The MARCELLUS SHALE Play in Pennsylvania

PART 1: A HISTORICAL OVERVIEW

John A. Harper
Pennsylvania Geological Survey
And
Jaime Kostelnik
Weatherford Laboratories, Golden, CO

pennsylvania
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

PENNSYLVANIA GEOLOGICAL SURVEY EST. 1836

Many people believe that gas from shales is a new phenomenon. In fact, the first gas well in North America was a shale gas well, initially completed 38 years before "Colonel" Edwin L. Drake drilled his famous oil well in Titusville, Pennsylvania in 1859.

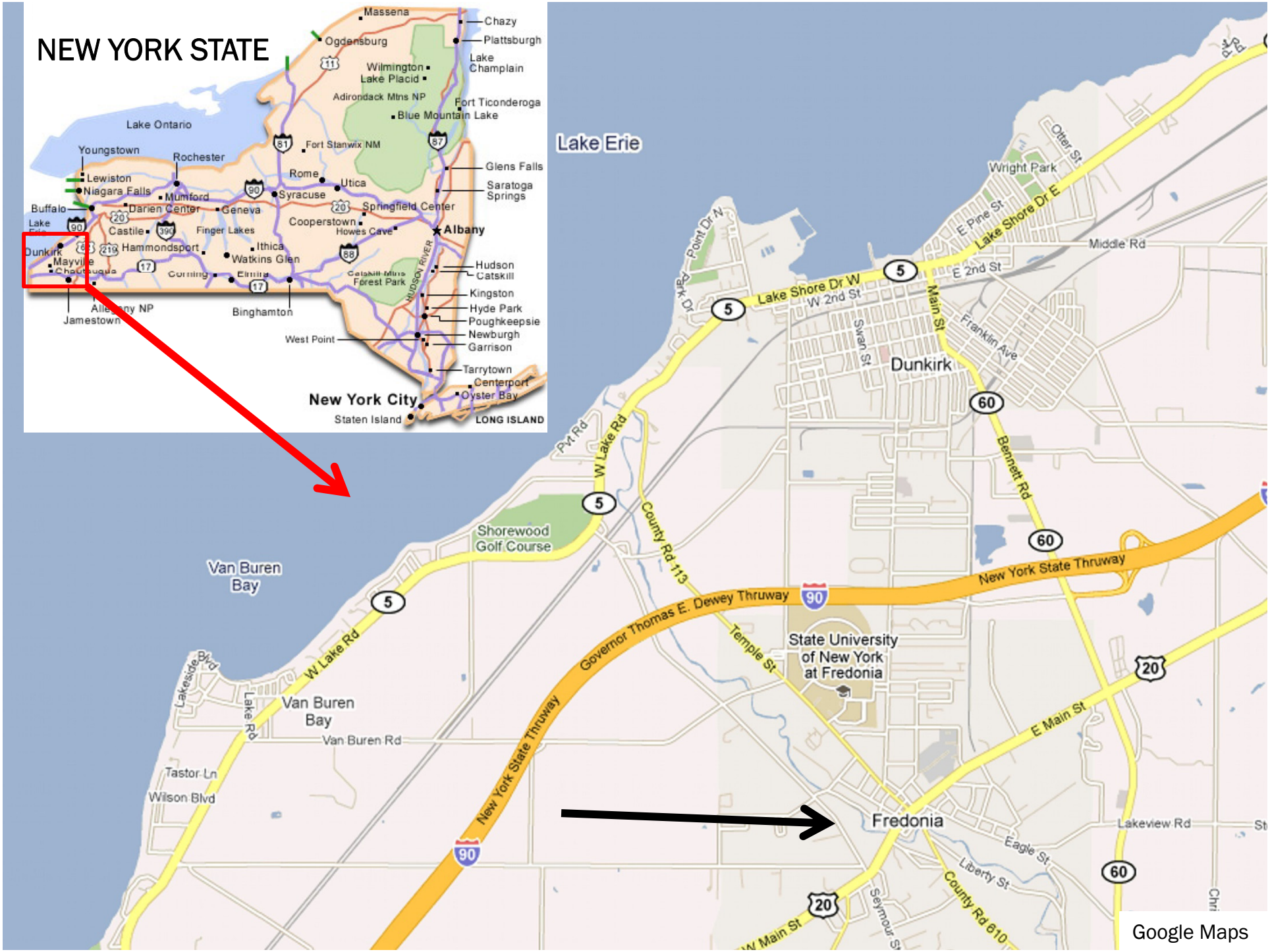
1821-1825

- William Hart noticed gas bubbling out of the bed of Canadaway Creek in the village of Fredonia, Chautauqua County, New York
- He dug, with pick and shovel, a 27-foot deep gas well into Devonian shale
- The gas provided the light of "two good candles"
- By 1825, it supplied enough natural gas for lights in two stores, two shops, and a grist mill
- The pipeline to transport the gas was made from hollowed-out logs connected together with tar and rags

Commemorative plaque on glacial erratic

(From Work and Play Travel, 2008)

