

# History of Structure Contour Mapping in the Appalachian Basin: 1870-1917

James McDonald<sup>1</sup>

Search and Discovery Article #70412 (2022)\*\*

Posted August 20, 2022

\*Adapted from extended abstract based on oral presentation given at 2019 AAPG Eastern Section Meeting, Columbus, Ohio October 12-16.

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<sup>1</sup>ODNR Division of Geological Survey, Columbus, OH, ([james.mcdonald@dnr.ohio.gov](mailto:james.mcdonald@dnr.ohio.gov))

## Abstract

Subsurface structure contours have been used as a method in delineating anticlines since the 1870s. Between 1870 and 1900, there were a handful of geologists and mining engineers who began using map-based depictions of structure contours to show the relationship between anticlines and oil accumulations. These geologists – Benjamin Smith Lyman, John F. Carll, Edward Orton Sr., and Marius Campbell published some of the earliest structure contour maps. The early contributions of these geologists slowly advanced the technique of using structure contours to depict the subsurface geology and aid in the hunt for anticlines.

In 1902, William T. Griswold of the U.S. Geological Survey (USGS) created a technique to map structure contours using plane table and alidade in the Cadiz, Ohio area. This technique was used to identify anticlinal traps for petroleum exploration. Griswold also taught this technique to his geologist colleagues, including Malcolm J. Munn and Frederick Clapp. In 1908, Griswold left the USGS and started one of the first petroleum-geology consulting firms in the world, W.T. Griswold & Company, with his former colleagues Edgar McCrary and Fred Hutchinson. After two years, Griswold left to become the Chief Geologist of the Philadelphia Company. The firm was renamed the Hutchinson & McCrary and was in operation for five years in Marietta, Ohio, until it was dissolved in 1912.

Between 1908 and 1917, more geologists began using structure contours to identify anticlines in the subsurface in the Appalachian Basin. Griswold left the Philadelphia Company to work with Guffey and Gillespie in the Appalachian Basin from the early 1910s through the late 1920s. Between 1908 and 1917, the USGS hired many geologists to replace those who had left government employment for the private sector. These new USGS geologists, such as D.D. Condit, G.S. Rogers, and C.A. Bonine, continued mapping and publishing structure contour maps in the Appalachian Basin up to the beginning of World War 1.

During the 1910s, major oil field discoveries were made in Oklahoma. This brought many people to the Midcontinent to explore for oil, including geologists such as Edgar McCrary and Malcolm Munn, who applied geological techniques. Because these geologists were extremely successful in finding oil, the industry adopted their techniques. Mapping structure contours using plane table and alidade was the practical technique that made the use of geology indispensable to oil and gas exploration.

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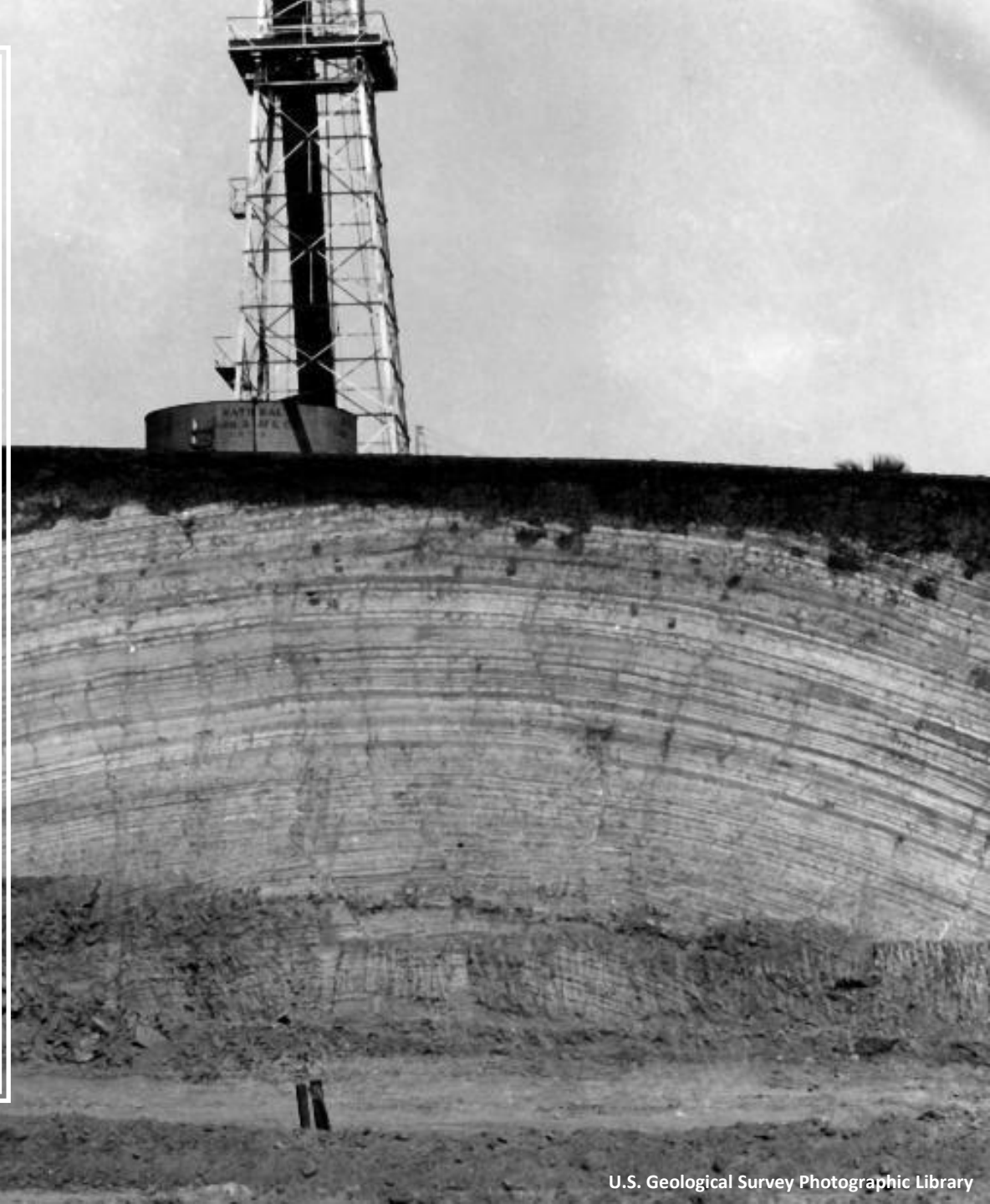
James McDonald  
Ohio Department of  
Natural Resources,  
Division of  
Geological Survey

# History of Structure Contour Mapping in the Appalachian Basin: 1870 – 1917



# Outline

- The Pioneers – 1870-1900
- William T. Griswold – 1900-1912
- Griswold's Colleagues
- Marietta Ohio – 1908-1912
- Tulsa Oklahoma – 1913-1917
- Conclusions





