Geologic Structure and Seismic Analysis

Kentucky Geological Survey
John B. Hickman, Paul D. Lake, David C. Harris, and James A. Drahovzal

Trenton–Black River Research Consortium

March 29, 2005

Columbus, OH

Structure and Seismic Analysis

- Structure and isopach maps
  - Base of Devonian Shale
  - Ordovician (top)
  - Kope Fm
  - Utica Shale
  - Trenton Fm
  - Black River Ls
  - Knox Unconformity
  - Basal Sandstones
    - (needed as hydrothermal fluid conduit for dolomitization?)
  - Top of Precambrian Basement
  - Major structural features (esp. those affecting dolomitization)
- Assist in evaluating zones of potential hydrothermal dolomite development

Outline of Tasks

- Data Acquisition
  - Seismic, well logs, and stratigraphic well tops
- Load Seismic data
  - Digital SEGY files into Kingdom Suite
  - Raster images into PetraSeis
- Load Well Data
  - Digital LAS files into Kingdom Suite & Petra
  - Raster images into Petra
- Load Preliminary (i.e. any available) Well Tops

Outline, con't.

Use sonic logs for synthetic seismogram creation and creation of velocity model

Correlate log tops to reflecting seismic horizons

Interpret stratigraphy and structure from seismic

Use velocity model to transform depths in time to depths in feet subsea

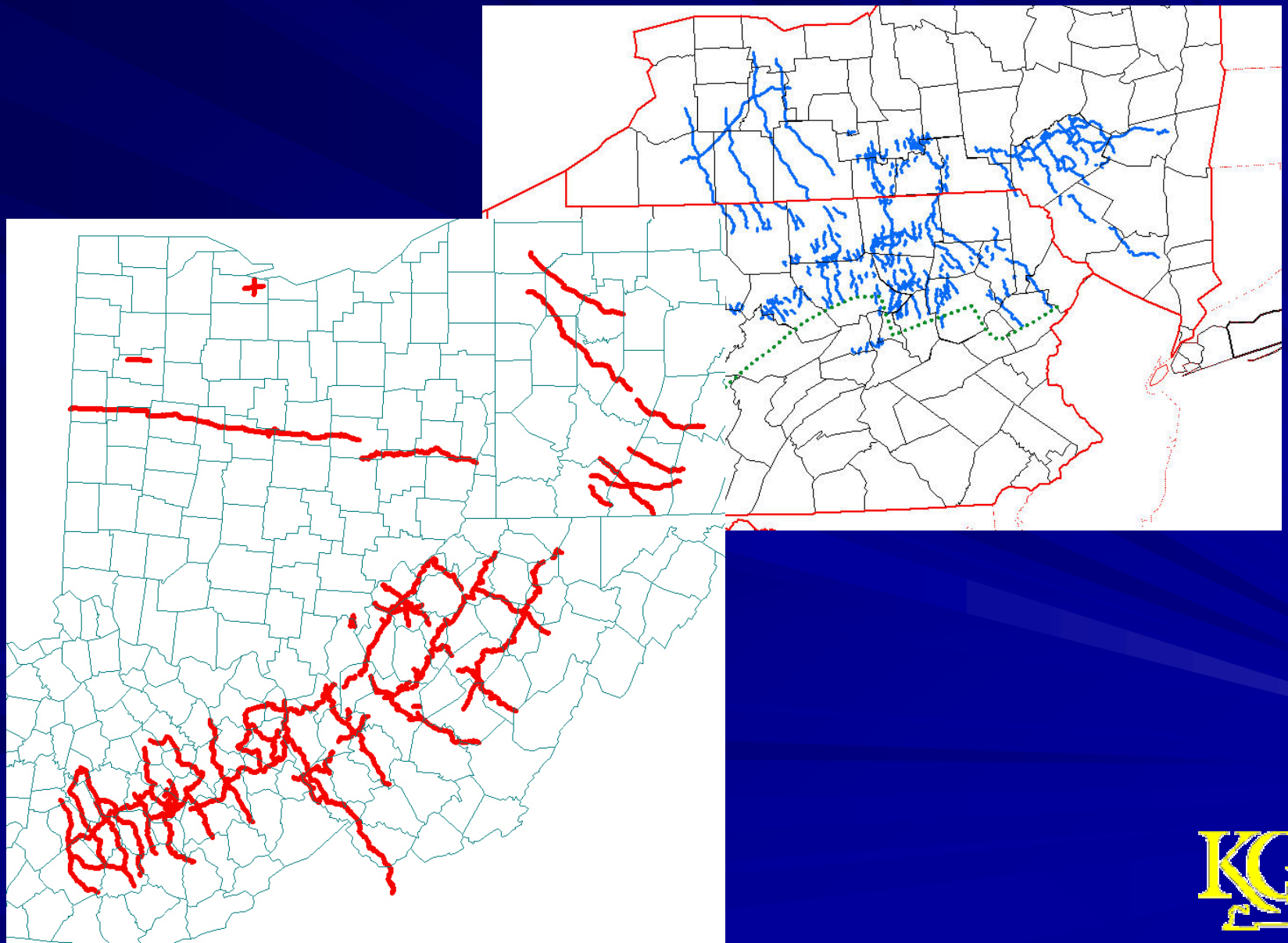
Create 3D surfaces from seismic horizon and well based stratigraphic tops elevations

Merge products with those of the other members of TBRRC

Newly Acquired Seismic Data

- Two new analog (paper copies) and three new digital (SEGY) Ohio seismic lines have been received and loaded
- Three new digital (SEG-Y) field scale seismic lines from eastern Kentucky have been received (from ABARTA) and loaded into Kingdom Suite™ software
- Two new digital (SEG-Y) regional seismic lines from central Ohio have been loaded into Kingdom Suite™ software (reprocessed COCORP lines)

Current Seismic Data Loaded



Well Data Loaded

- Total of 402 digital well log files loaded into Petra and Kingdom Suite software projects
  - Includes sonic logs for 114 wells

- *Preliminary* set of tops loaded:
  - 831 KY wells
  - 103 OH wells
  - 644 NY wells
  - 101 PA wells
  - 22 WV wells

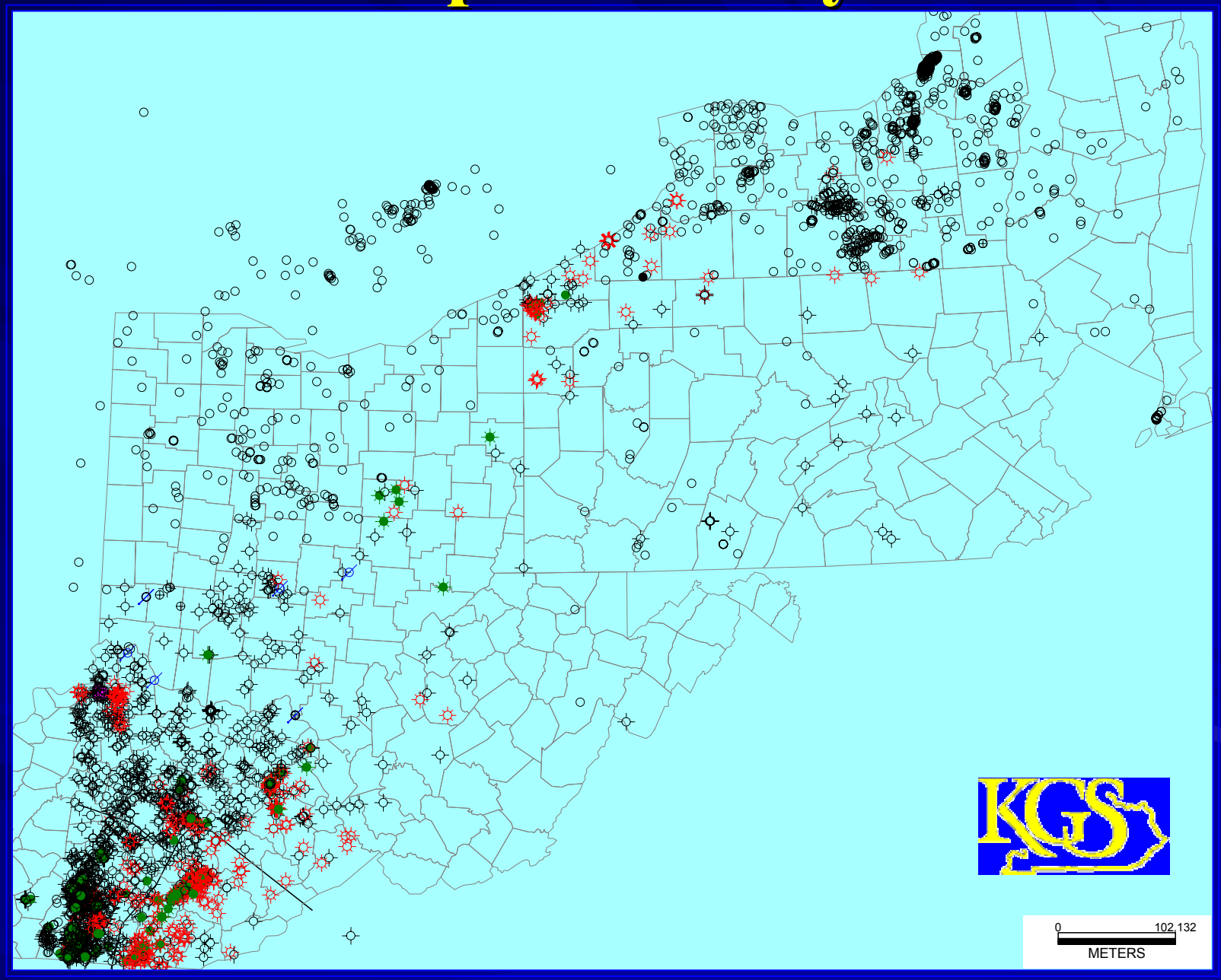
Well Tops Picked or Loaded

- Current set of tops being picked for project:
  - Ohio Shale
  - Top of Ordovician
  - Kope Sh
  - Point Pleasant Fm
  - Trenton Fm
  - Black River Gp
  - Deike and Millbrig Bentonites
  - Wells Creek Dolomite

Well Tops Picked or Loaded, con't.

