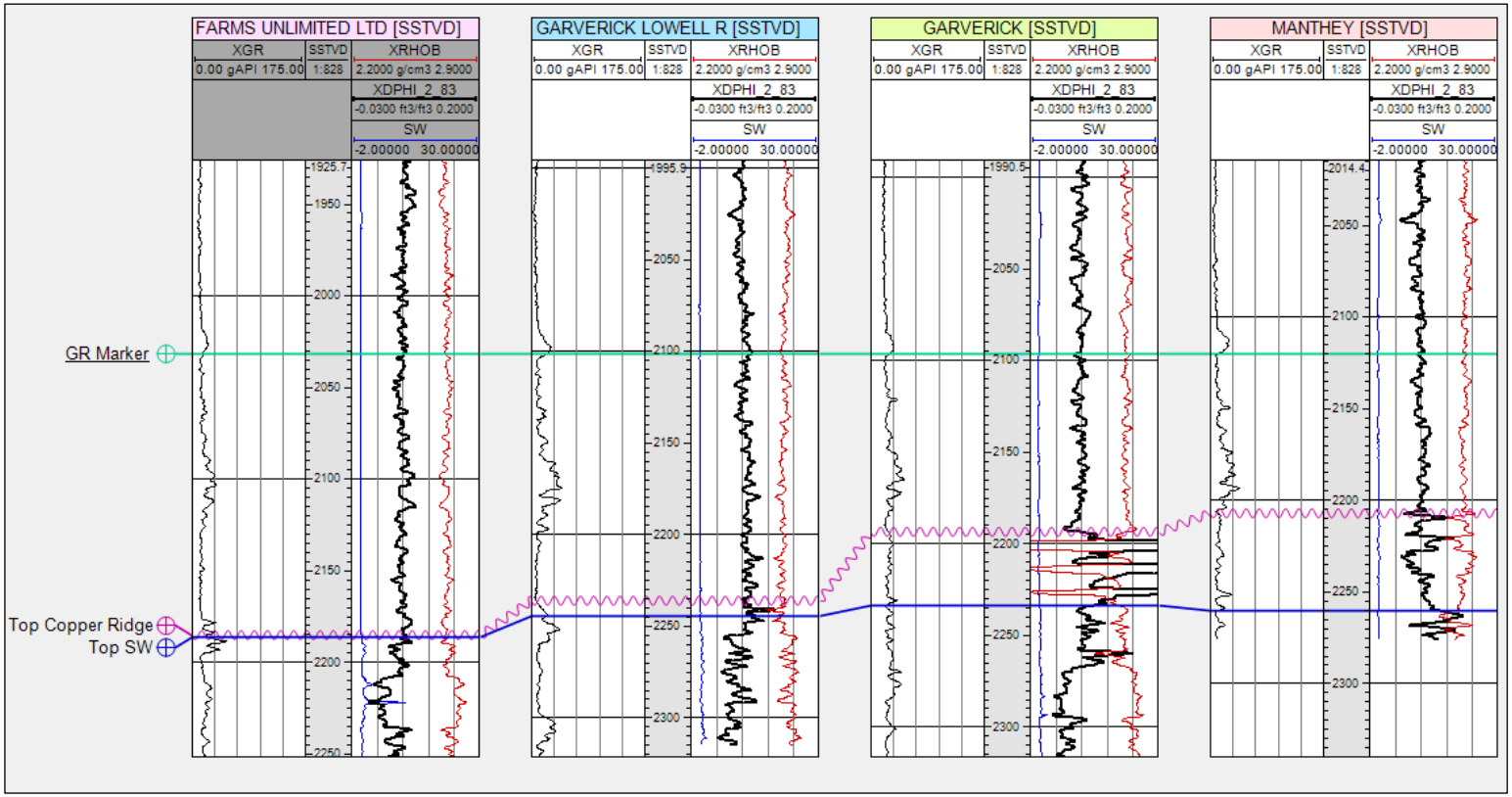
Copper Ridge Petrophysical Averages with Sw Cutoff

	Gross	Net	Net to Gross	Average Porosity	Porosity Feet
Average	35	34	90%	7%	2
Range	3-128	3- 128	0%-100%	3-18%	0-10