# The Pioneers 1870-1900

- The Theorists

- S.P. Hildreth
- T. Sterry Hunt
- E.B. Andrews
- I.C. White

- The Mappers

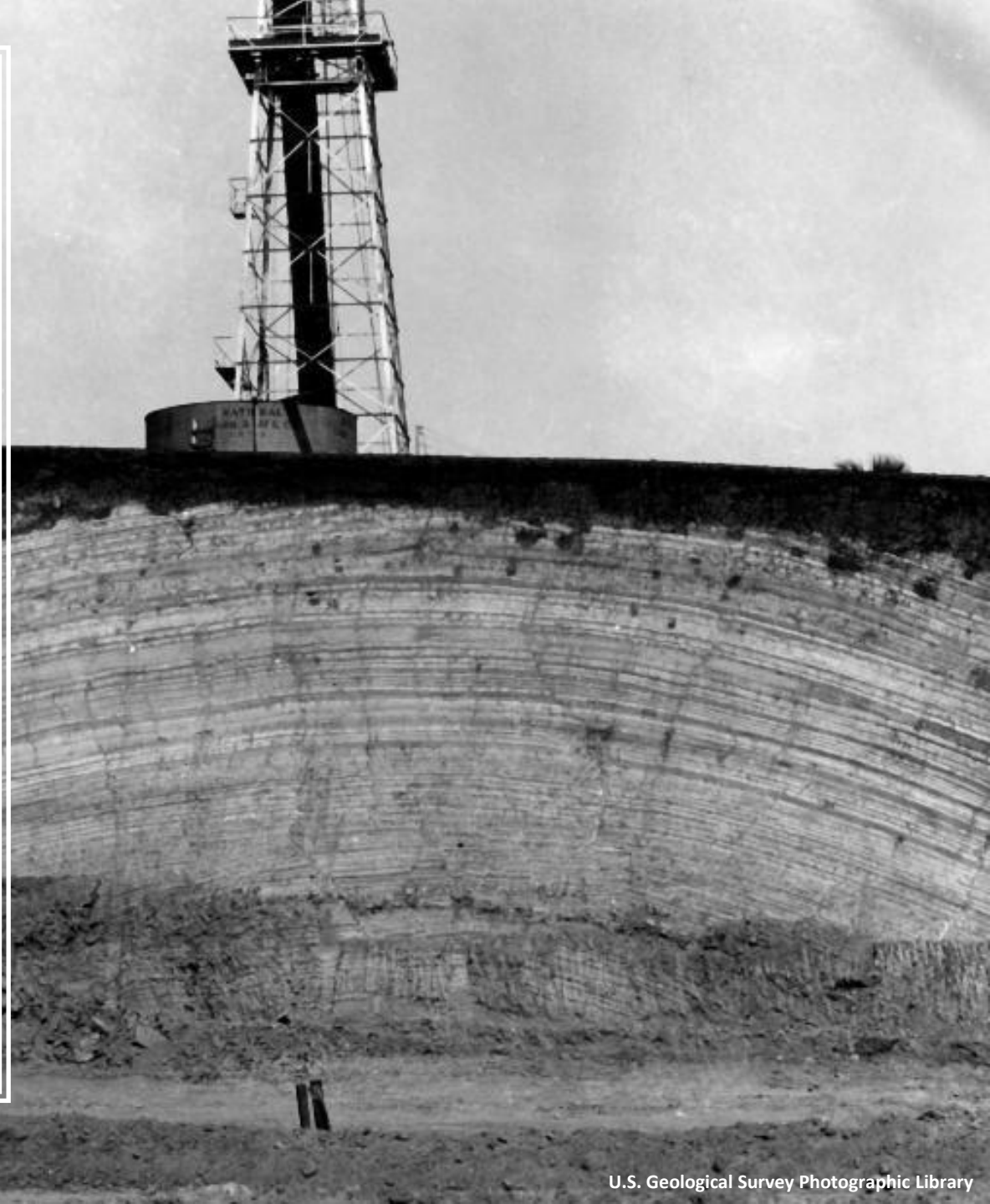
- Benjamin Smith Lyman
- John F. Carll
- Edward Orton, Sr.
- Marius R. Campbell





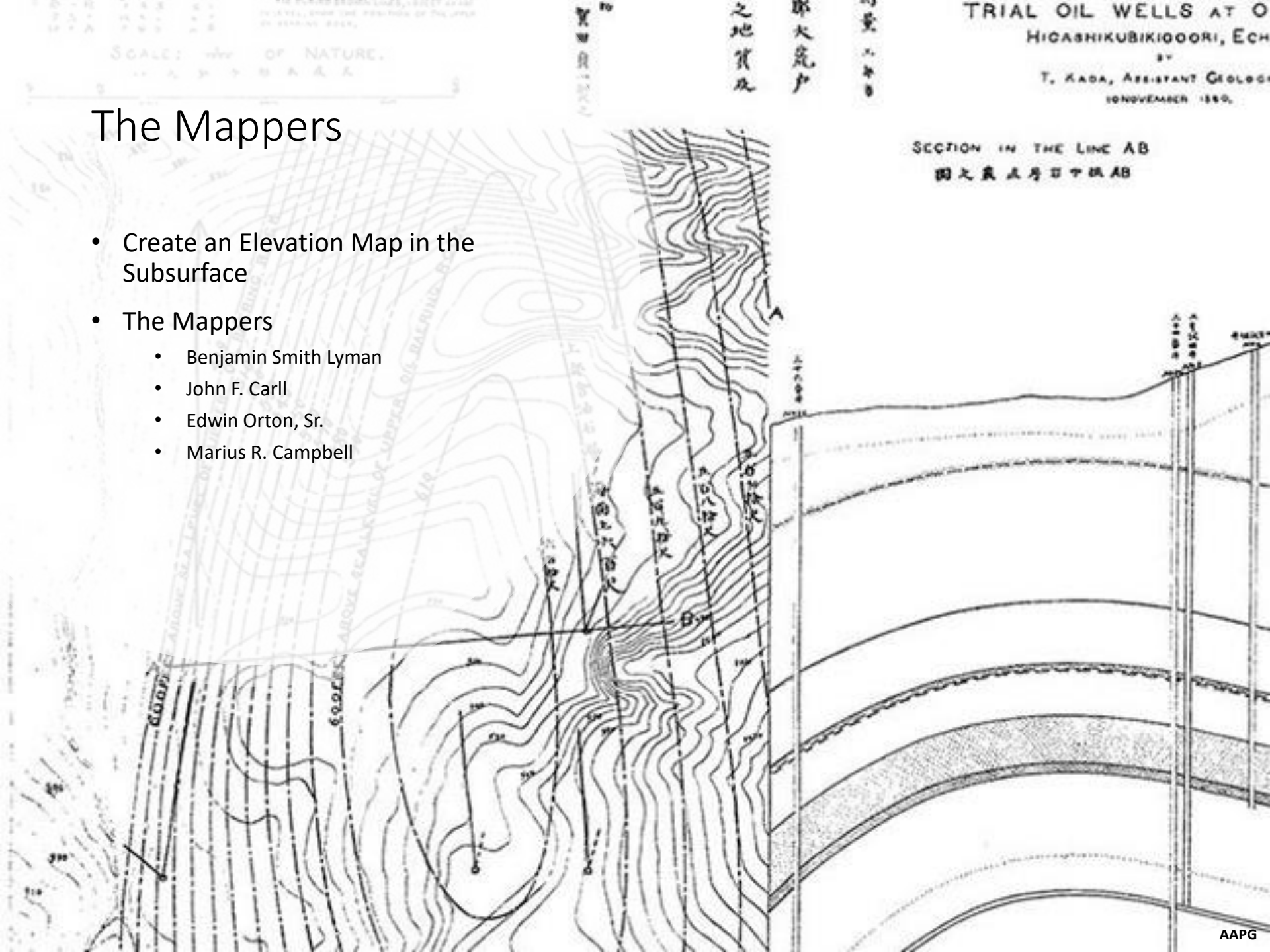
# The Theorists - Anticlinal Theory of Oil Accumulation

- Many Competing Theories
- Anticlinal Theory
- The Theorists
  - S.P. Hildreth, 1836
  - T. Sterry Hunt, 1859
  - E.B Andrews, 1861
  - I.C. White, 1885



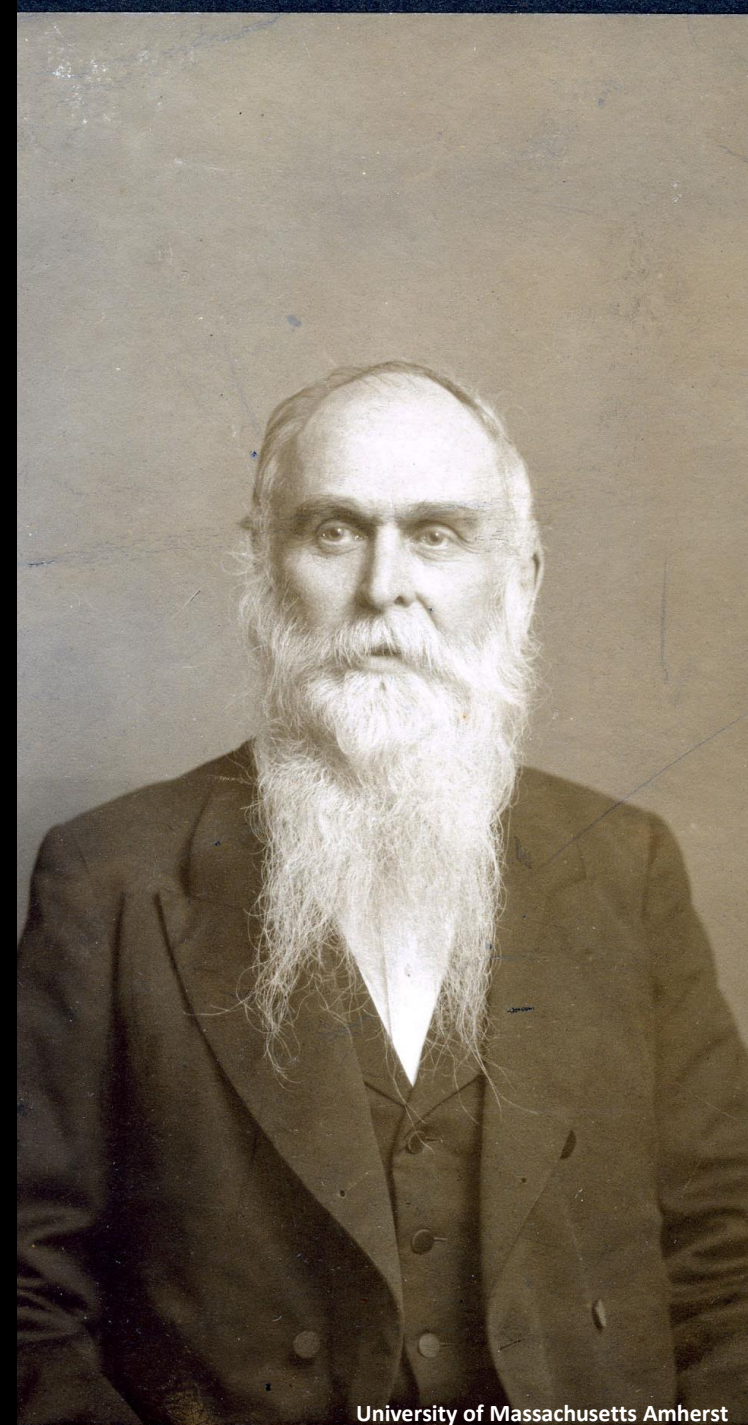
# The Mappers

- Create an Elevation Map in the Subsurface
- The Mappers
  - Benjamin Smith Lyman
  - John F. Carll
  - Edwin Orton, Sr.
  - Marius R. Campbell