- Current set of tops being picked for project:
  - St. Peter Sandstone
  - Knox Unconformity
  - Rose Run Sandstone
  - Conasauga Gp
  - Rome Fm
  - Basal & Mt. Simon Ss
  - Precambrian Unconformity

Wells used for preliminary correlations



Southern App. Velocity Model

- Continuing to assist in time-to-depth calculations of seismic horizons, and aiding in stratigraphic correlation in areas of low resolution data
- A sixteen layer regional velocity model for the Southern Appalachian area, with an average error < 5%, based on well data
- Quality checking horizon tops based on time calculations ongoing

New Northern Region Velocity Model

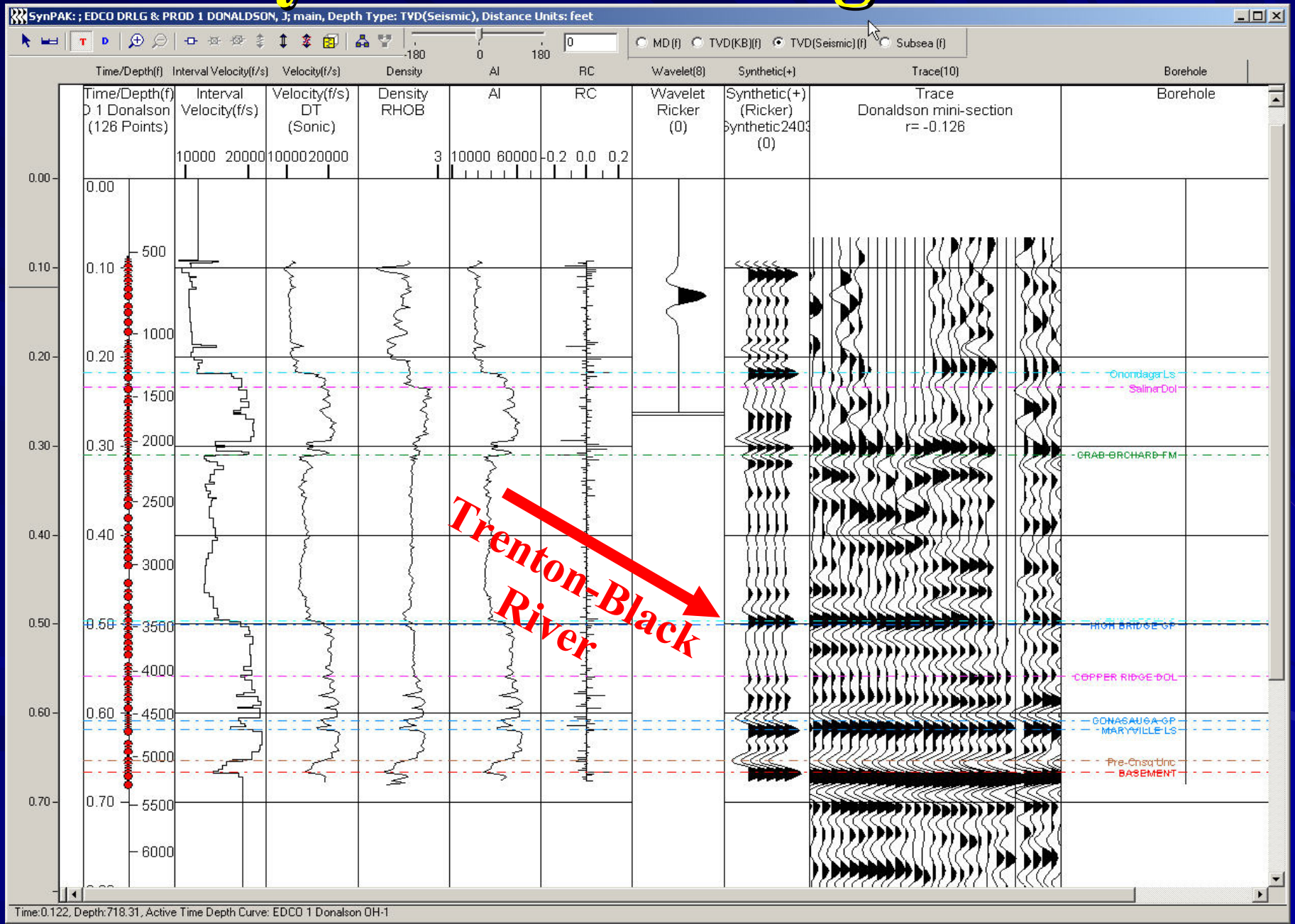
- Created to help determine the time-to-depth of seismic horizons, and to aid in stratigraphic correlation in areas of low resolution data
- Formation tops from 745 wells, and sonic logs from 53 LAS files were used from the deep wells in PA and NY
- Sonic log data averaged with petrophysical software (Petra®) within groups of strata resulted in precise interval velocities

New Velocity Model, con't.

- Interval velocities of sixteen layers (groups of strata) corresponding to possible seismic horizons were gridded over PA & NY project area, and edited for known fault trends

- In wells without sonic logs, internal velocities were calculated by the creating sonic log grids. These grids then were used to calculate the depth of formation tops in time.