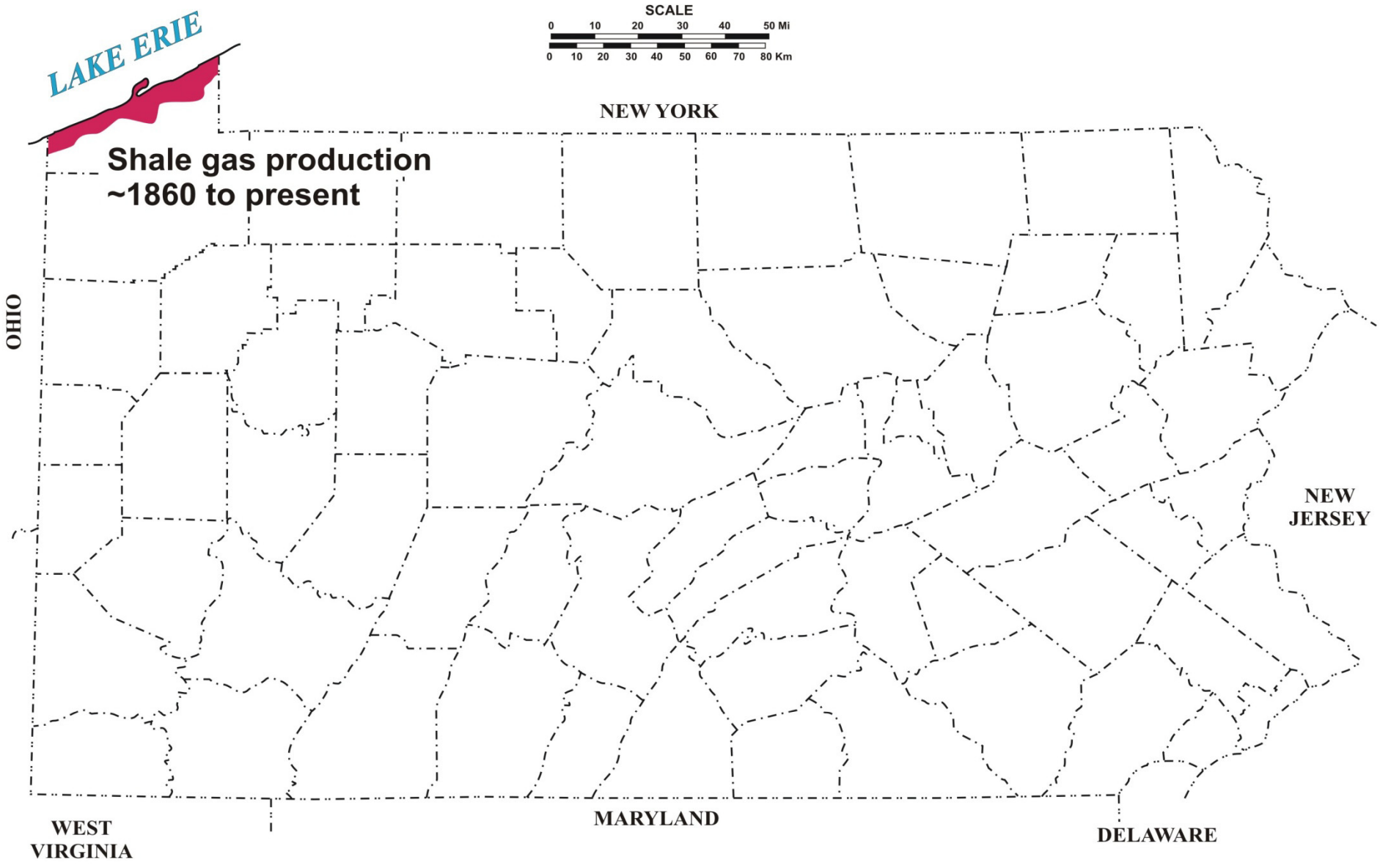
CANADAWAY CREEK AT FREDONIA, NY
Canadaway Creek Conservation Project, 2008


NEW YORK STATE
Massena
Ogdensburg
Chazy
Plattsburgh
Lake Champlain
Wilmington
Lake Placid
Adirondack Mtns NP
Fort Ticonderoga
Blue Mountain Lake
Lake Ontario
Youngstown
Rochester
Fort Stanwix NM
Glens Falls
Lewiston
Niagara Falls
Mumford
Rome
Utica
Saratoga Springs
Buffalo
Darien Center
Geneva
Syracuse
Springfield Center
Lake Erie
Castile
Finger Lakes
Cooperstown
Howes Cave
Albany
Dunkirk
Hammondsport
Ithica
Watkins Glen
Hudson
Catskill
Mayville
Corning
Elmira
Catskill Mtns Forest Park
Kingston
Allegany NP
Jamestown
Binghamton
Hyde Park
Poughkeepsie
West Point
Newburgh
Garrison
Tarrytown
Centerport
Oyster Bay
New York City
Staten Island
LONG ISLAND
Lake Erie
Wright Park
Otter St
E Pine St
Lake Shore Dr E
Middle Rd
E 2nd St
Lake Shore Dr W
W 2nd St
Point Dr N
Main St
Swan St
Franklin Ave
Dunkirk
Bennett Rd
Pvt Rd
W Lake Rd
County Rd 113
Shorewood Golf Course
Van Buren Bay
New York State Thruway
Governor Thomas E. Dewey Thruway
Temple St
State University of New York at Fredonia
Lakeside Blvd
Lake Rd
Van Buren Bay
Van Buren Rd
E Main St
Tastor Ln
Wilson Blvd
Fredonia
Lakeview Rd
Eagle St
Liberty St
County Rd 810
Seymour St
W Main St

Google Maps

1850-1890

- In 1850, the well was deepened to 50 feet and produced enough gas to light 200 burners
- Fredonia Gas Light Company, North America's first gas company, was formed in 1858 – they drilled a second well to more than 200 feet
- Similar shale gas wells were dug along the Lake Erie shoreline from Buffalo, NY to Sandusky, OH. After Drake's discovery, most wells were drilled.
- Second Geological Survey of Pennsylvania geologist I. C. White (later State Geologist of West Virginia) documented numerous shallow (shale) gas wells in Erie, PA in his report from 1881