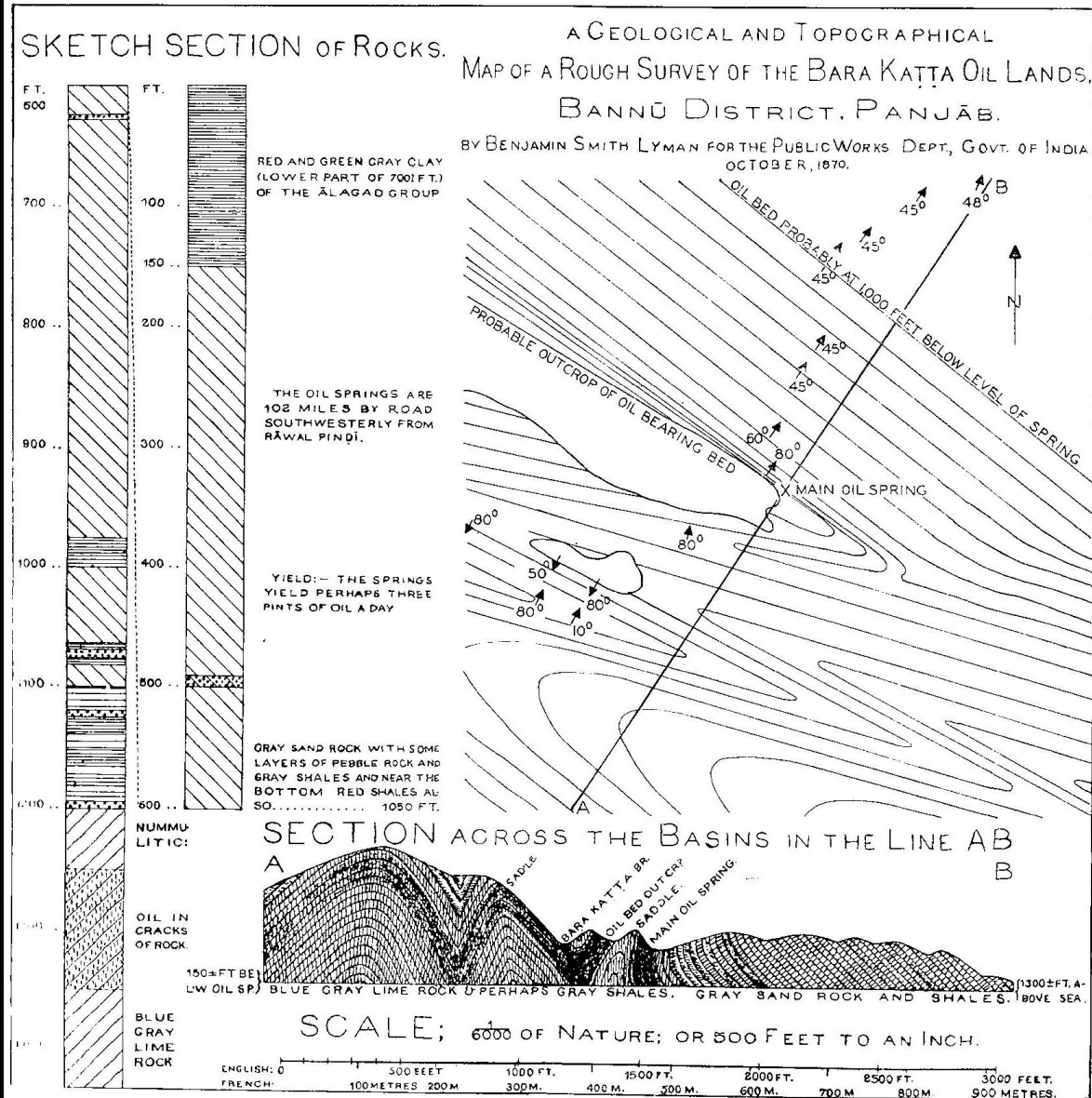
# Benjamin Smith Lyman 1835-1920

- Mining Engineer, Philadelphia, PA
- Attended Ecole Imperiale des Mines
- Broad Top Coal Field, PA
  - J. Peter Lesley, His Uncle and Future State Geologist of Pennsylvania
- Worked in India, Japan, Pennsylvania, Nova Scotia, Arizona, California
- Created 1<sup>st</sup> Structure Contour Map for Oil Exploration – 1870



# Map of a Rough Survey of the Bara Katta Oil Lands

- 1870 - 1<sup>st</sup> Structure Contour Map Created for Oil Exploration
- Bannu District, Panjab, India
- Created for the Public Works Department, Government of India