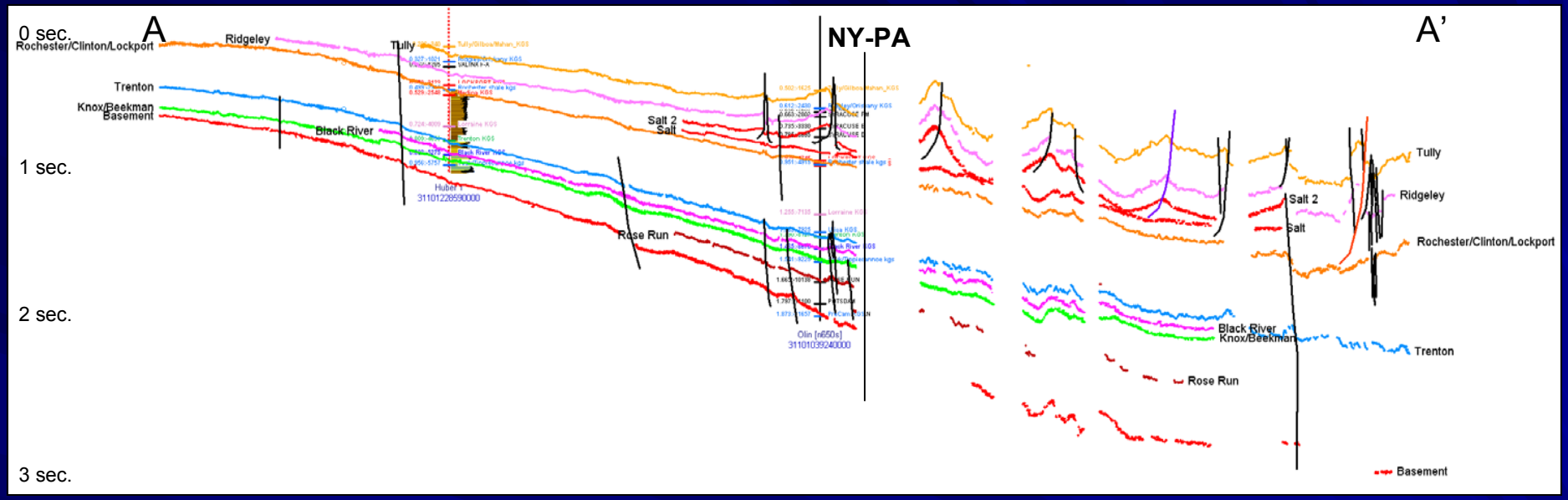
Synthetic Seismograms

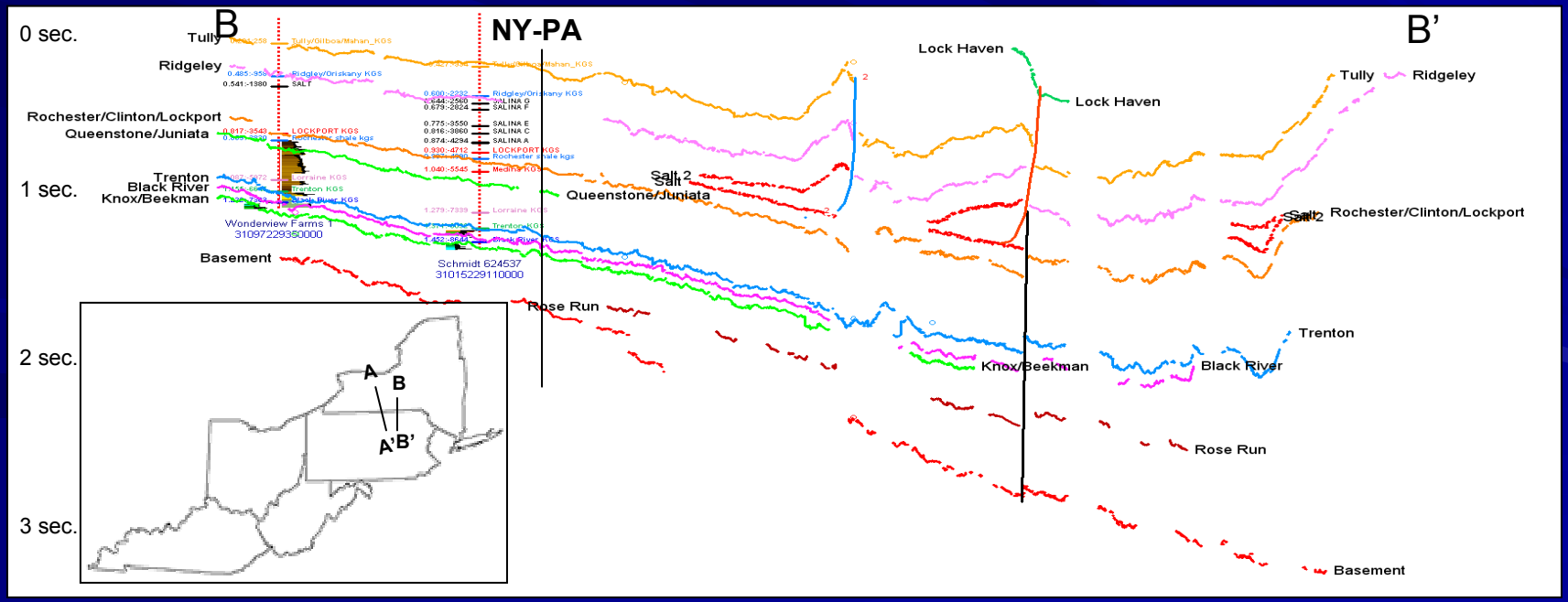


Interpretation of Current Data

- Initial framework of 648 deep well's tops in KY complete
- Infilling with shallower wells, and addition of additional related members beginning
- Initial interpretation of NY, PA, and WV seismic horizons complete, OH and KY nearing completion
- QC and "fine tuning" of horizon picks ongoing