MCOF Structural Surface



MCOF Gamma Ray Marker Bed

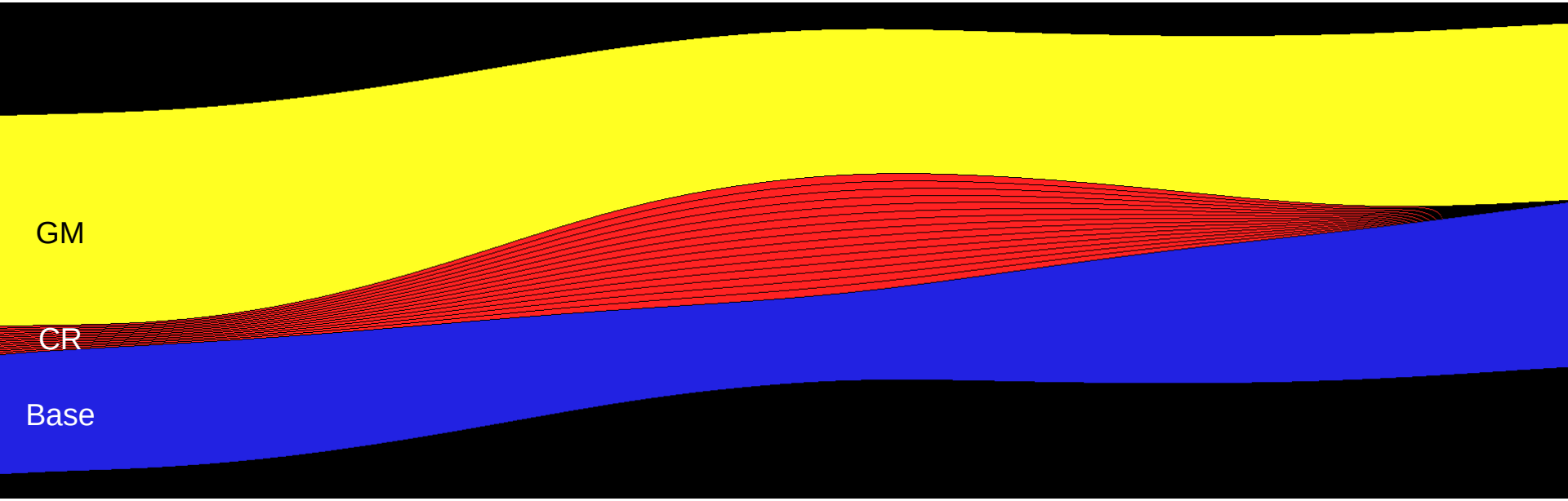


The “GR Marker” is a lithologic marker bed observed on gamma ray-neutron logs in the MCOF (Dolly and Busch, 1972). The marker bed is a 10 ft argillaceous carbonate in the lower portion of the Black River Group. Pick was made at the base of the marker bed (base of the gamma ray signature).