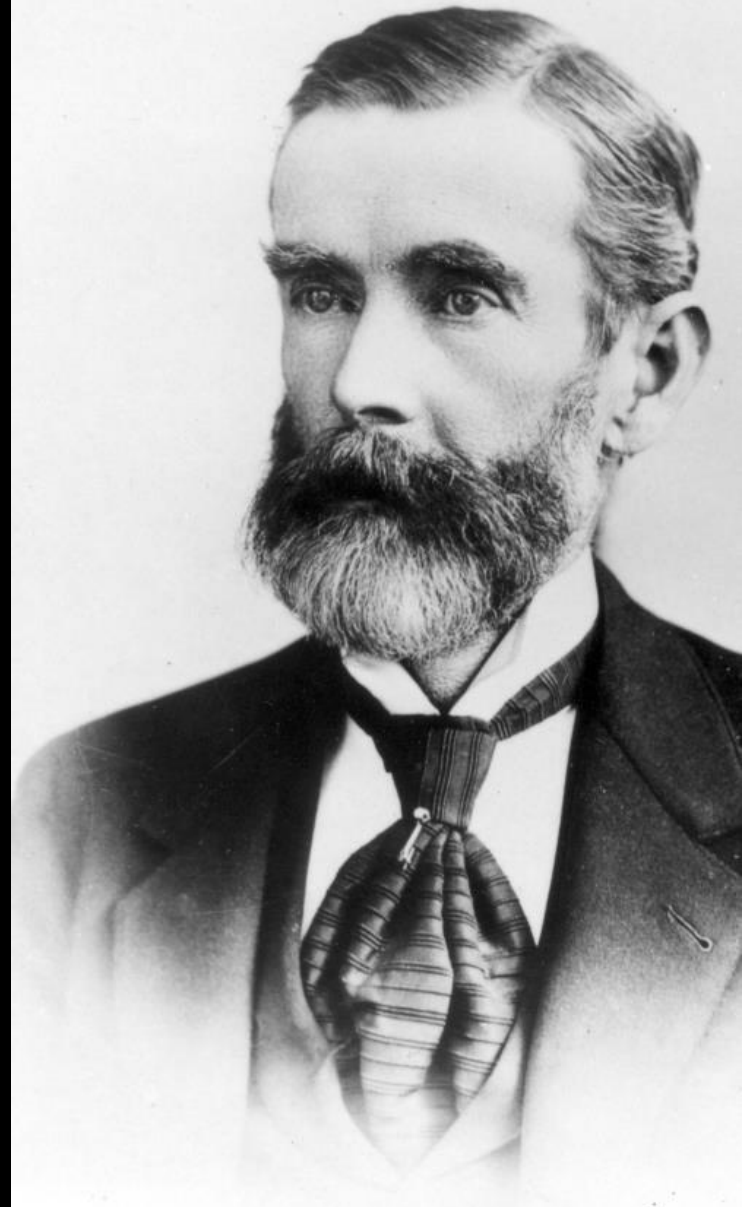




# John F. Carl

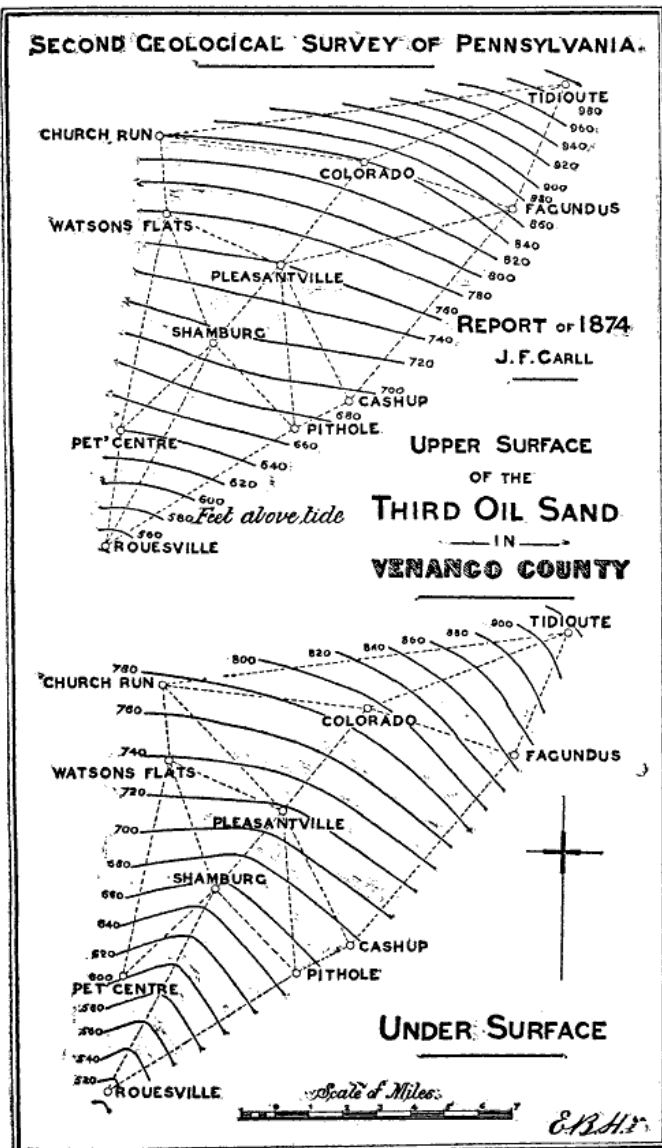
## 1828-1904

- Considered to be the 1<sup>st</sup> Petroleum Geologist
- Born Brooklyn New York
- Geologist for the Geological Survey of Pennsylvania – 1874
  - Appointed by J. Peter Lesley
- 1<sup>st</sup> Structure Contour Maps in the Appalachian Basin in 1875



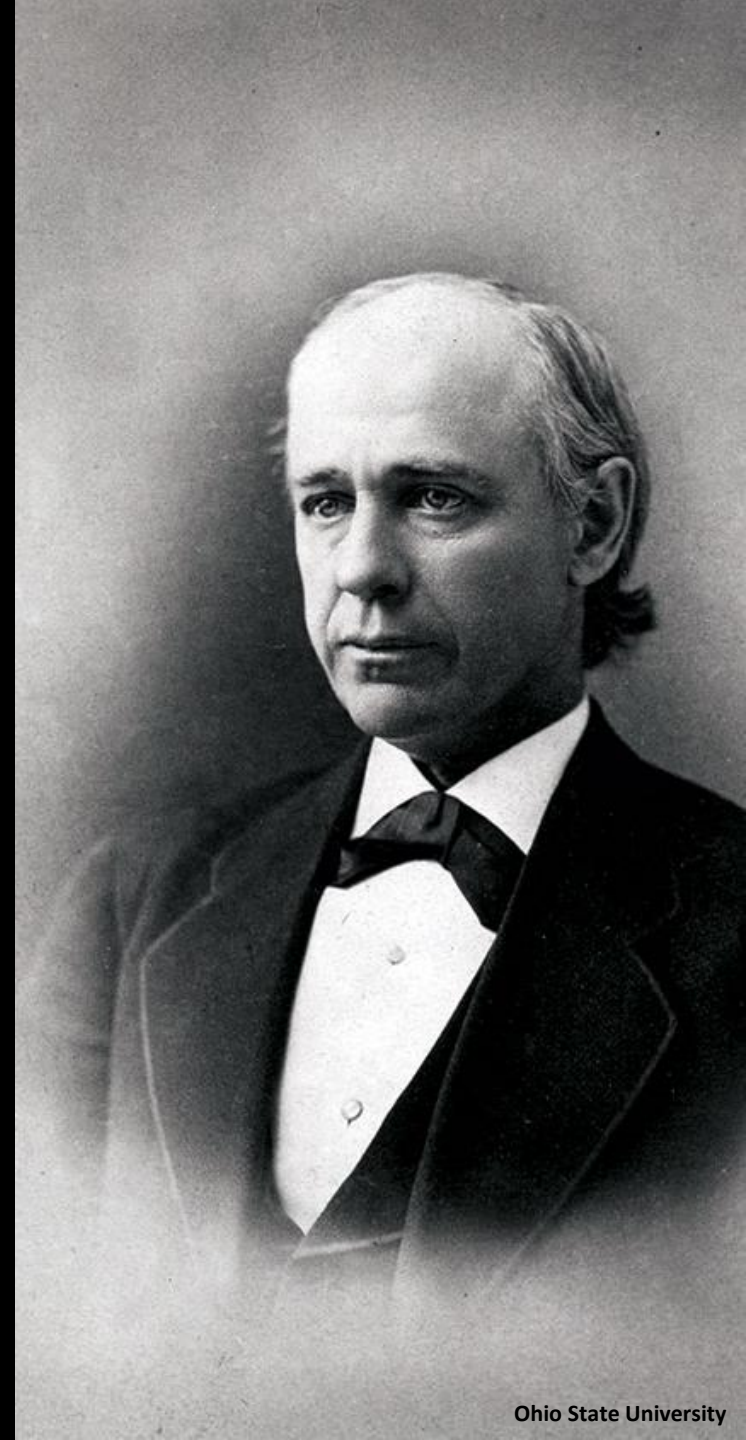
# Third Oil Sand, Venango County

- 1<sup>st</sup> Structure Contour Maps in the Appalachian Basin
- Published in the Report of Progress in the Venango County District, 1875



# Edward Orton, Sr. 1829-1899

- 1<sup>st</sup> President of The Ohio State University – 1873-1881
- Professor of Geology – 1873-1899
- State Geologist – 1882-1899
- Geology of the Trenton Limestone Oil and Gas Fields – 1889