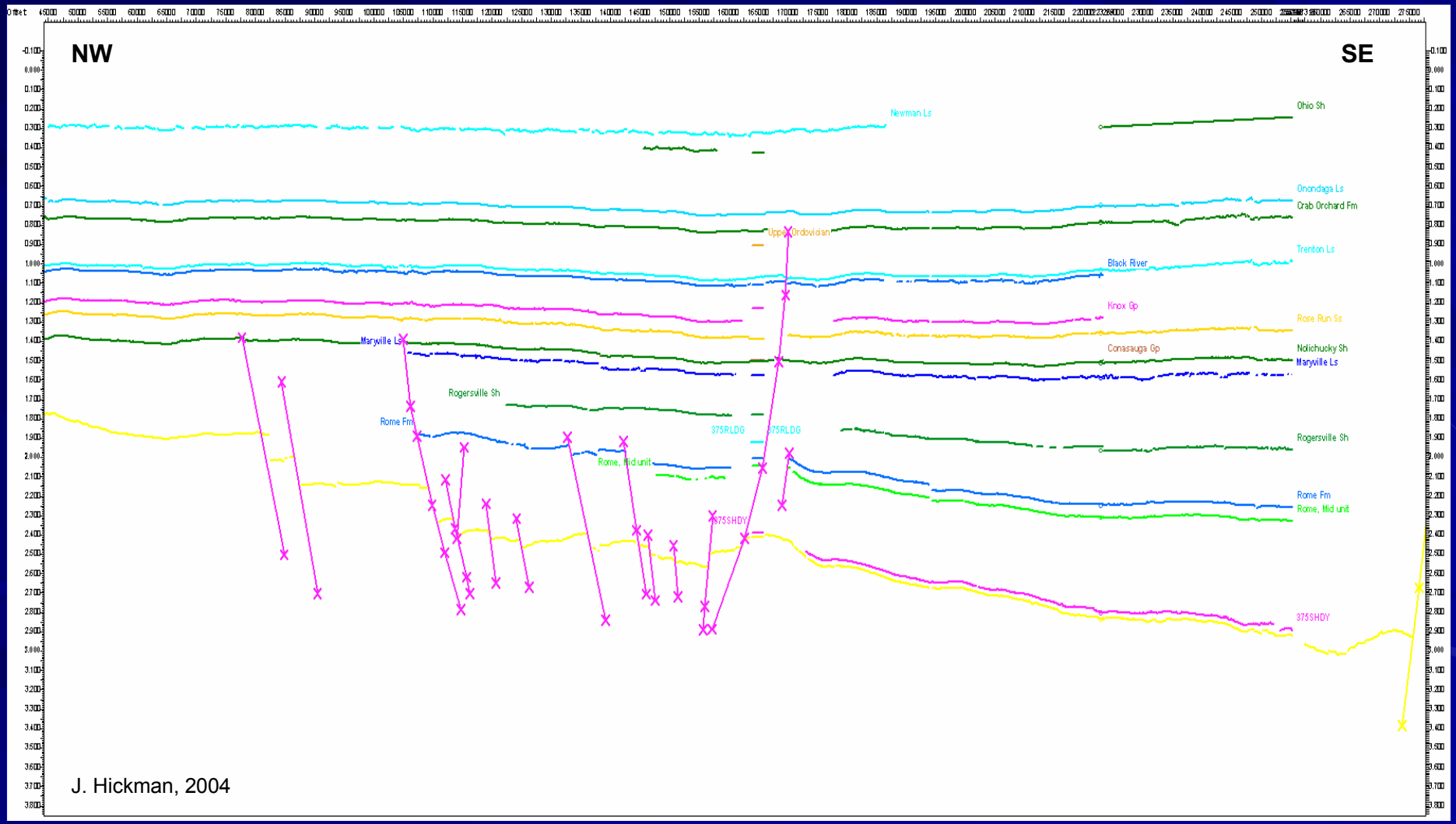
Seismic Interpretation





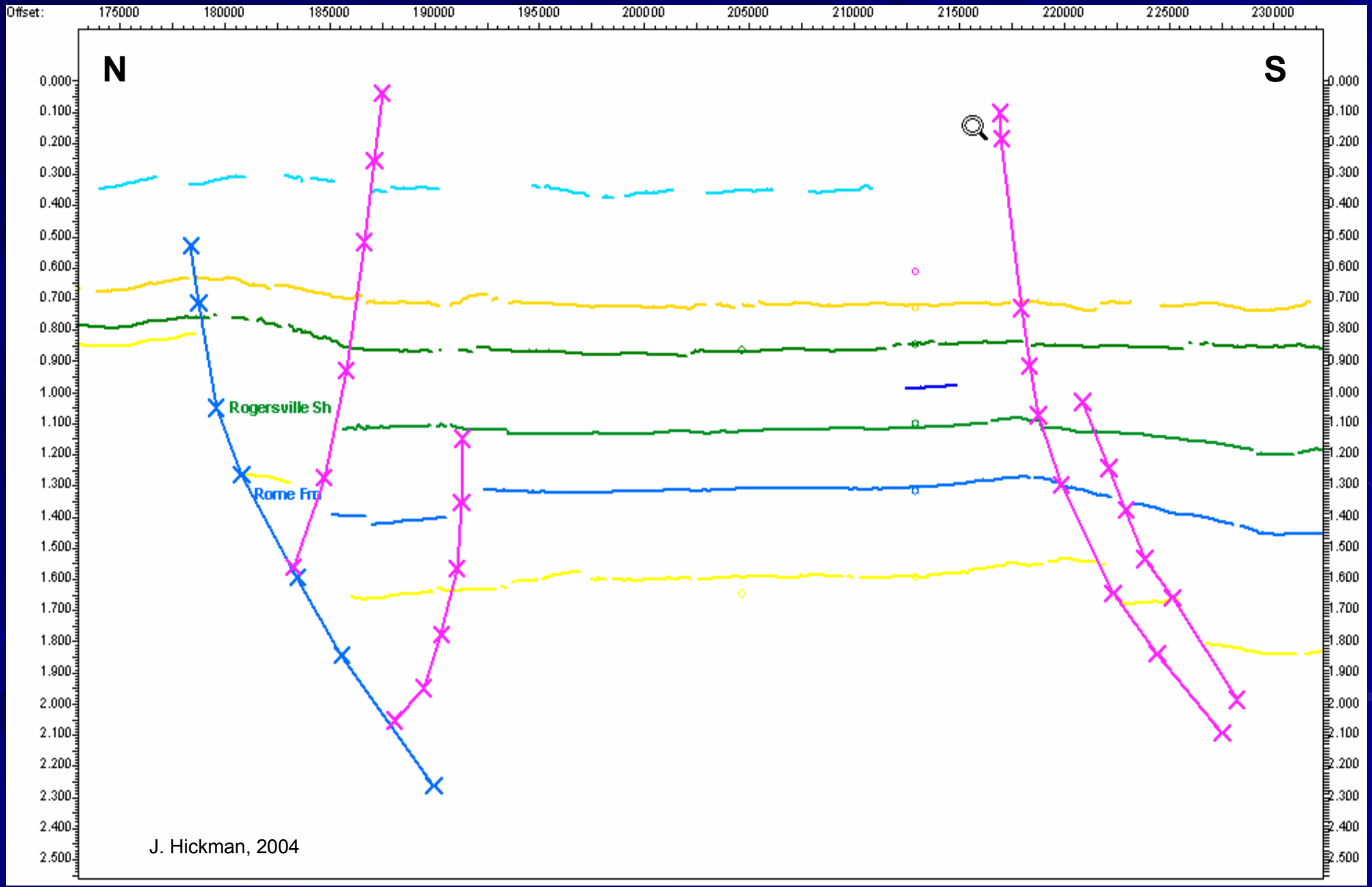
Paul Lake, 2004

Northern Rome Trough Section, WV

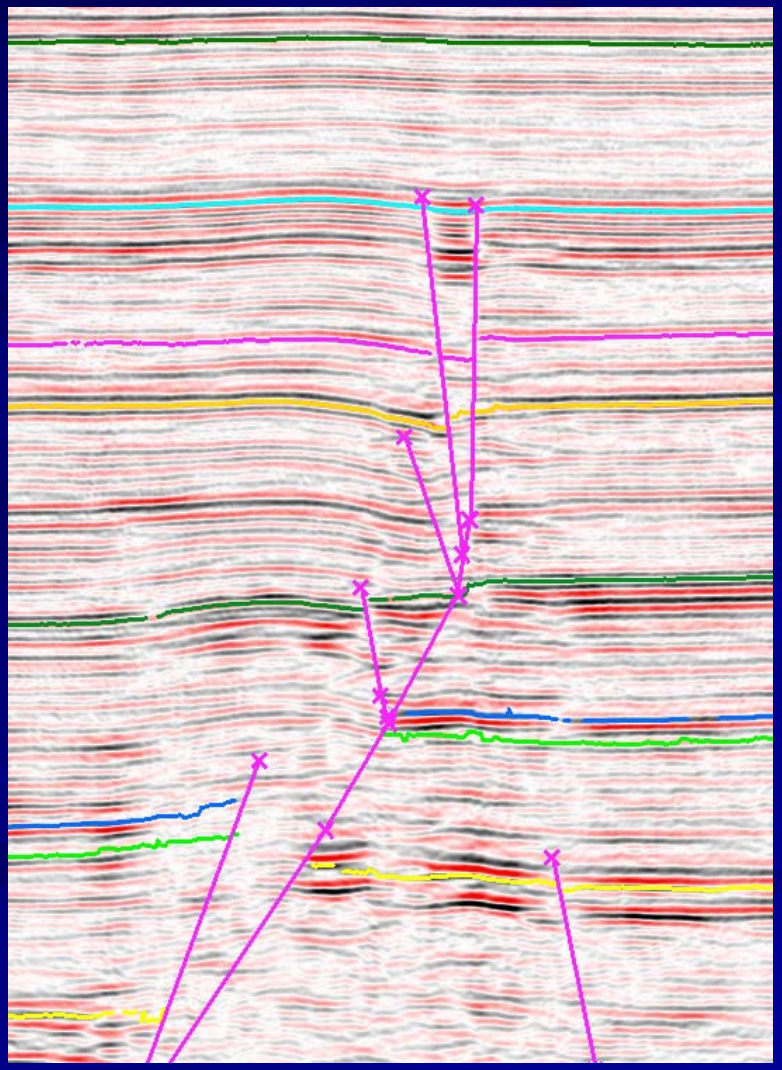


J. Hickman, 2004

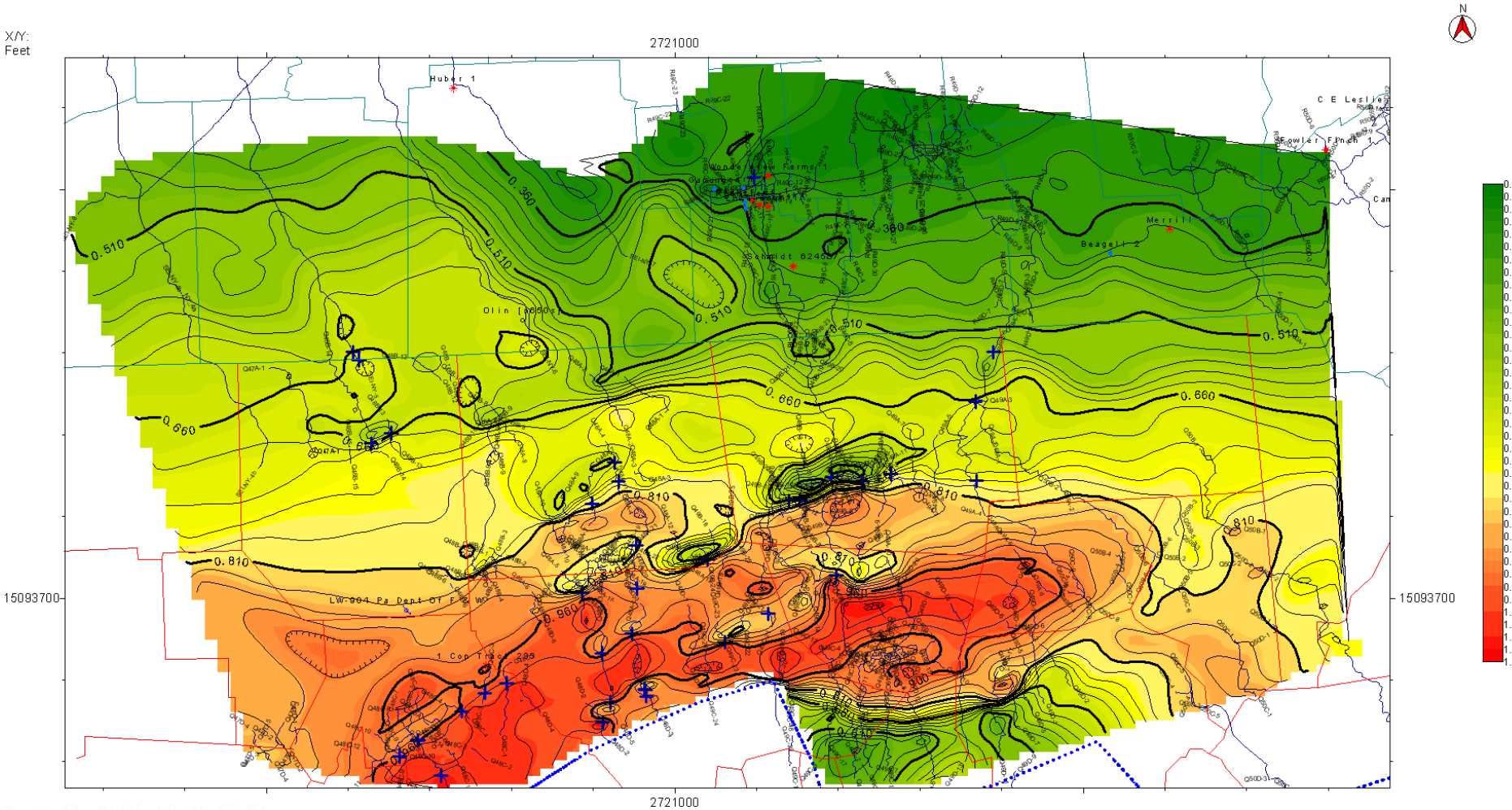
Eastern KY Rome Trough Section

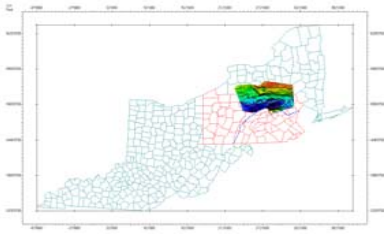