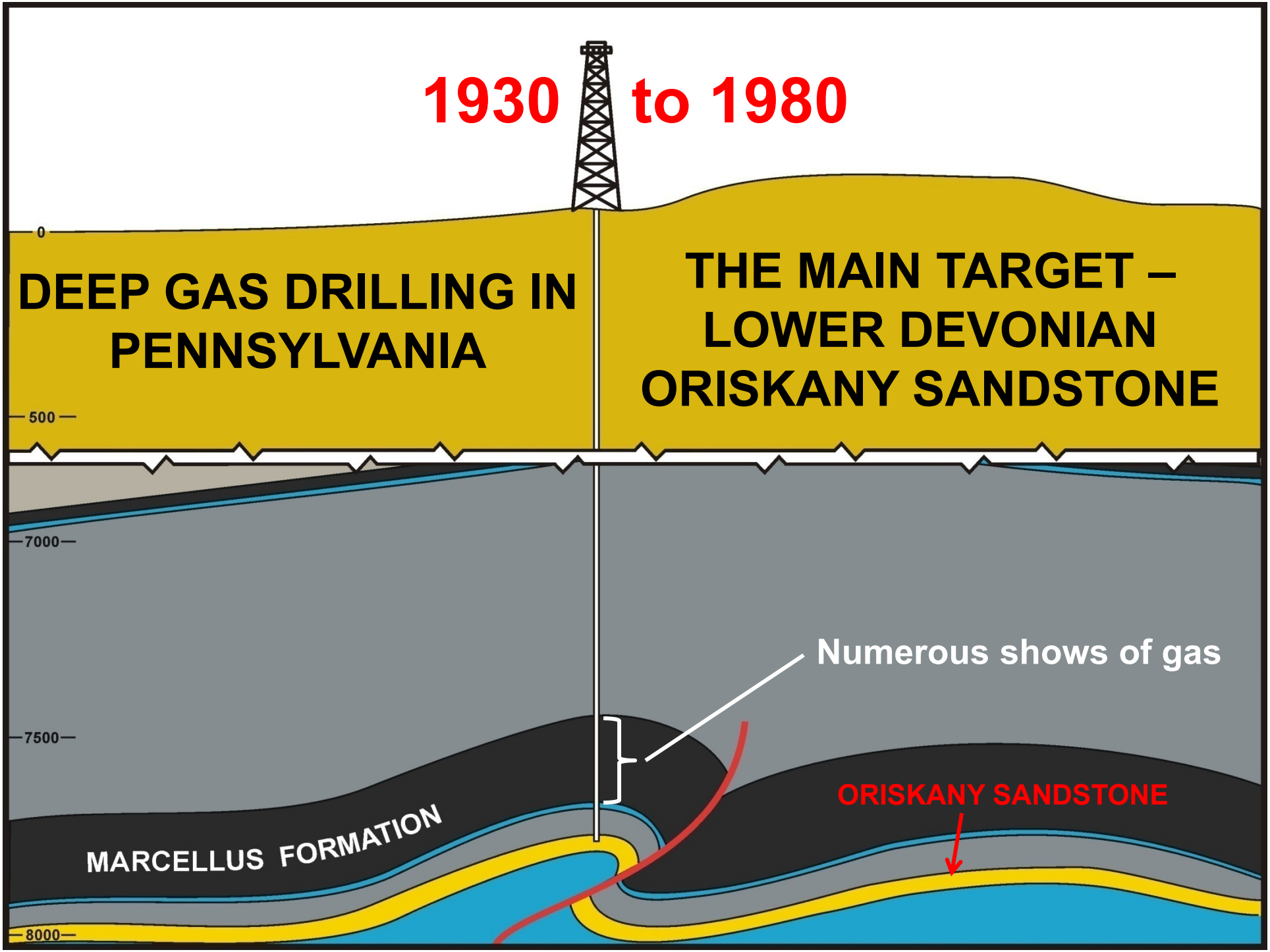
Wells are 300 to 1,500 feet deep and have small flows – measured in ounces of pressure – but they last for scores of years

- Shales were virtually ignored by the commercial oil and gas industry in Pennsylvania until the 1930s. Everyone “KNEW” oil and natural gas came from sandstone and limestone, not shale, so those were the targets of the driller

- Discovery of large amounts of natural gas in the Lower Devonian Oriskany Sandstone in Steuben County, NY in 1930 set off a flurry of drilling in nearby Tioga County, PA in the search for profits

- While drilling to the Oriskany, operators commonly encountered very large flows of gas when they penetrated the Marcellus shale

- Although the flows were large, they typically petered out in a few hours or a few days, and drilling continued to the Oriskany


1930 to 1980
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DEEP GAS DRILLING IN PENNSYLVANIA
THE MAIN TARGET – LOWER DEVONIAN ORISKANY SANDSTONE
500
7000
Numerous shows of gas
7500
ORISKANY SANDSTONE
MARCELLUS FORMATION
8000