MCOF Zones and Layers

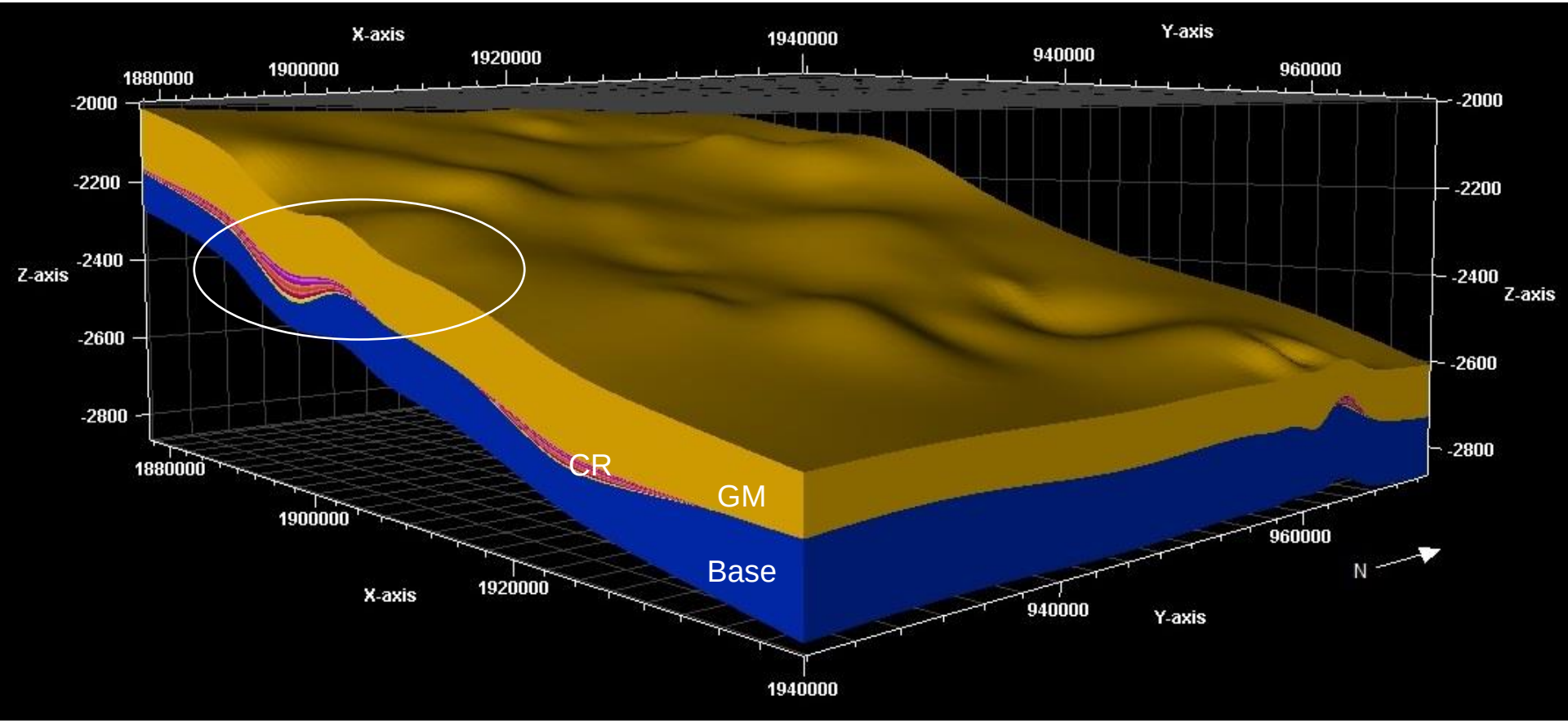
Morrow Consolidated Oil Field		
Zone	# of Layers	Average Layer Thickness (ft)
Gamma Marker	1	131.4
Copper Ridge Reservoir	15	1.7
Base	1	108.6

- 4 horizons, 3 zones, and 17 layers.



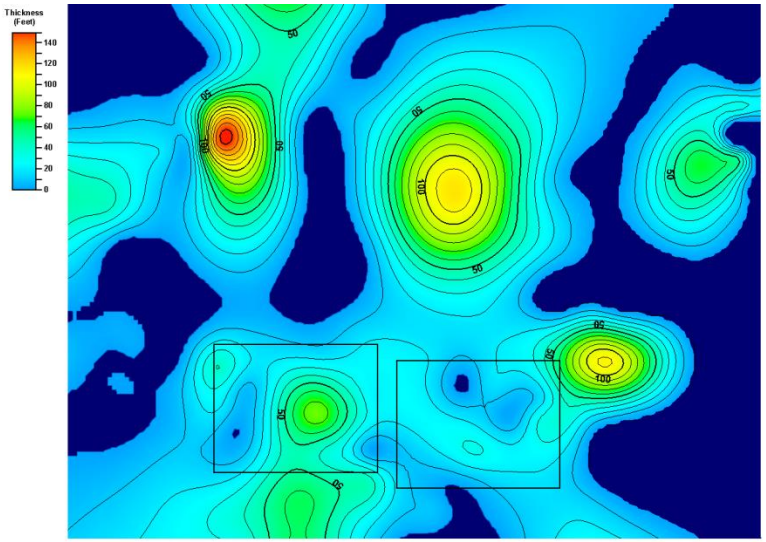
* Copper Ridge Dolomite reservoir in red, water saturated Copper Ridge in blue