WV Wrench Fault with Trenton Sag



Preliminary Tully Two Way Time Structure





Kentucky Geological Survey

Trenton Black River Project

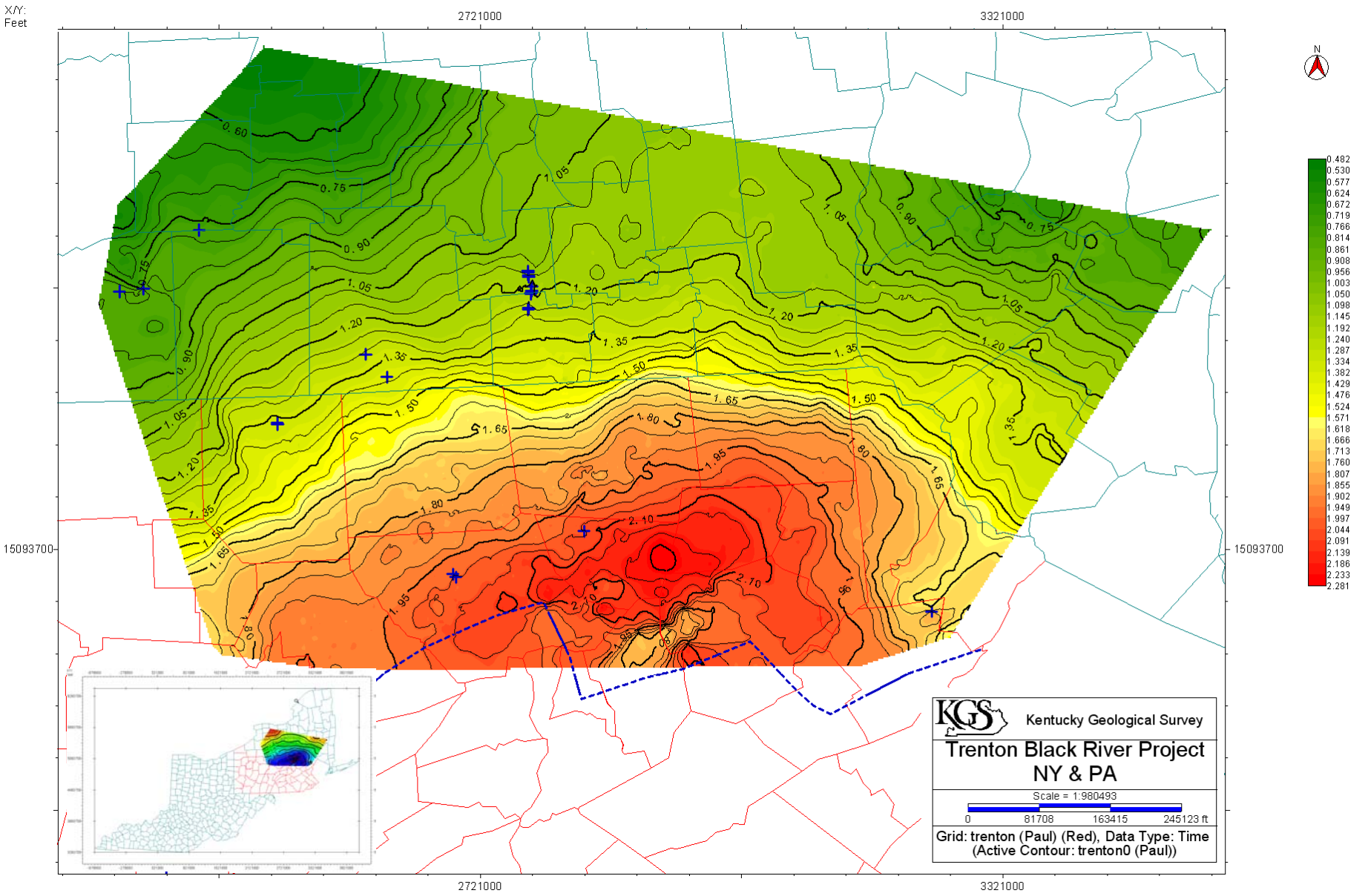
NY & PA

Scale = 1:702416

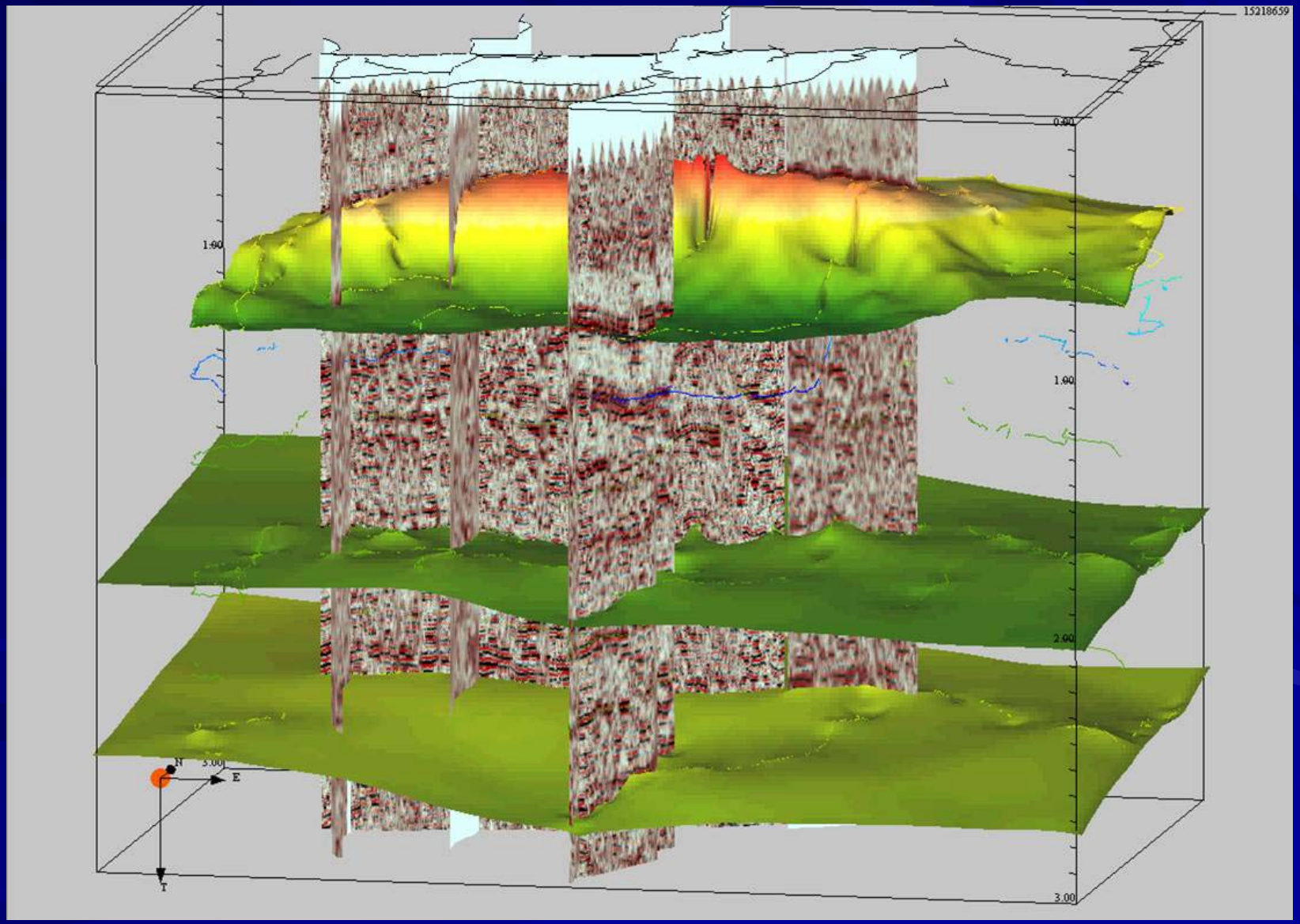
0 58535 117069 175604 ft

Grid: tully (Paul) (Red), Data Type: Time
(Active Contour: tully (Paul))