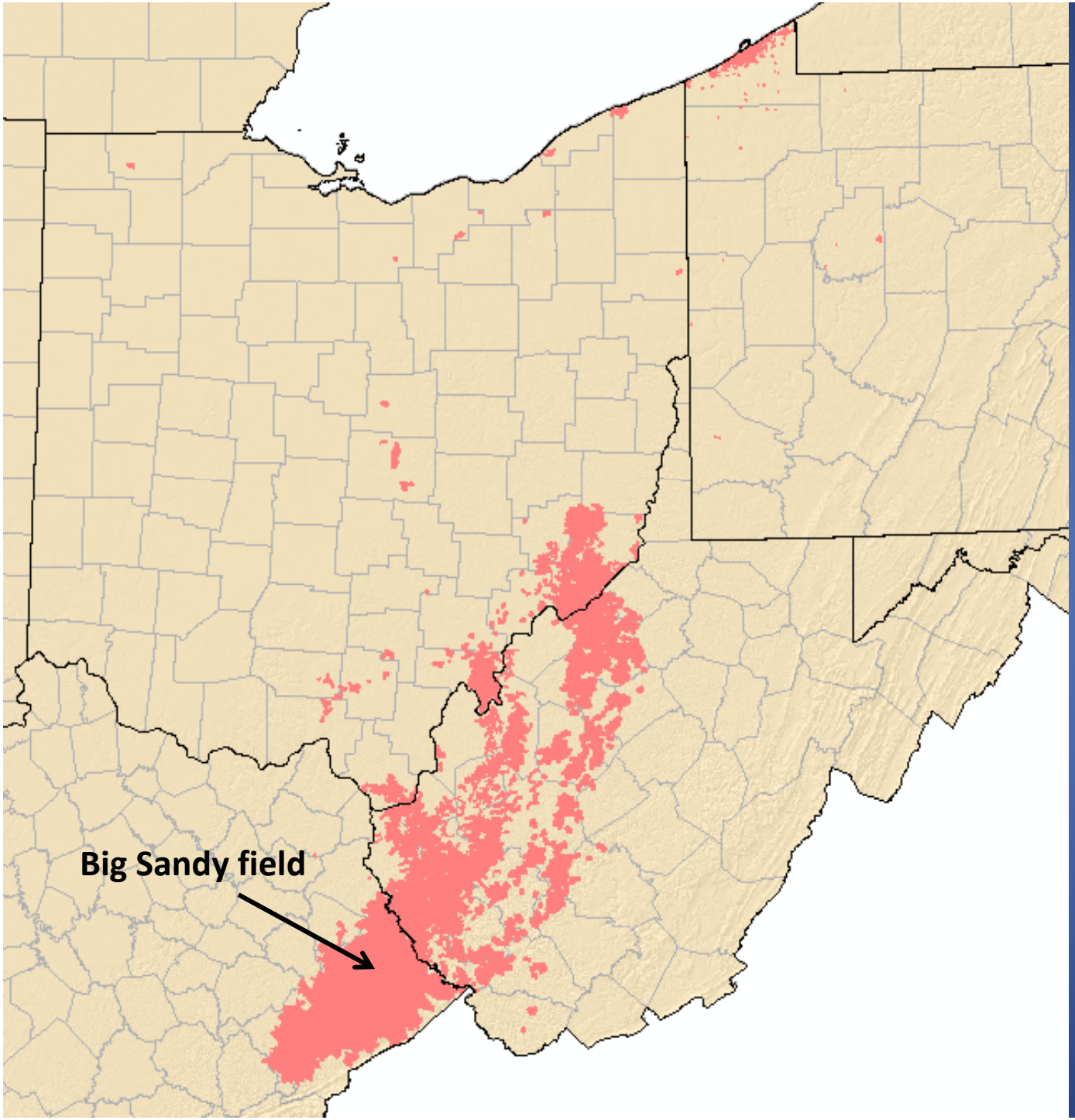
LATE 1970S – EARLY 1990S

EASTERN GAS SHALES PROJECT (EGSP)

A multistate program spanning the Appalachian, Michigan, and Illinois basins

GOALS:

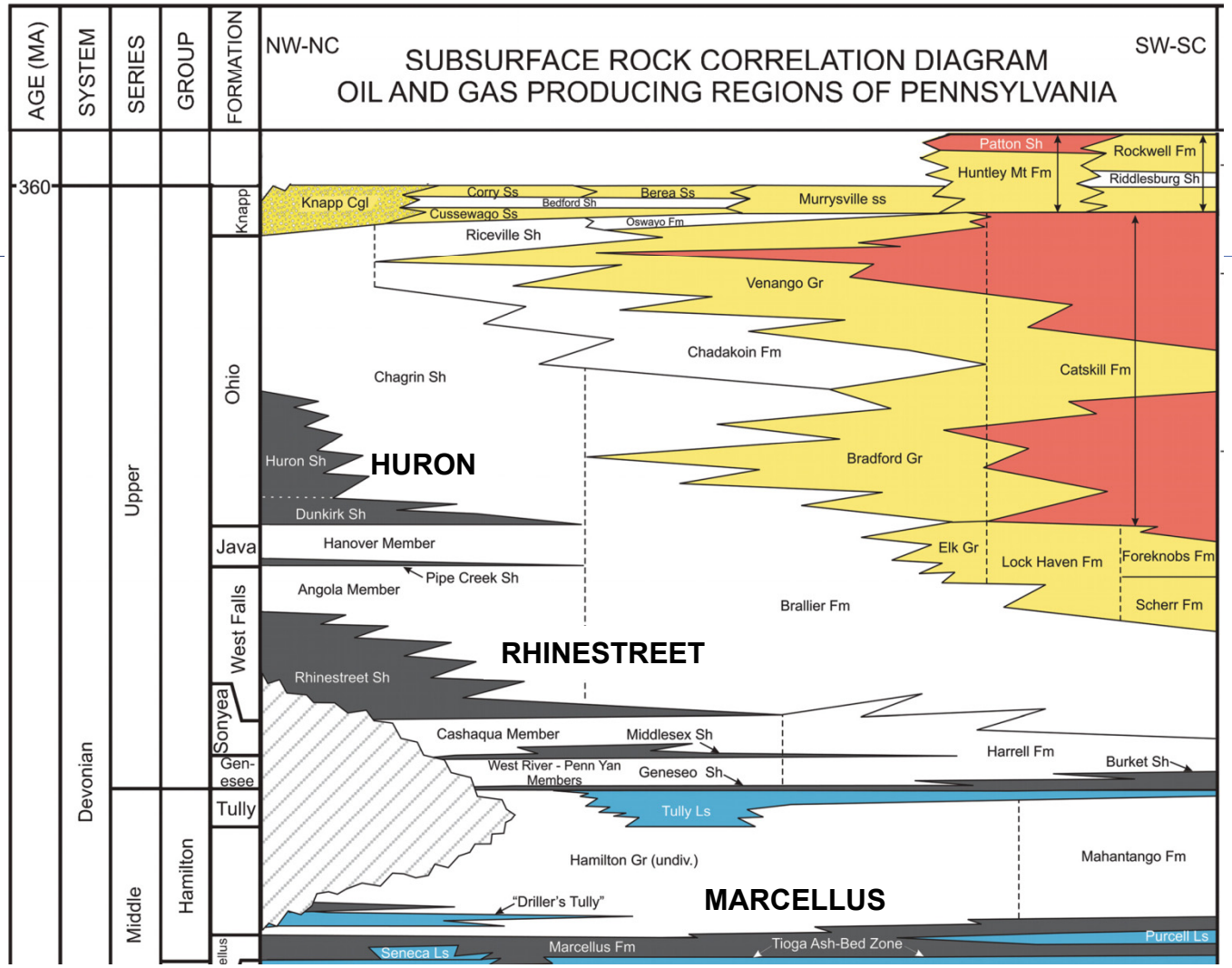
- Determine the extent, thickness, structure and stratigraphy of all Devonian organic-rich shales
- Develop and implement drilling, stimulation and recovery technologies
- Generate numerous cross sections, maps, and technical reports related to the entire Middle and Upper Devonian sequence in western and north-central Pennsylvania