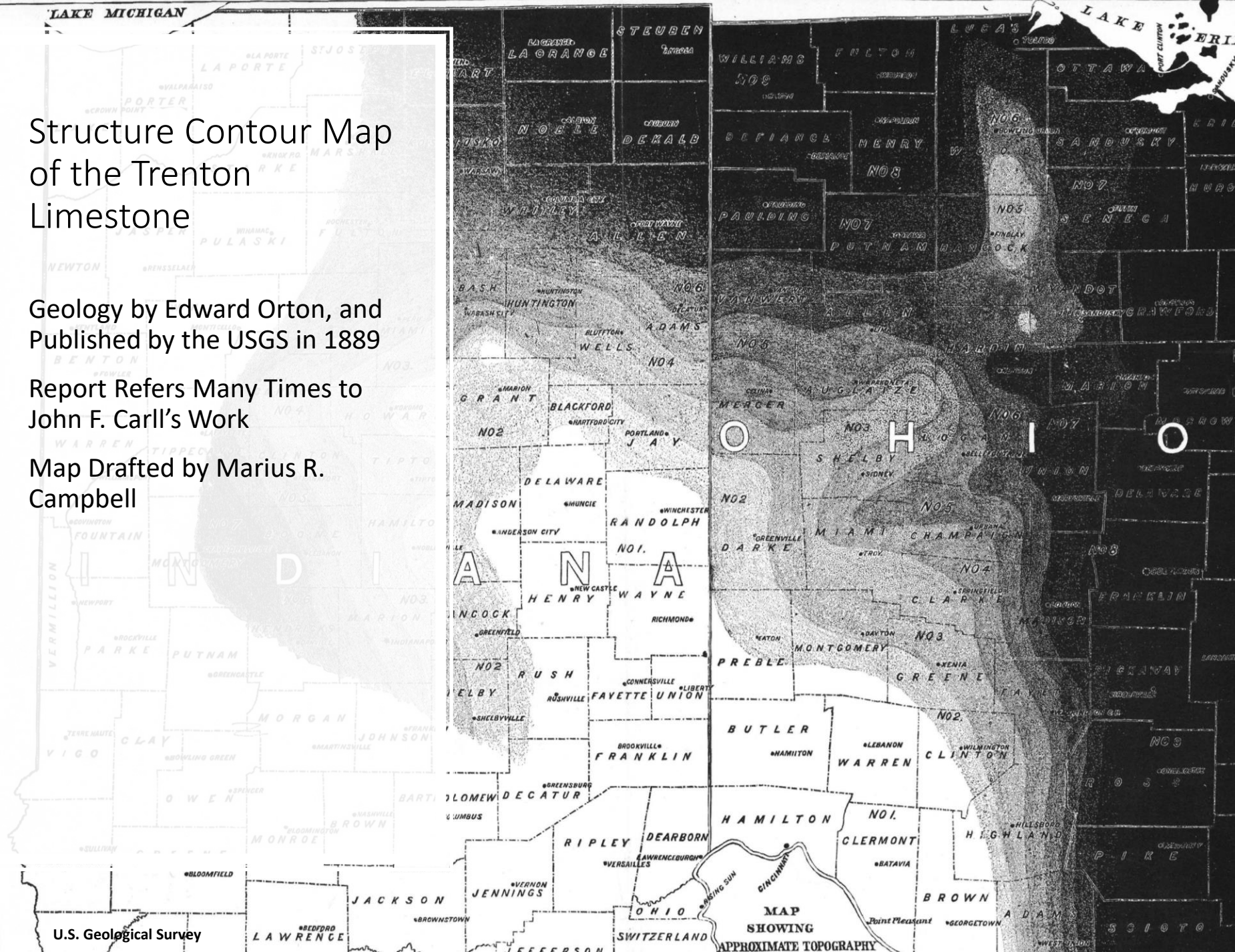


# Structure Contour Map of the Trenton Limestone

Geology by Edward Orton, and  
Published by the USGS in 1889

Report Refers Many Times to  
John F. Carll's Work

Map Drafted by Marius R.  
Campbell





# Marius R. Campbell

## 1858-1940

- Born Garden Grove Iowa, Raised in Cleveland Ohio
- Attended Ohio State University
- Drafted Trenton Limestone Map
- Senior Geologist with the USGS
- AAPG Honorary Member



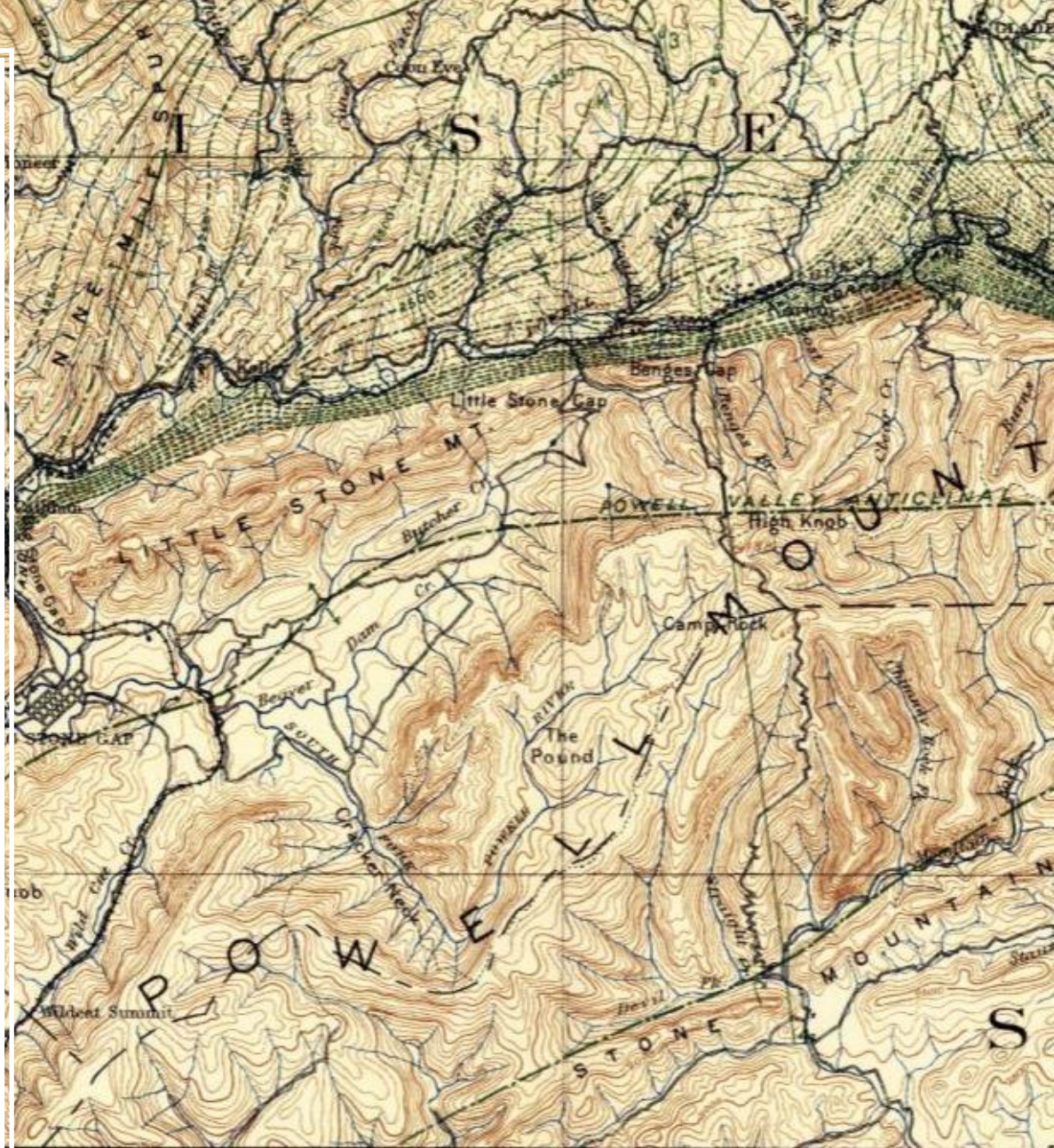
# Contour Map of the Upper Surface of the Gladeville Sandstone

Geology by Marius R. Campbell, 1893

Structure Contour Map for Coal Exploration

None of the previous maps were used to explore for oil

- Covered Too Large of an Area
- Too General/Not Detailed
- Possibly Not Cost Effective



AXES OF FOLDS  
CONTOURS BELOW THE SURFACE  
" ABOVE " "

CONTOUR MAP OF THE UPPER SURFACE OF THE GLADEVILLE S  
BY  
MARIUS R. CAMPBELL.



# William T. Griswold

## 1859-1931

- Columbia School of Mines, C.E. 1881
- Topographer, USGS, 1883-1901
  - Assigned in 1900 to the Ohio Cooperative Topographic Mapping Program – Cadiz Ohio
- Geologist, USGS, 1901-1908
- W.T. Griswold & Associates, 1908-1909
- Chief Geologist, Philadelphia Company, 1909-1917
- Independent Geologist, 1917-1927



UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

THE

BEREA GRIT OIL SAND

IN THE

CADIZ QUADRANGLE, OHIO

BY

W. T. GRISWOLD



WASHINGTON

GOVERNMENT PRINTING OFFICE

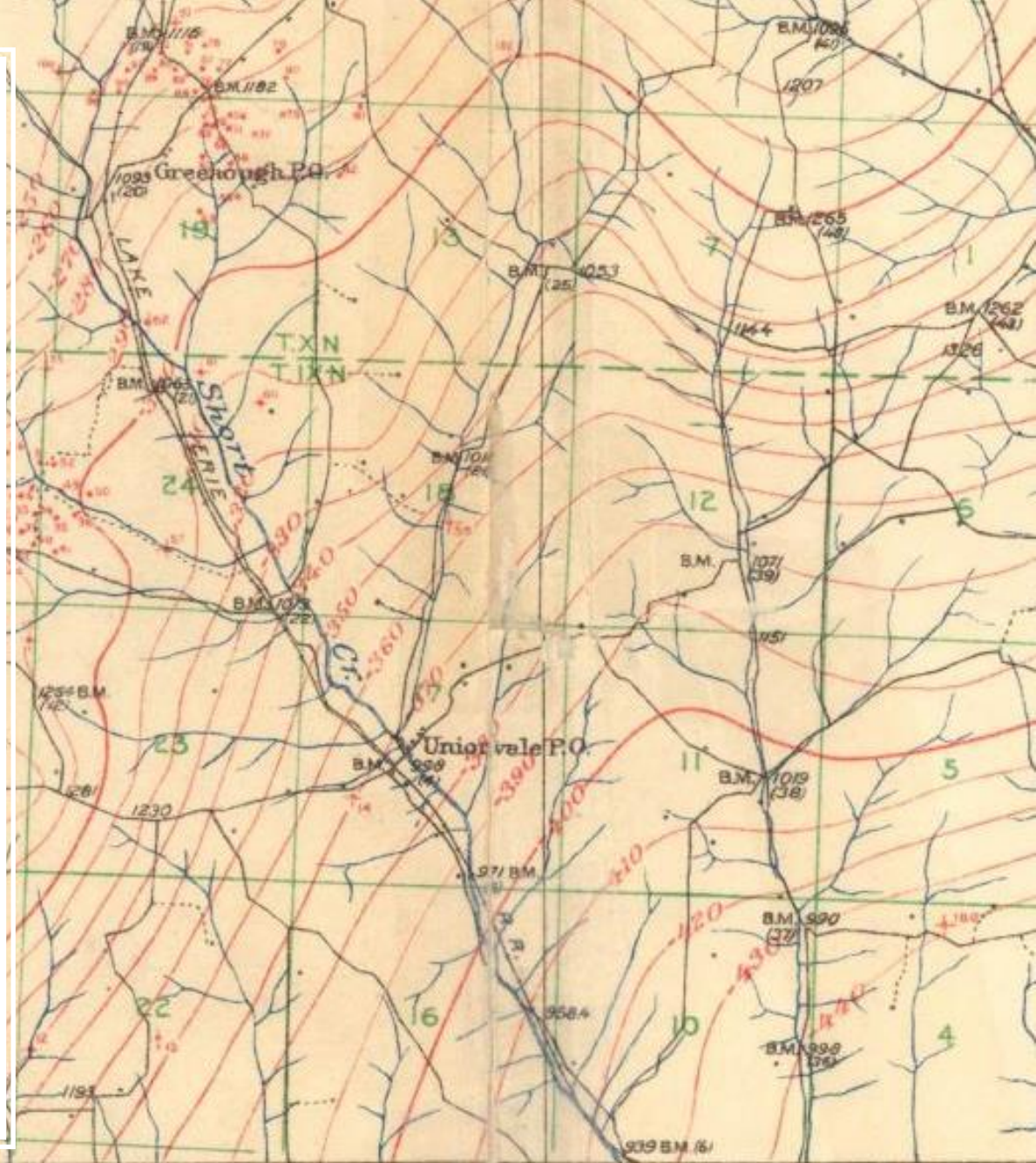
1902

# Mapping Structure Contours

- Structure Contours
  - Use Existing Topographic Maps as Control
  - Mapped Elevations of the Outcrops
  - Mapped the Well Locations
  - Created a Structure Contour Map of the shallow Pittsburgh coal bed
- Projecting Surfaces
  - Interval Thickness Map – Convergence Sheet
  - Subtracted the Interval Map from the Shallow Structure – Created Structure Contour Map of the Berea Sandstone

# Berea Structure Contour Map

- USGS Bulletin 198 - Berea Grit Oil Sands, Cadiz, Ohio Quadrangle, 1902
- Easy, Cost Effective, and Detailed
- Mapped the Deeper Sands, with Limited Data, No Outcrops
- Innovative/Revolutionary Method – Imaging the Subsurface
- Taught the Technique to His Colleagues



# Malcolm J. Munn

## 1874-1949

- Attended University of Arkansas, 1894-1898
- USGS Geologist, 1899-1912
  - Worked with Griswold
- Chief Geologist, Gypsy Oil, 1913-1918
- Consultant/Riverland Company, 1918-1919
- Munn Brothers, 1920-1949
- AAPG Founder





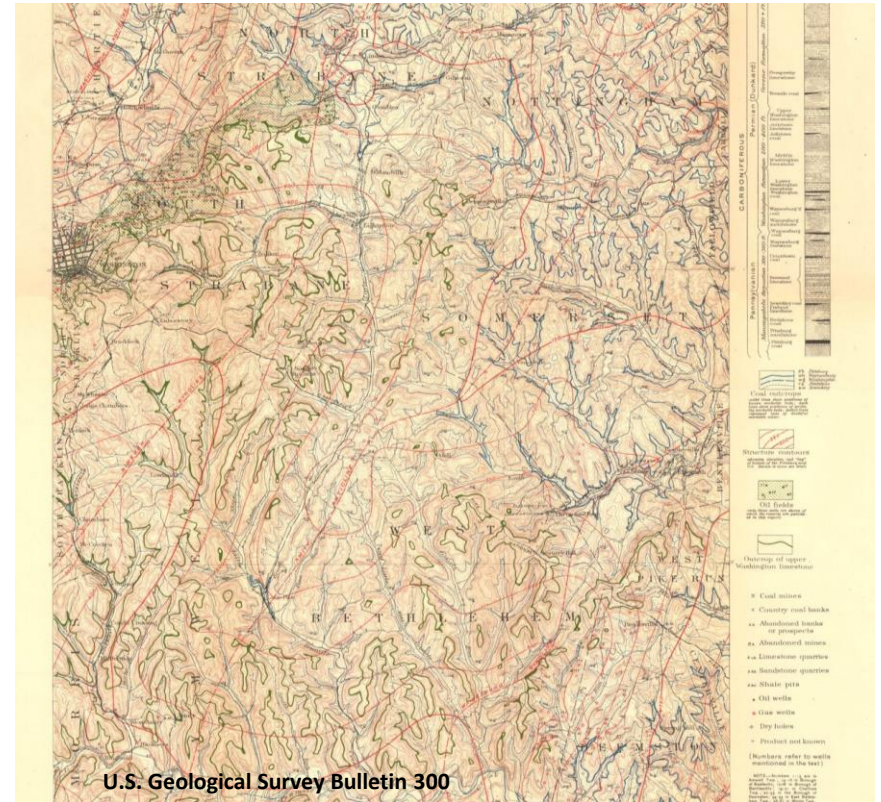
# Edgar W. McCrary

## 1878-1976

- Attended University of Arkansas 1900-1904
- Topographer/Geologist, USGS, 1904-1907
  - Worked for Griswold
- Geologist, W.T. Griswold & Associates, 1908-1909
- Co-Owner & Geologist, Hutchinson & McCrary, 1910-1912
- Chief Geologist, Guffey & Gillespie and Tidewater Osage, 1913-1924
- AAPG Founder

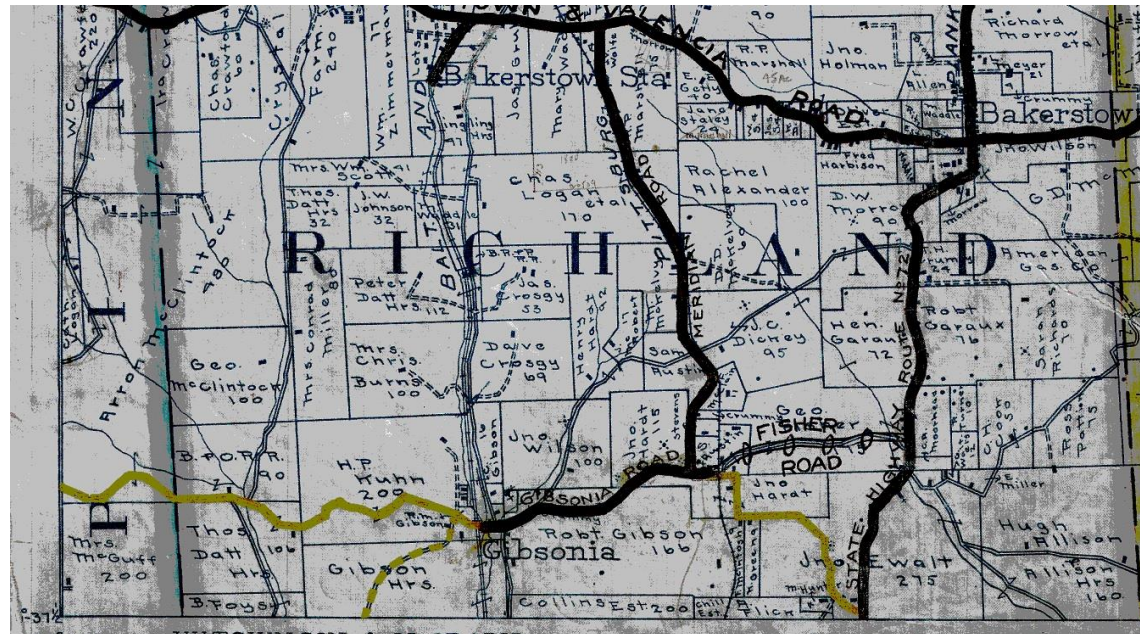
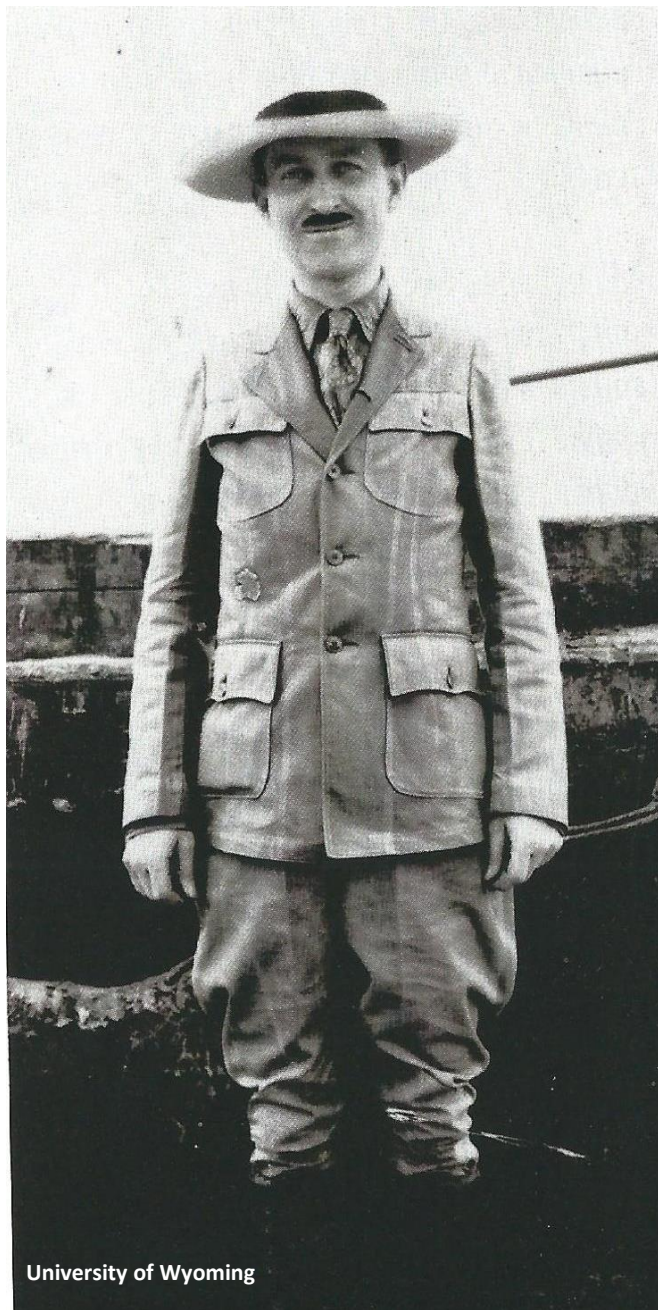