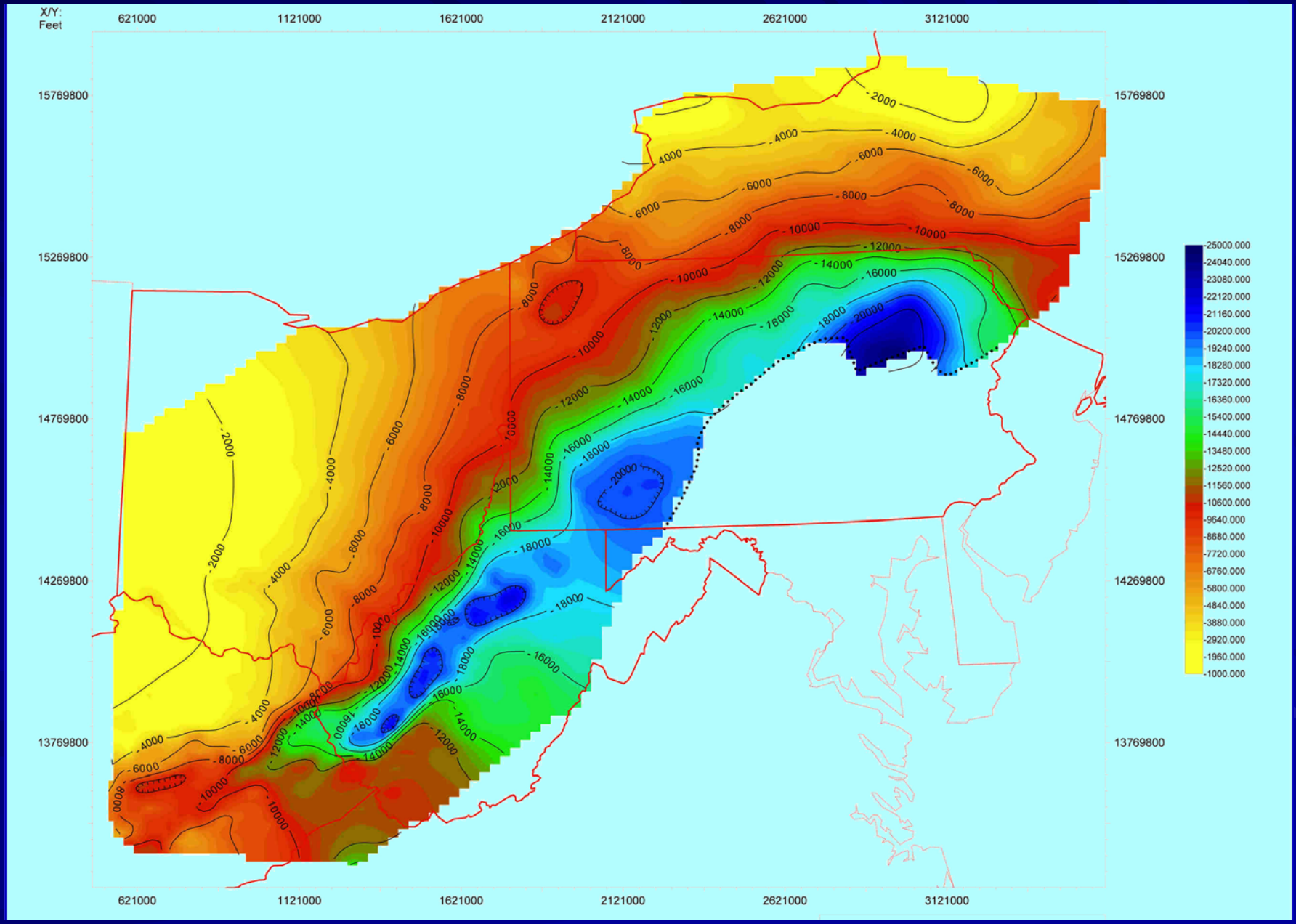
Preliminary Trenton 2-Way Time Structure