PRODUCING DEVONIAN SHALE GAS FIELDS IN THE APPALACHIAN BASIN PRIOR TO DISCOVERY OF THE MARCELLUS PLAY

Wickstrom and others, 2005

EGSP IDENTIFIED THREE MAJOR AND THREE MINOR BLACK SHALE FACIES IN PENNSYLVANIA



Major: **Huron, Rhinestreet, and Marcellus**

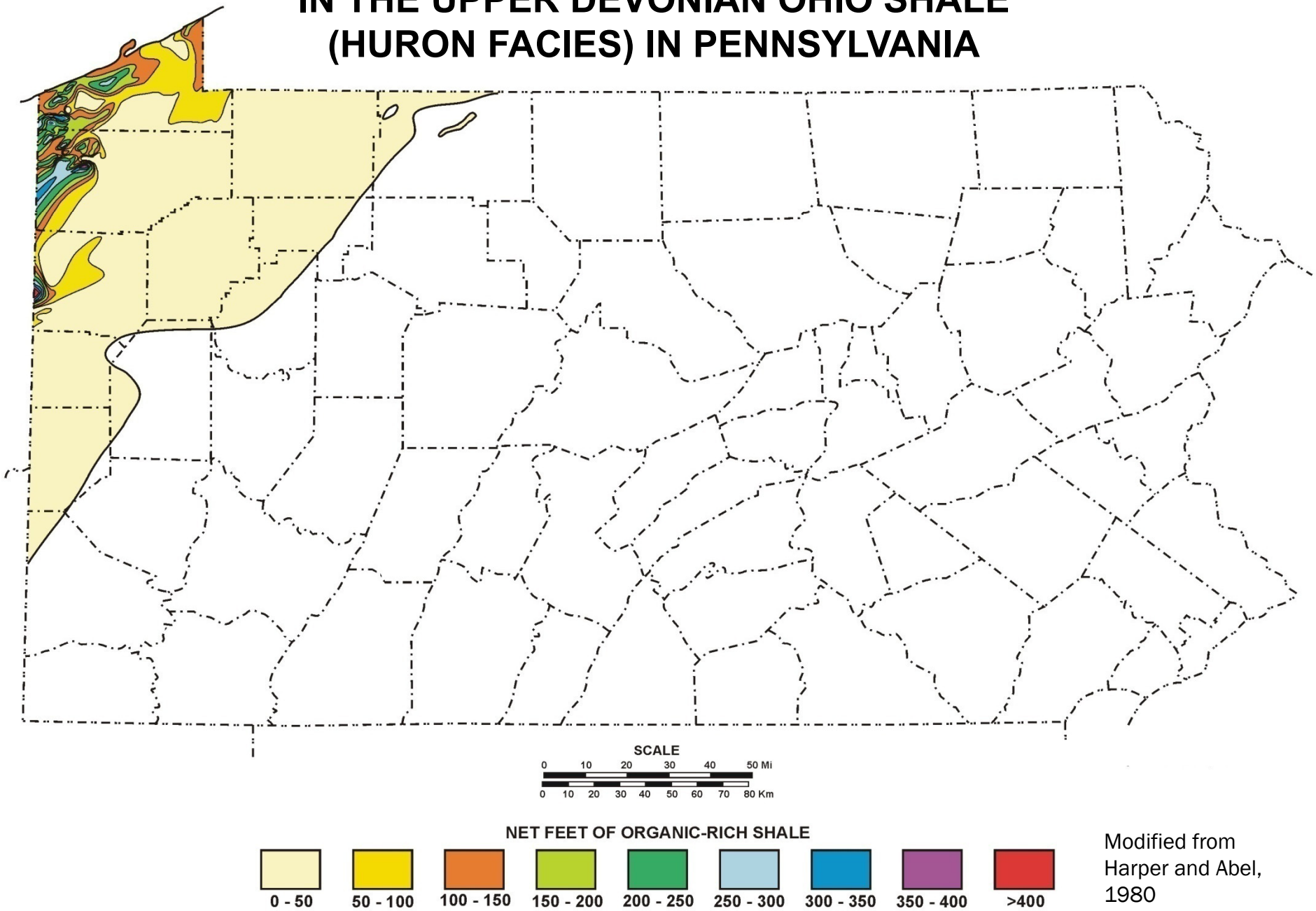
Minor: **Pipe Creek, Middlesex, and Geneseo/Burket**

Carter, 2007

Along with other state surveys in the eastern US, the Pennsylvania Geological Survey created numerous maps, cross sections, and reports during EGSP

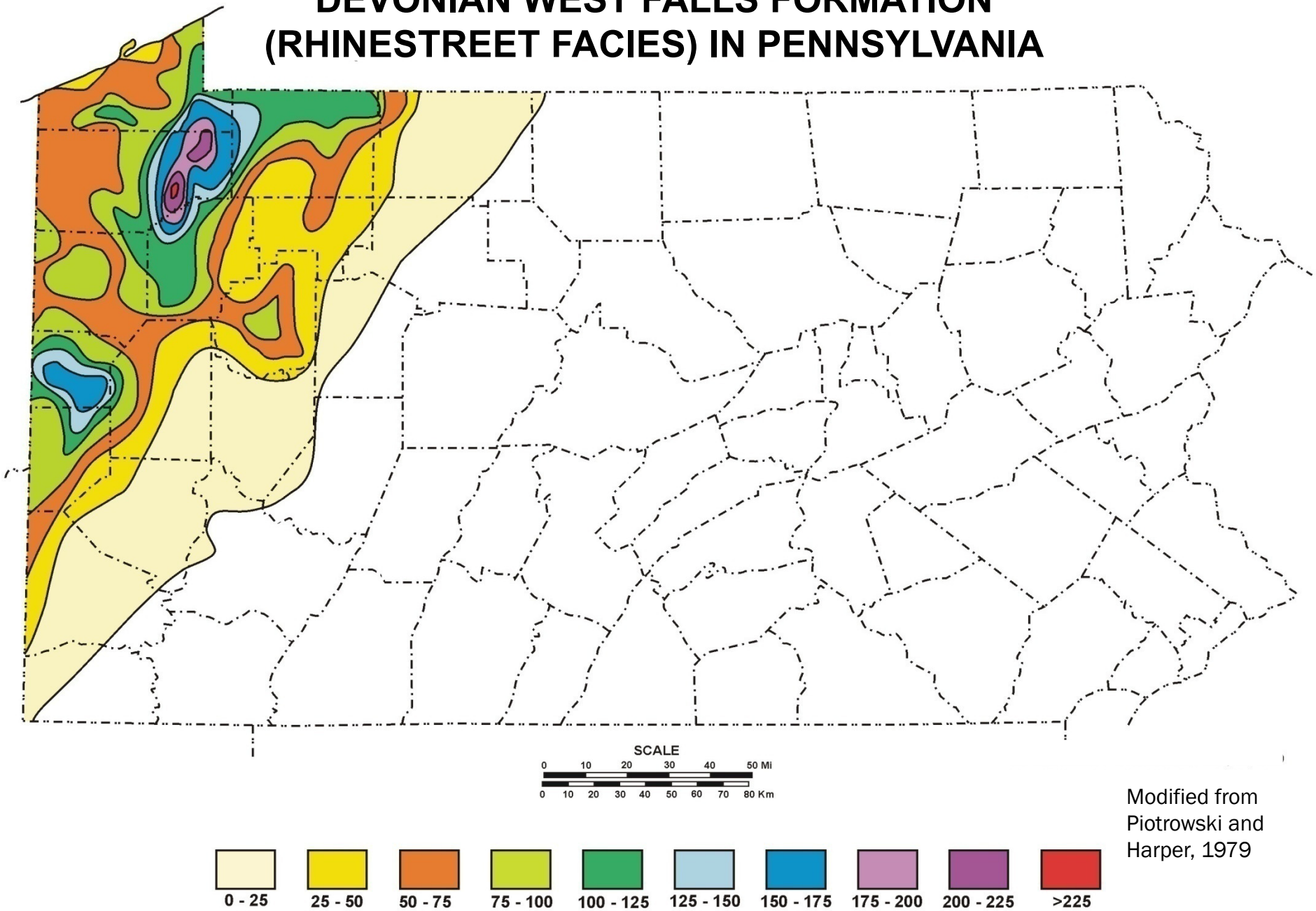
The following maps show the net feet of shale within a formation, rather than the thickness of the formations themselves.