Model Surface Incorporating Reservoir Zone

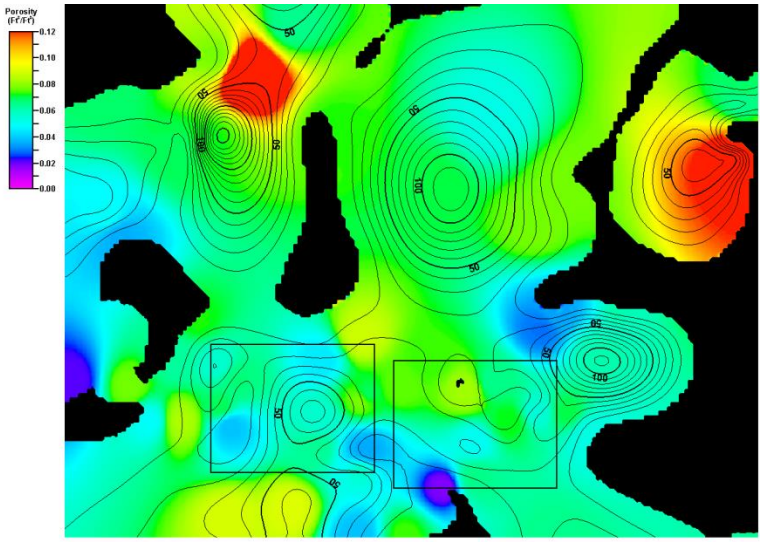


Correlation to Production

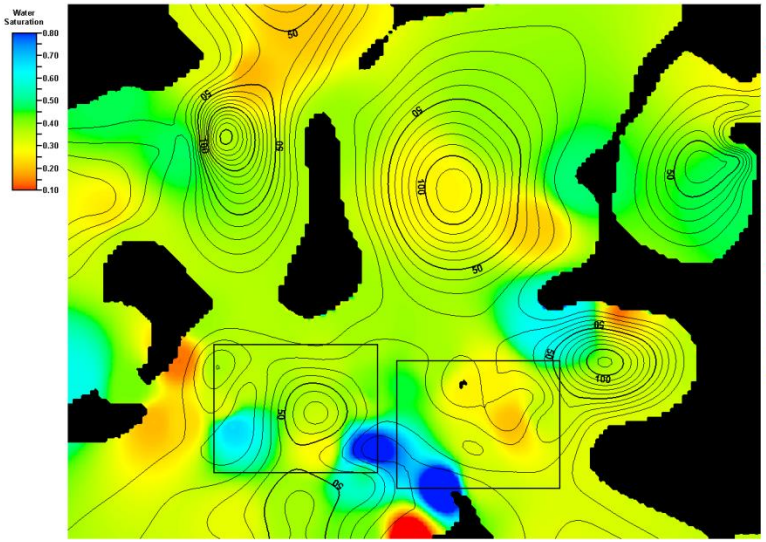
Thickness



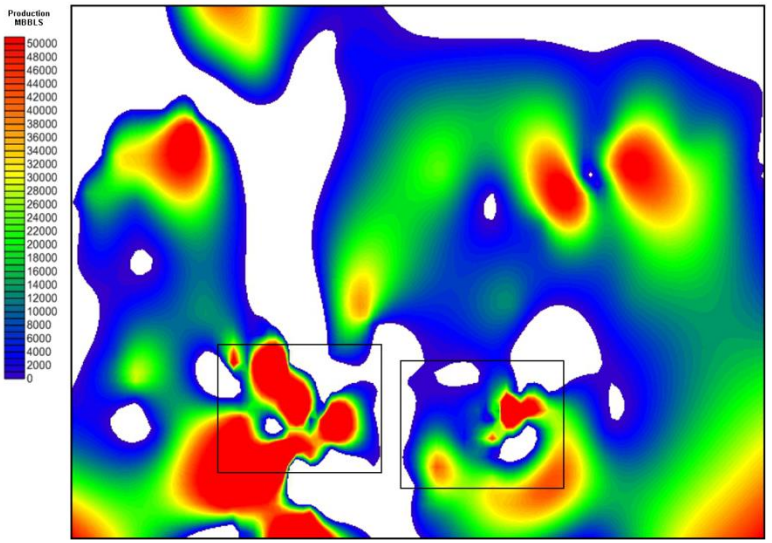