Gridding horizons across adjacent seismic lines



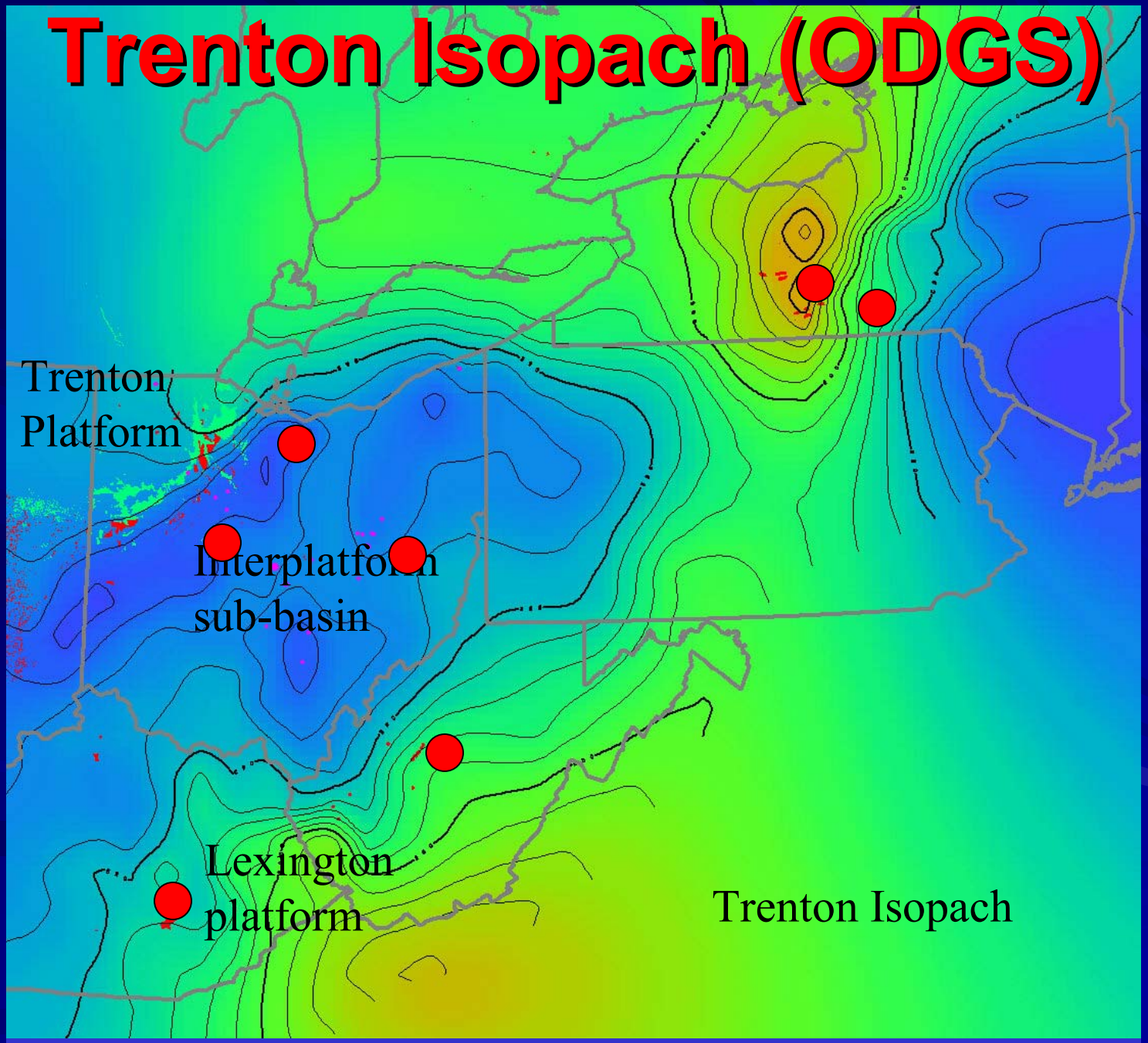
PC map combining wells & seismic



Ordovician seismic response

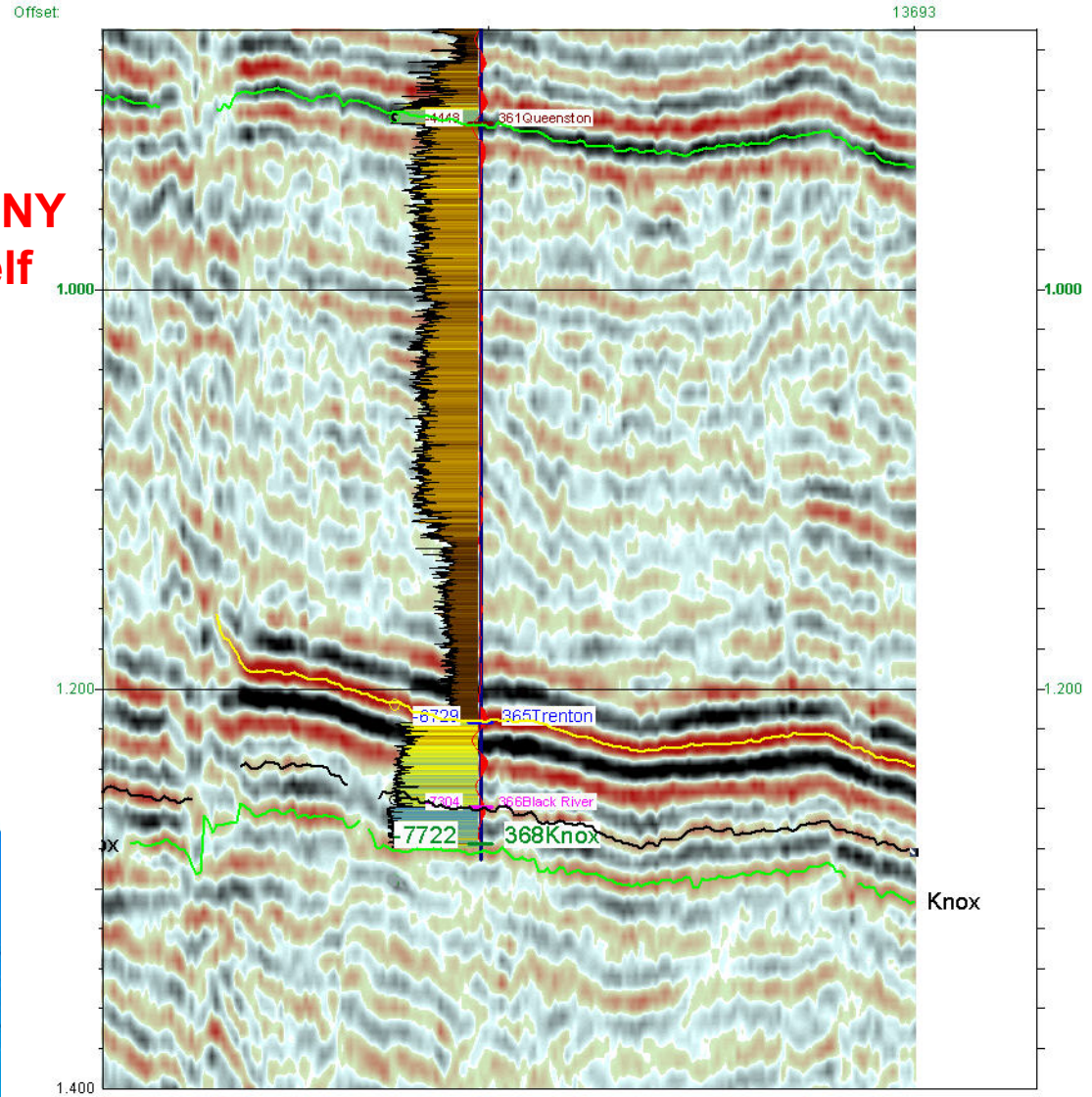
- Regional differences in seismic character of the Trenton-Black River interval
- How does local stratigraphy affect the seismic image?

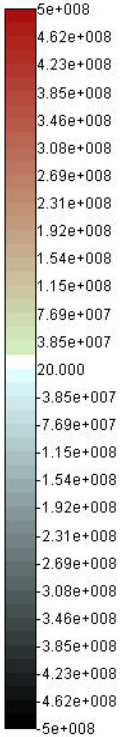
Trenton Isopach (ODGS)