NET FEET OF ORGANIC-RICH SHALE IN THE UPPER DEVONIAN OHIO SHALE (HURON FACIES) IN PENNSYLVANIA



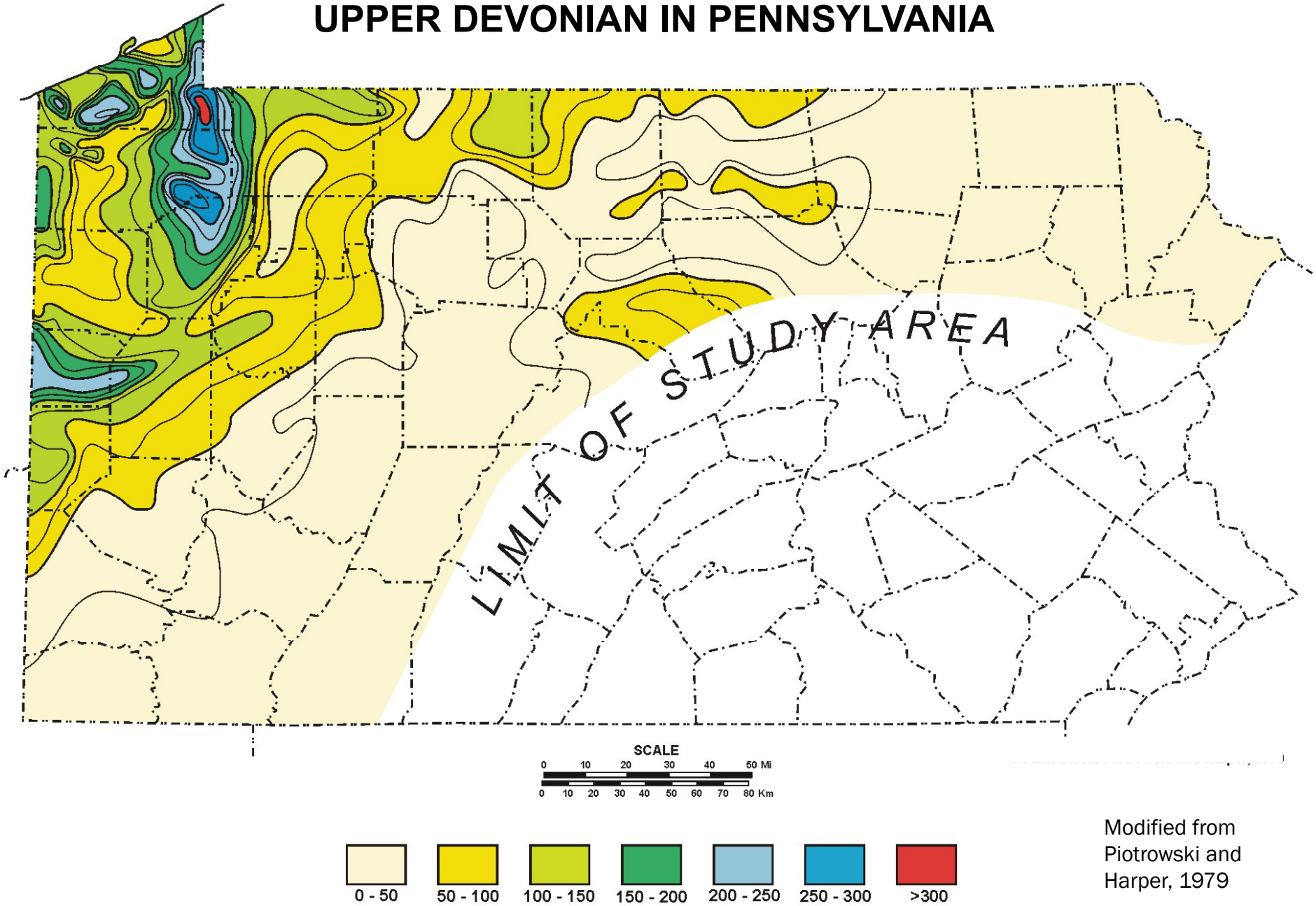
Modified from Harper and Abel, 1980

NET FEET OF ORGANIC-RICH SHALE IN THE UPPER DEVONIAN WEST FALLS FORMATION (RHINESTREET FACIES) IN PENNSYLVANIA