Porosity



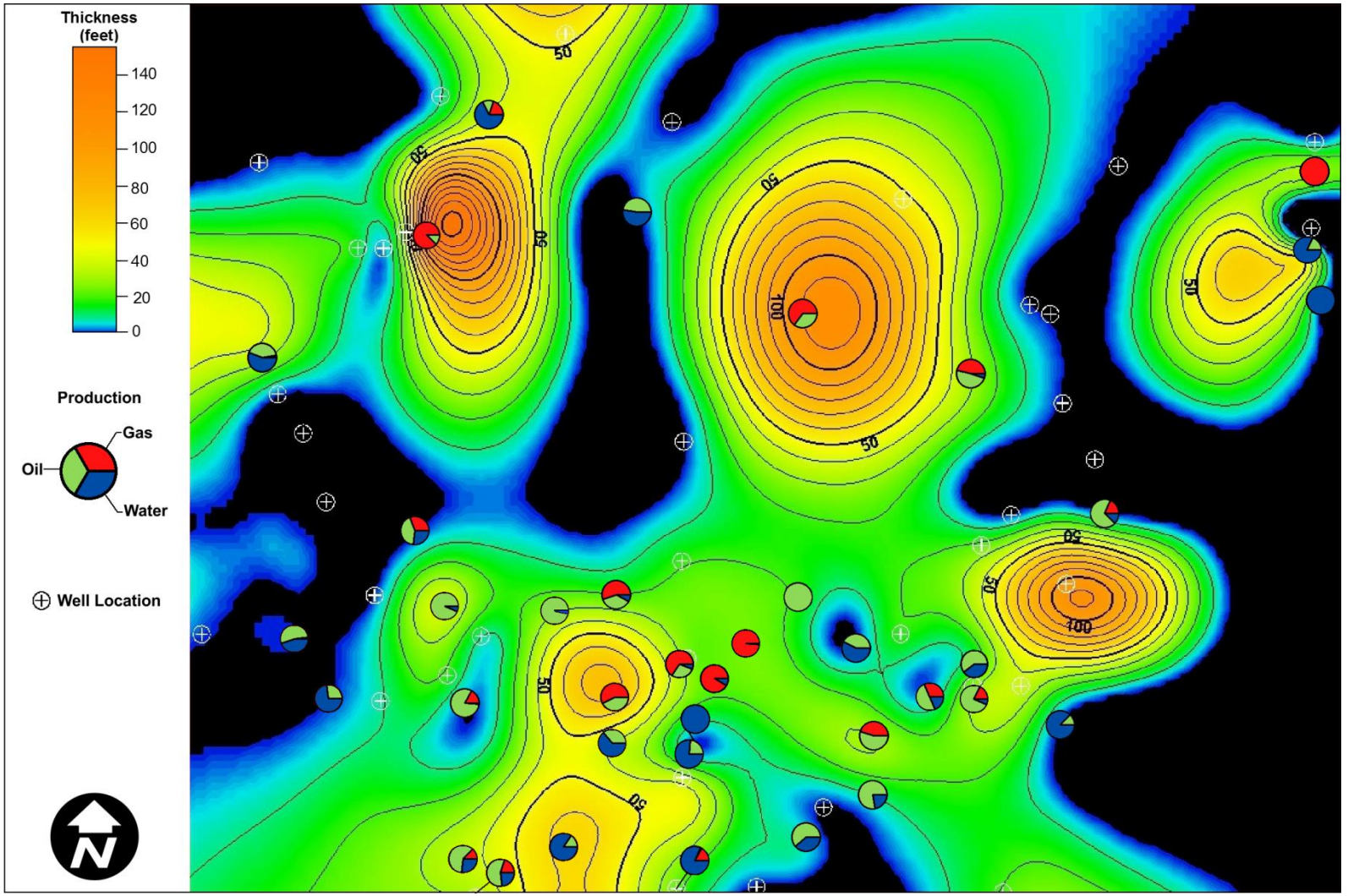
Water Saturation



Production



MCOF Remnant - Production Bubble Map



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