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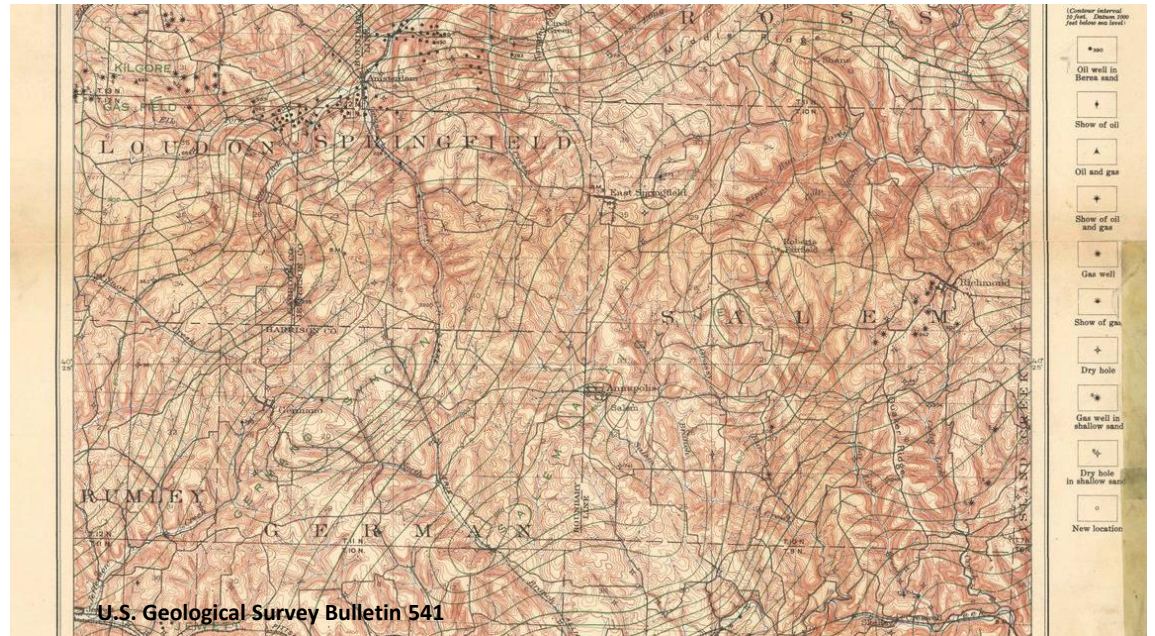
# Frederick Gardner Clapp





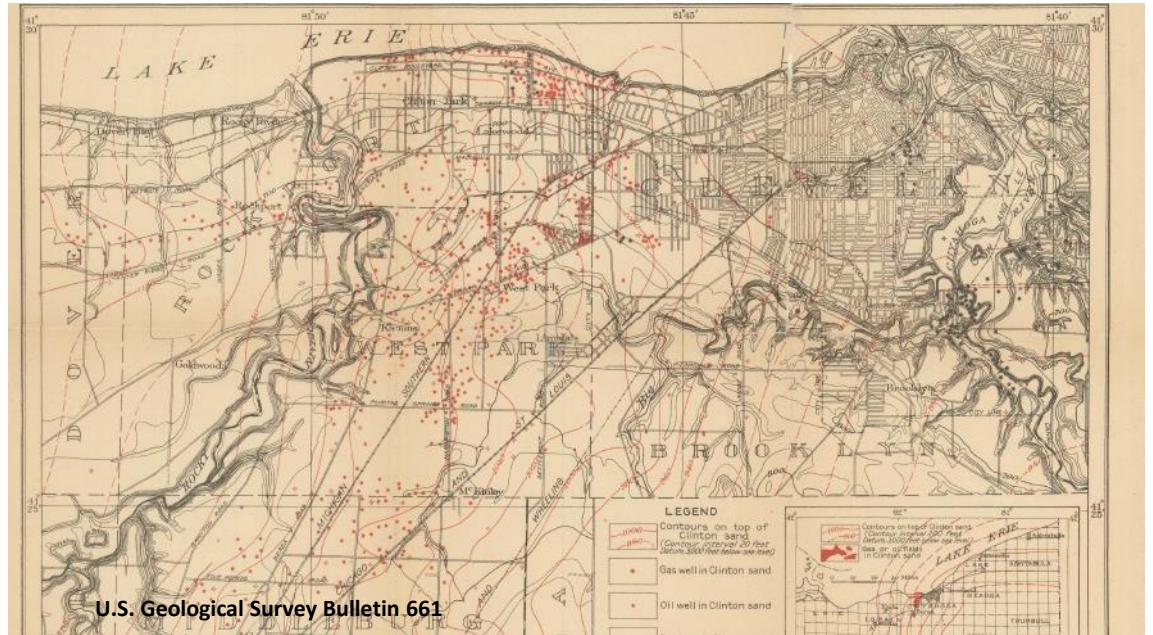
Kessick D. White





# D. Dale Condit

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# Gaillard Sherburene Rogers