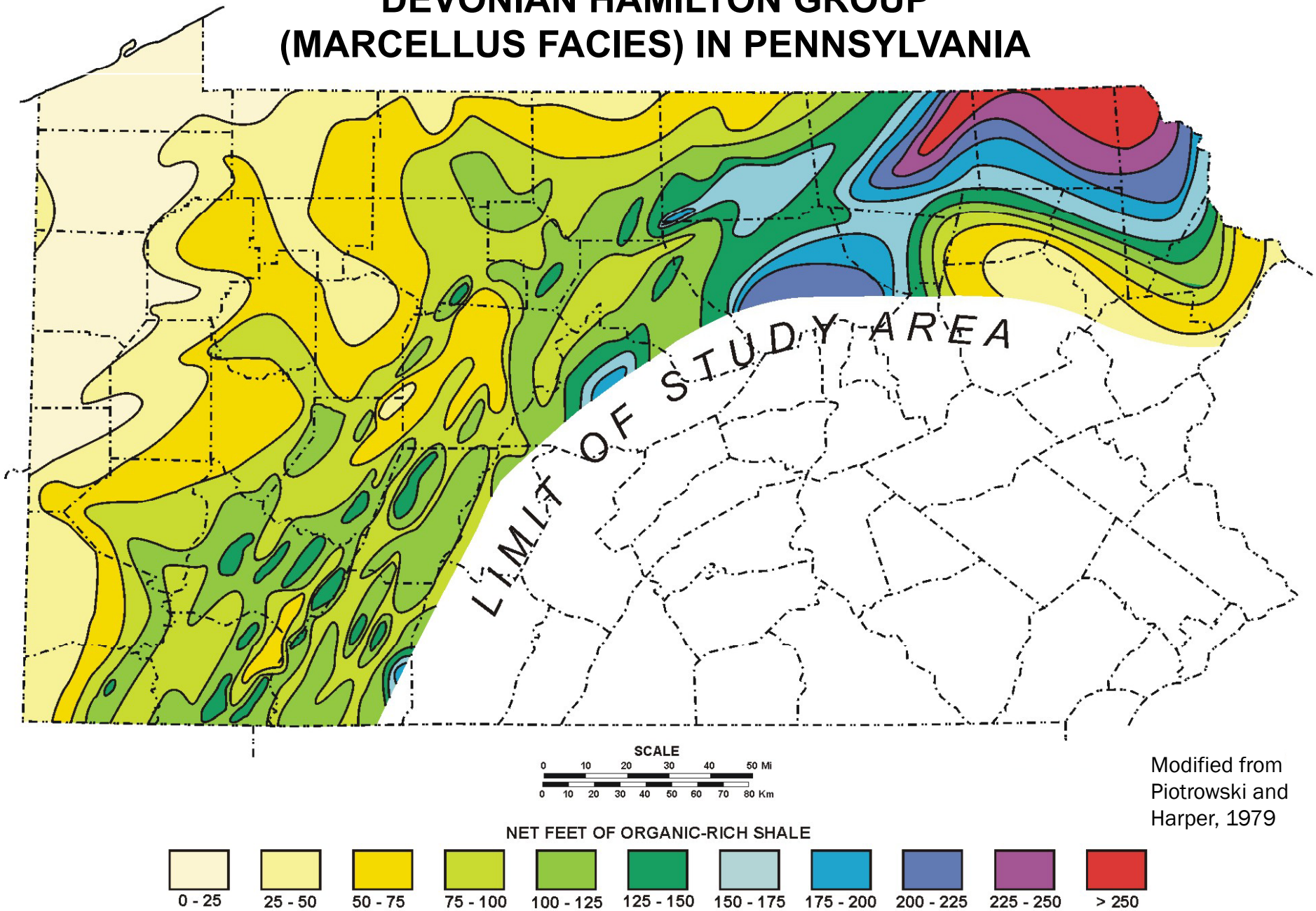
Modified from Piotrowski and Harper, 1979

NET FEET OF ORGANIC-RICH SHALE IN THE UPPER DEVONIAN IN PENNSYLVANIA



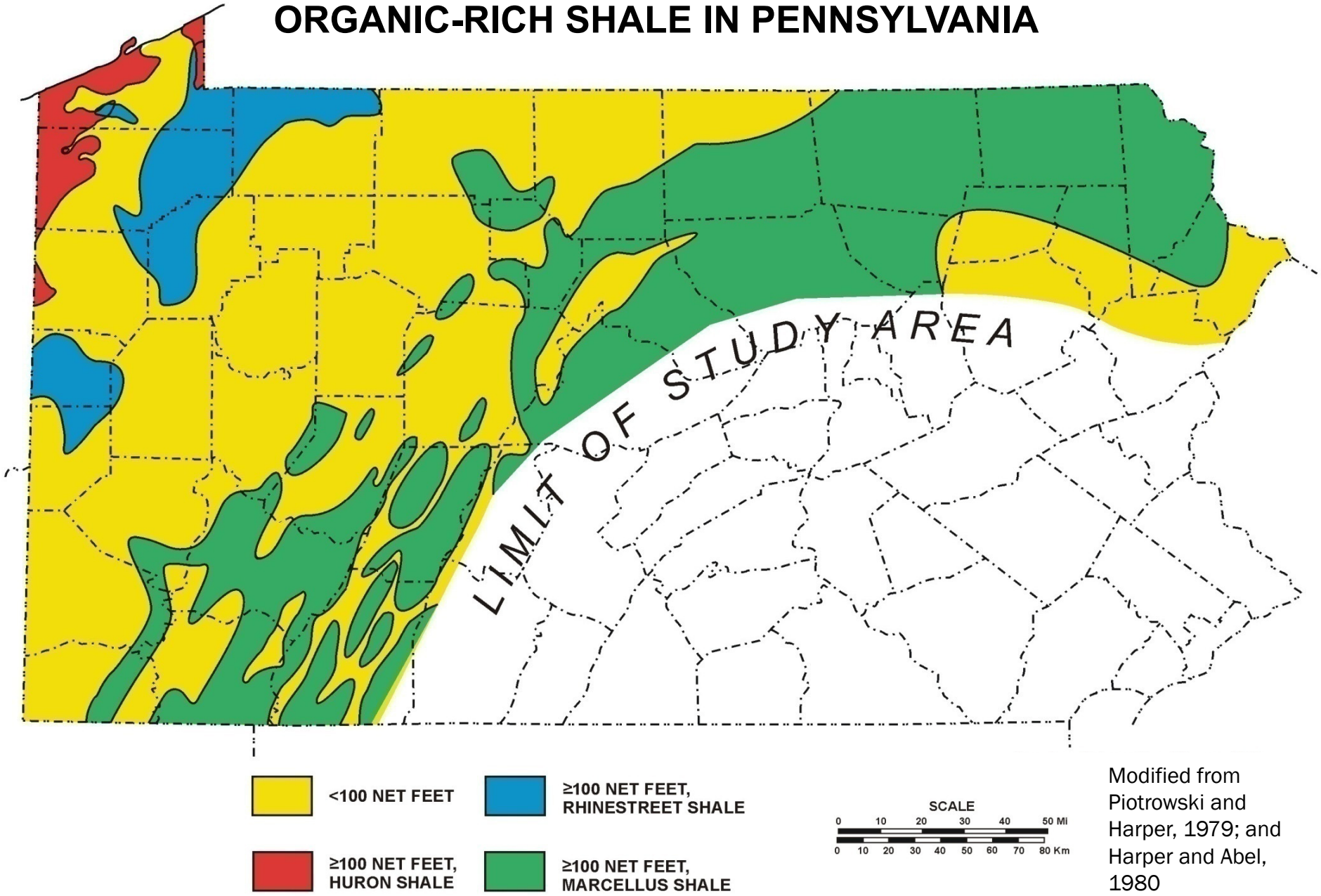
Modified from Piotrowski and Harper, 1979

NET FEET OF ORGANIC-RICH SHALE IN THE MIDDLE DEVONIAN HAMILTON GROUP (MARCELLUS FACIES) IN PENNSYLVANIA



Modified from Piotrowski and Harper, 1979

"THREE BELT" DISTRIBUTION OF THICK ORGANIC-RICH SHALE IN PENNSYLVANIA



Modified from Piotrowski and Harper, 1979; and Harper and Abel, 1980

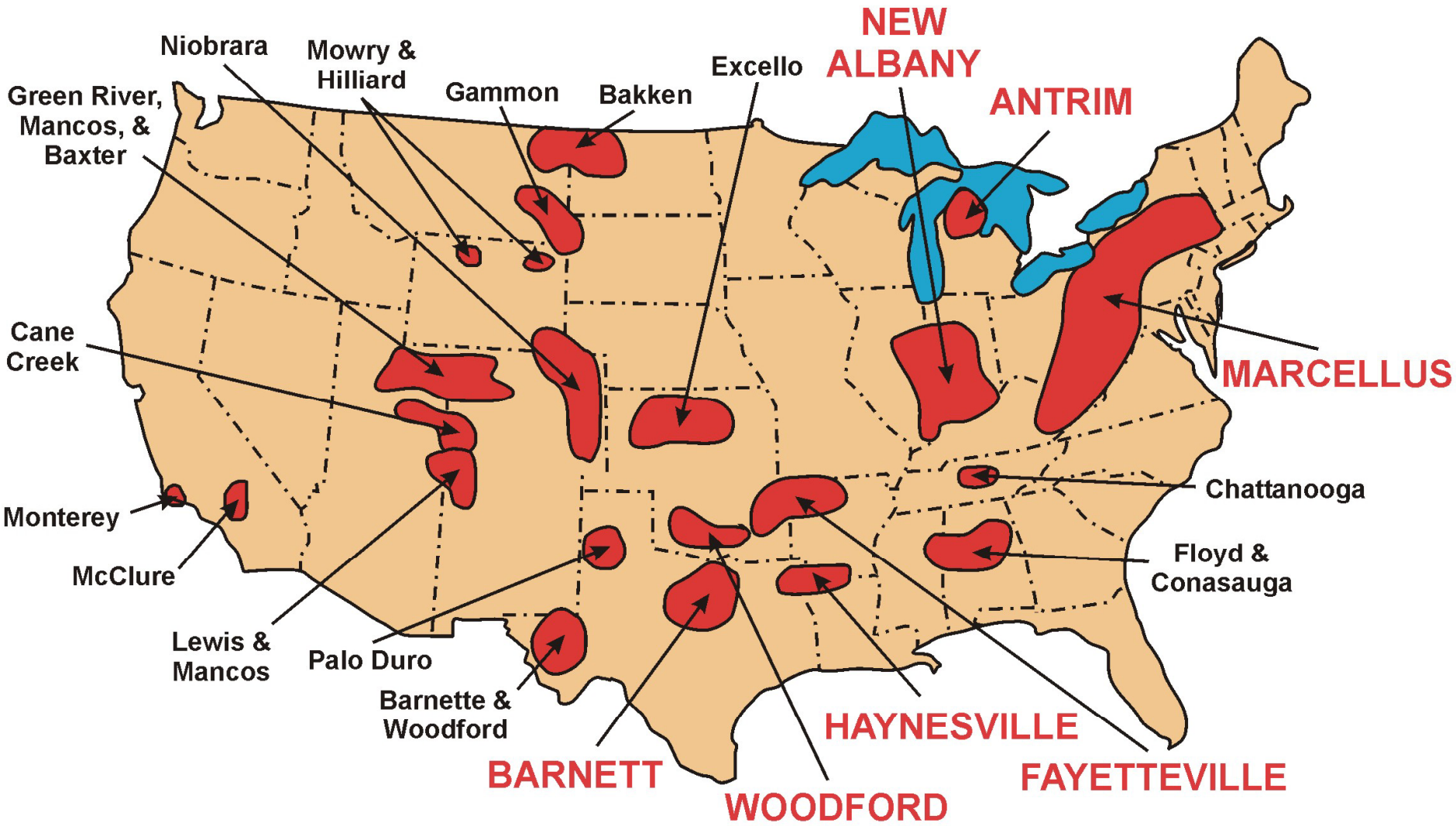
RESULTS OF EGSP

1. Devonian organic –rich shales could be important gas reservoirs in northwestern Pennsylvania where they are both thick and close to the surface and have excellent potential to fill the needs of users if better technology for inducing and enhancing fracture systems was developed.

2. The Marcellus was considered to be much less attractive and would remain so until **gas prices increased and technology advanced** enough to make drilling and completion competitive with more conventional targets.

AND SO IT REMAINED UNTIL NEW TECHNOLOGIES FOR EXPLOITING GAS RESOURCES IN SHALE WERE DEVELOPED IN THE BARNETT SHALE OF TEXAS IN THE 1990S

U.S. SHALE BASINS



Modified from Groundwater Protection Council, 2009

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