# Marietta Ohio – 1908-1912

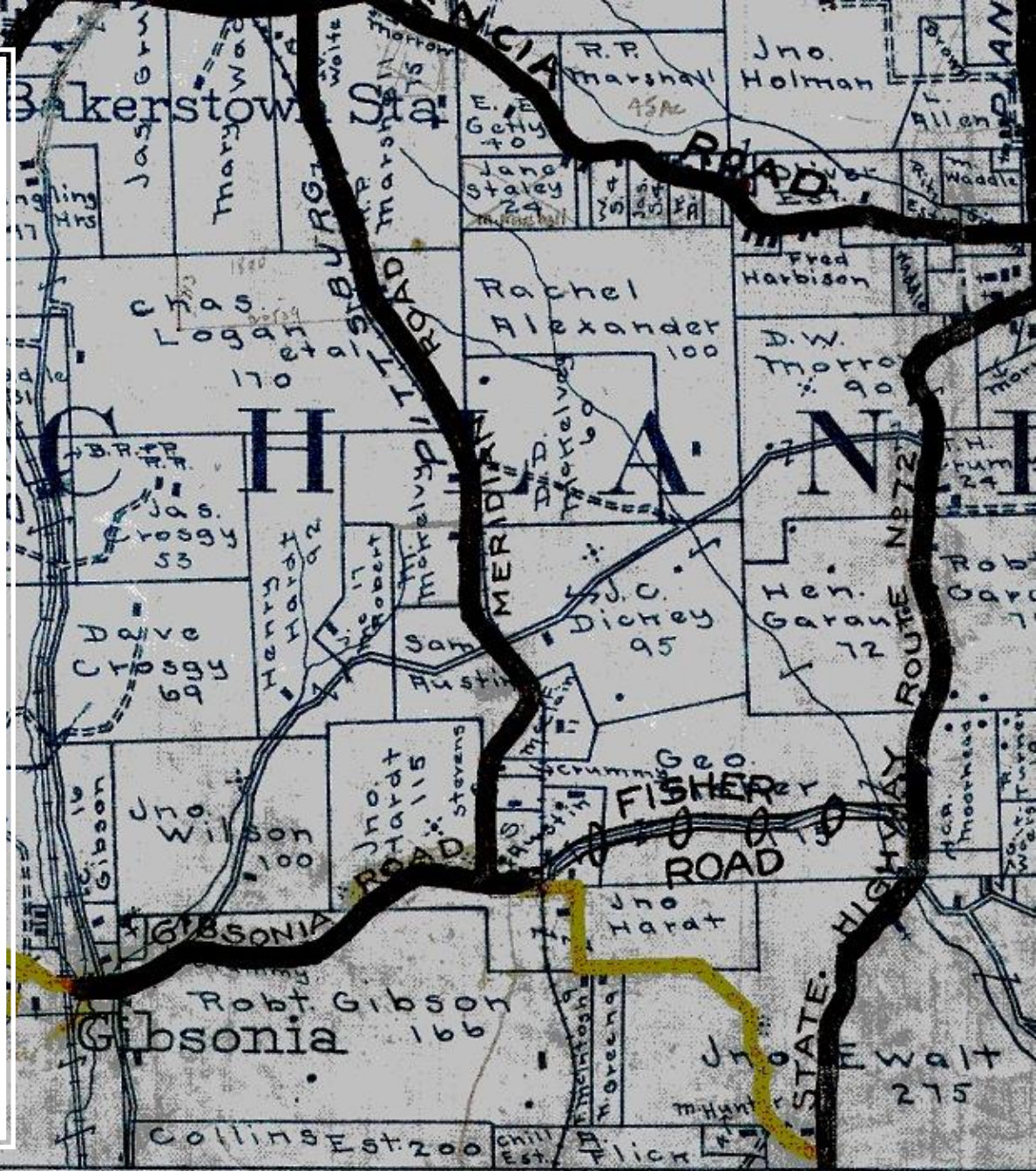
- One of the 1<sup>st</sup> Consulting Oil Exploration Companies
  - W.T. Griswold and Associates – 1908-1909
  - Hutchinson & McCrary – 1910-1912
- Clients
  - Philadelphia Company
  - Guffey & Gillespie Oil Company
  - Kentucky Geological Survey
- Standard Products
  - Structure Contour Maps of Oil Producing Horizons
  - Farm Line Maps with Well Locations





# Farm Line Map

- New Kensington Quadrangle-NW
  - 1 inch = 2000 feet (1:24,000-scale)
  - Published 1912, Marietta Ohio by Hutchinson & McCrary
- One of the Standard Products
  - Farm lines
  - Well Locations
- Used for Leasing







# Tulsa Oklahoma - 1913

- McCrary to Tulsa Oklahoma – January 1, 1913
  - 1<sup>st</sup> Geology Department
  - Guffey & Gillespie Oil Company
  - One of his employees was J. Elmer Thomas, 1<sup>st</sup> President of AAPG
- Munn to Tulsa Oklahoma – July 1913
  - 2<sup>nd</sup> Geological Department
  - Gypsy Oil Company (Gulf Oil)/ Mellon Family
- Cities Services started Geology Department in August 1913

# Everett Carpenter

## 1884-1968

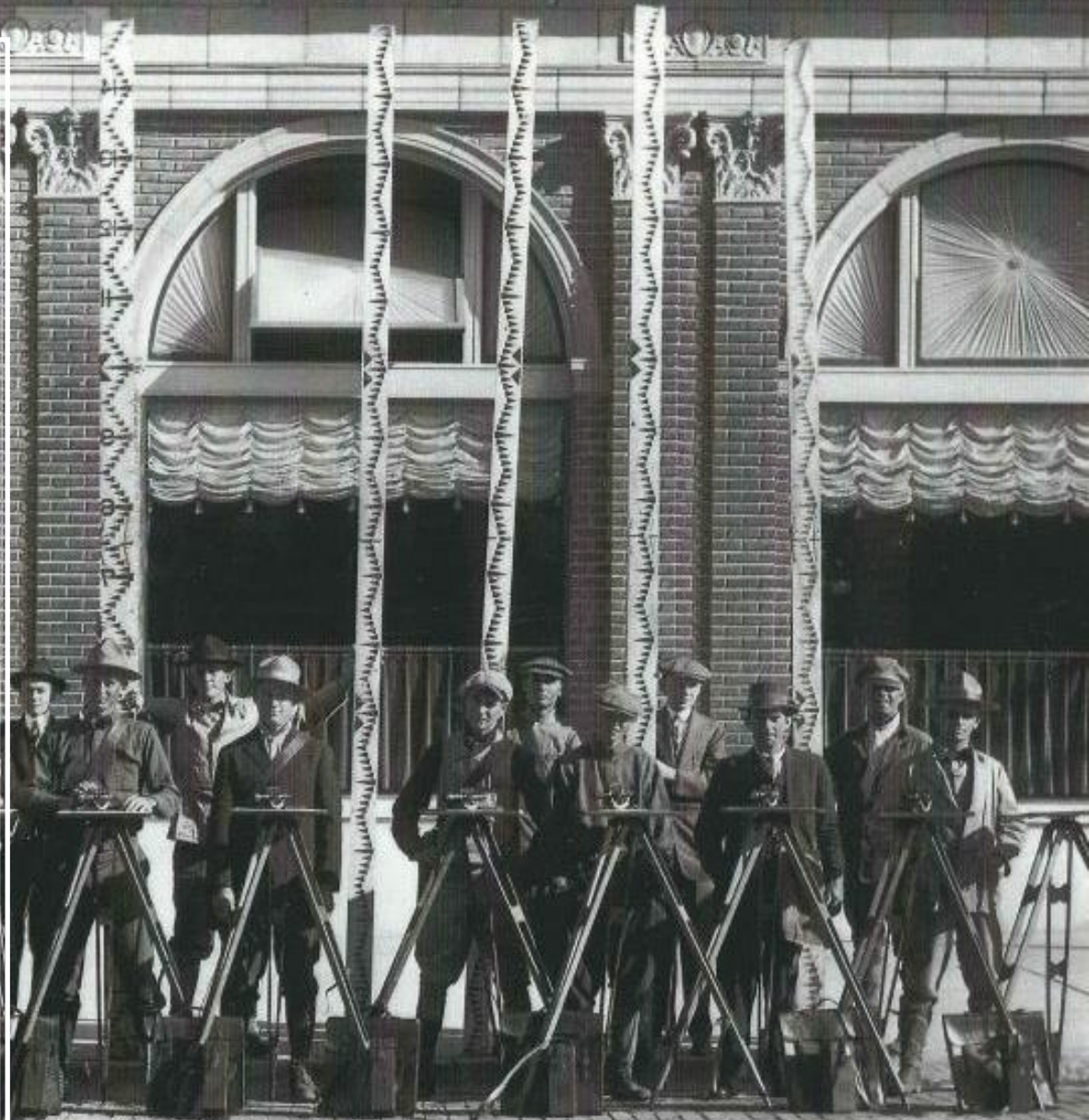
- Chief Geologist, Cities Services
- University of Oklahoma
- Oklahoma GS and USGS Employee
- His Discoveries in Kansas and Oklahoma were the Primary Driver in Adoption of Structure Contour Mapping in the Mid-Continent
- AAPG Founder and Honorary Member





# Plane Table Surveyors

- 1916 – Hundreds of Plane Table Crews Creating Structure Contour Maps in the Midcontinent
- Final Technology Leading to the Use of Geology in Oil Exploration
- Underlying Technology Leading to the Founding of AAPG



# Conclusions

- Early Pioneers in the Appalachian Basin
  - Experimenting with Techniques
  - None Were Adopted by Industry
- Griswold's Techniques
  - Easy and Cost-Effective Method
  - Detailed Level of Mapping
  - Innovative/Revolutionary – Imaging of the Subsurface
- Spread Rapidly Throughout the Industry
  - Griswold's Co-workers and Employees Taught the Rest of the Industry
  - McCrary, Munn, and Carpenter Demonstrated the Effectiveness of the Techniques in the Midcontinent
- Final Technology Leading to the Use of Geology in Oil Exploration
- USGS Bulletin 198 – One of the Most Significant Papers in the History of Petroleum Geology