Trenton Isopach

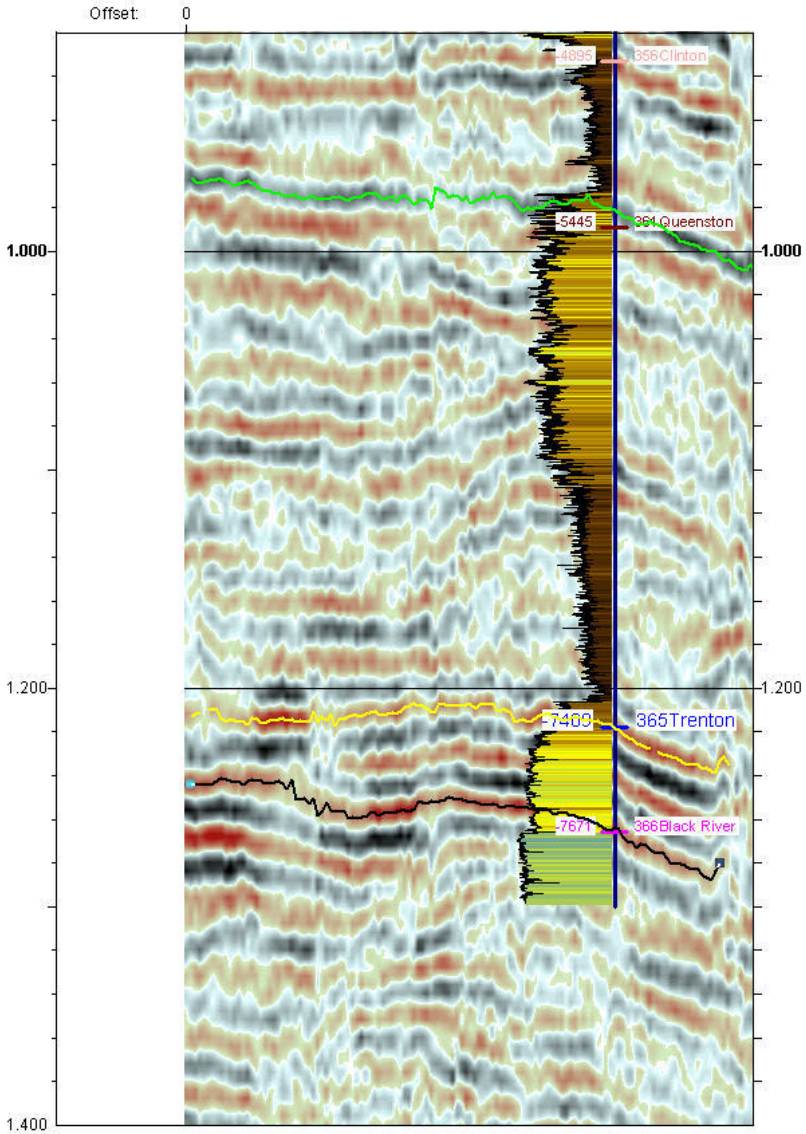
Schuyler Co, NY
Trenton shelf edge

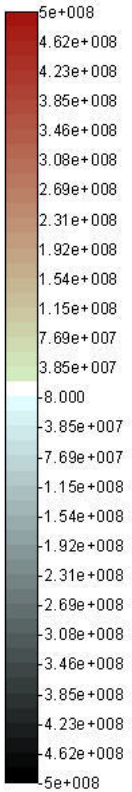


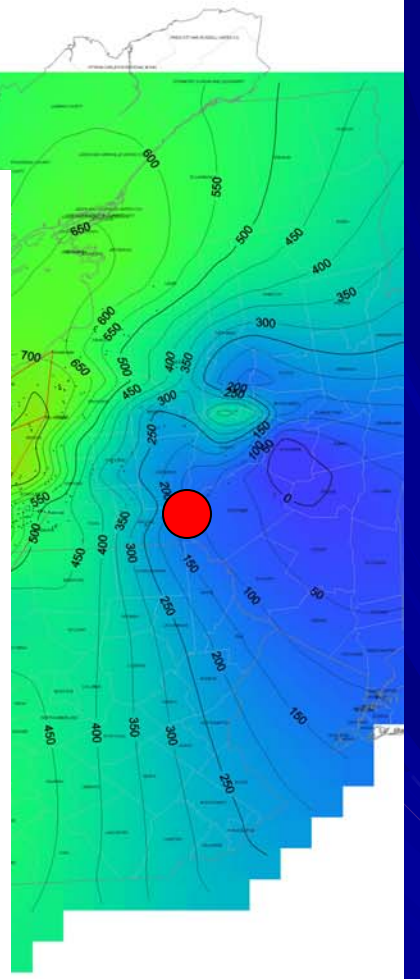


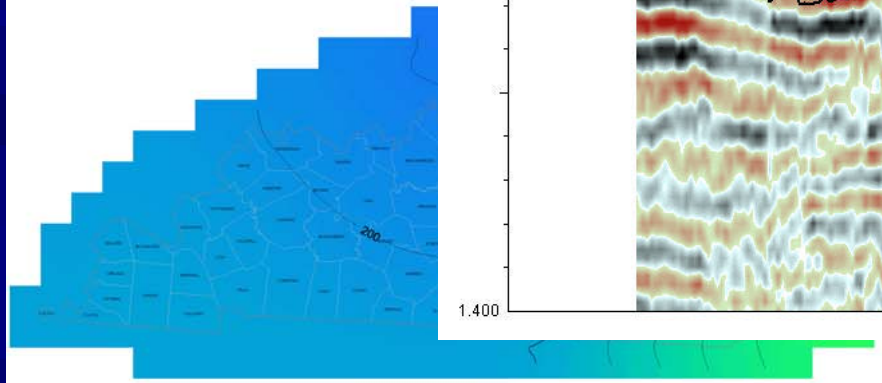
Trenton Isopach

Broome Co, NY
Trenton distal shelf



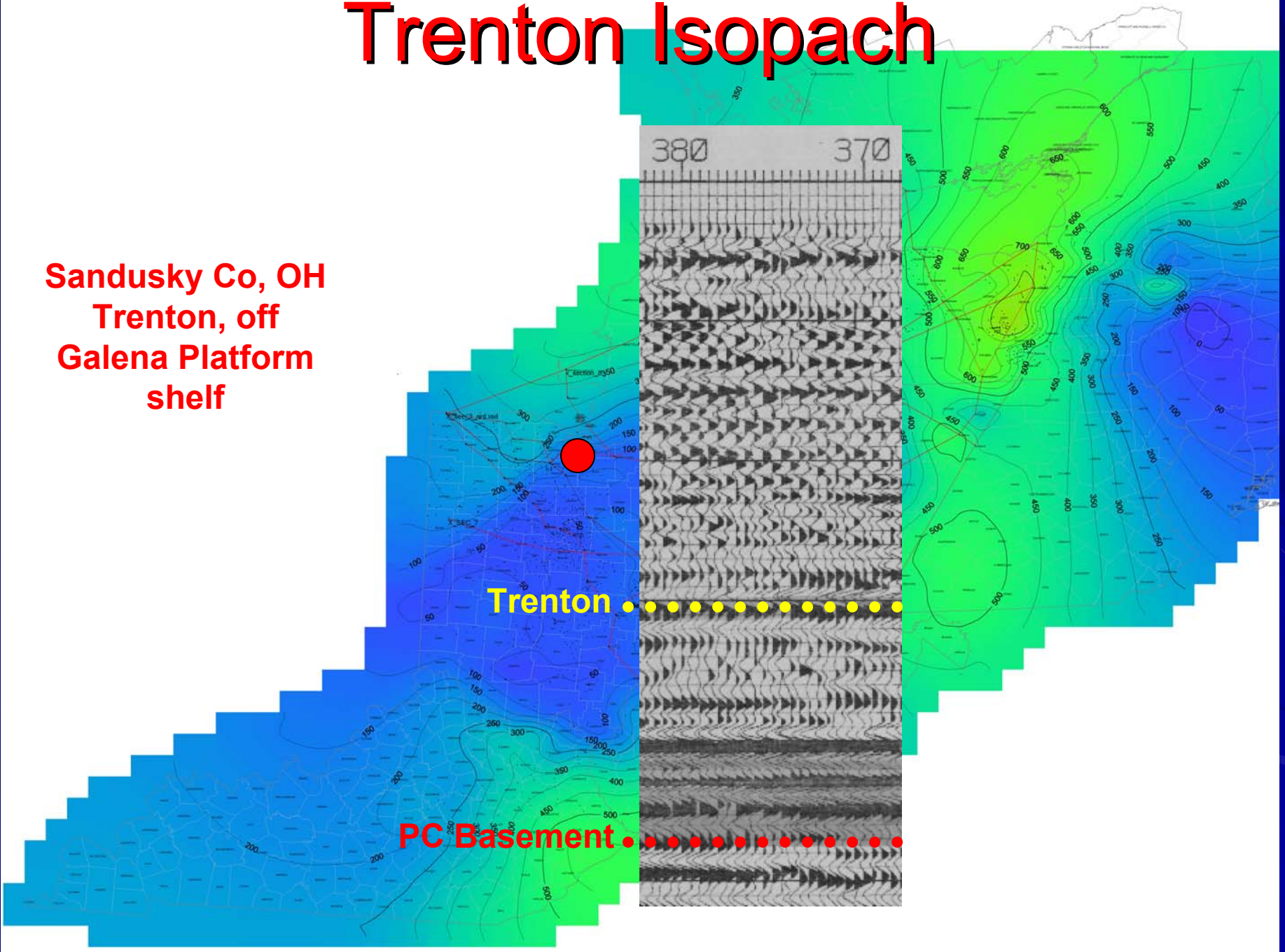






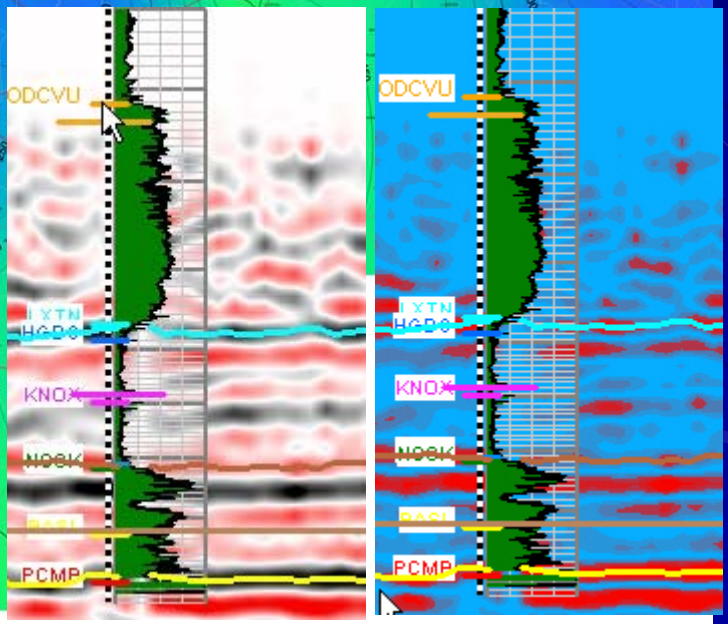
Trenton Isopach

Sandusky Co, OH
Trenton, off
Galena Platform
shelf



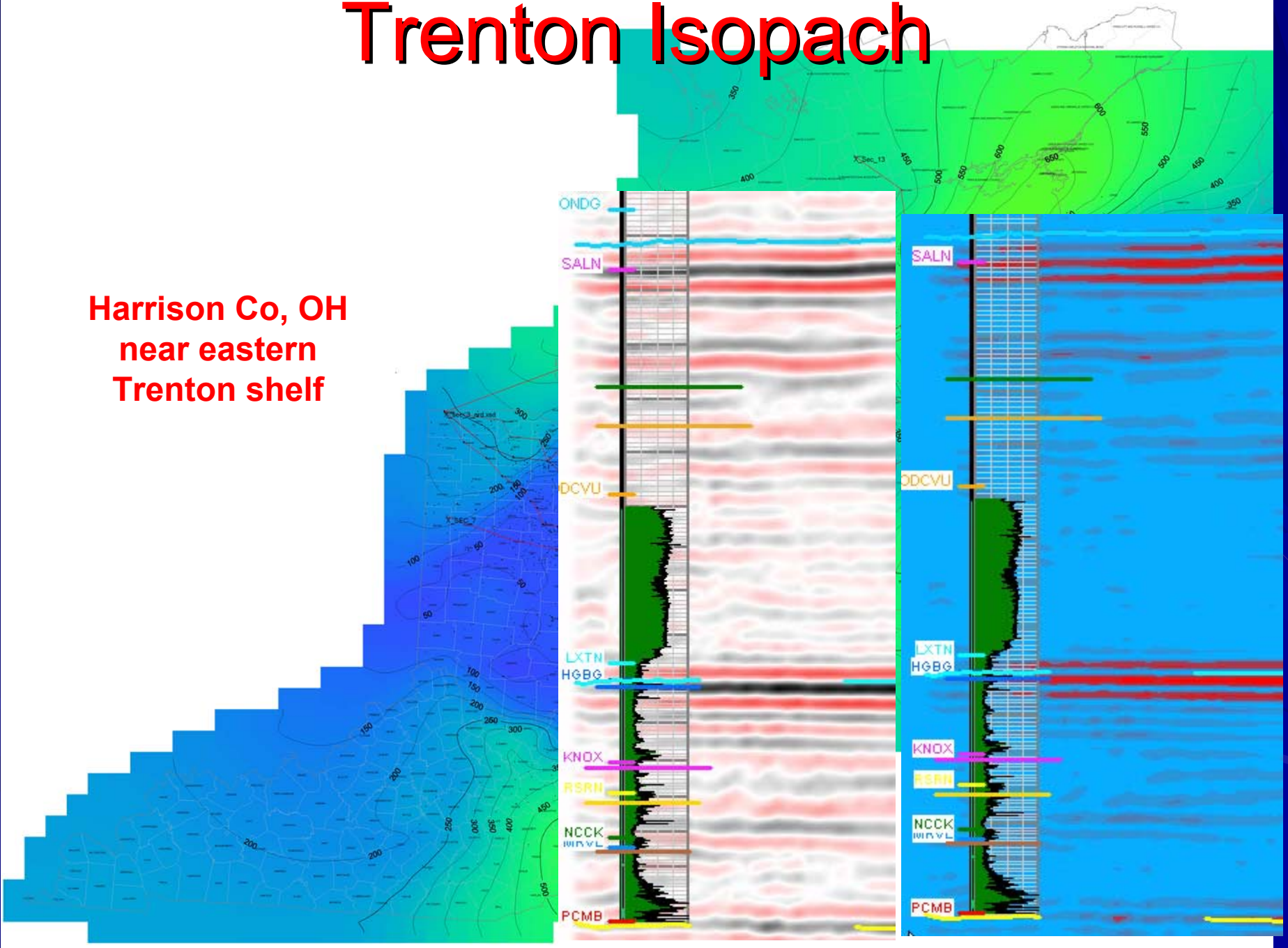
Trenton Isopach

Delaware Co, OH
Trenton, Sebree sub-basin



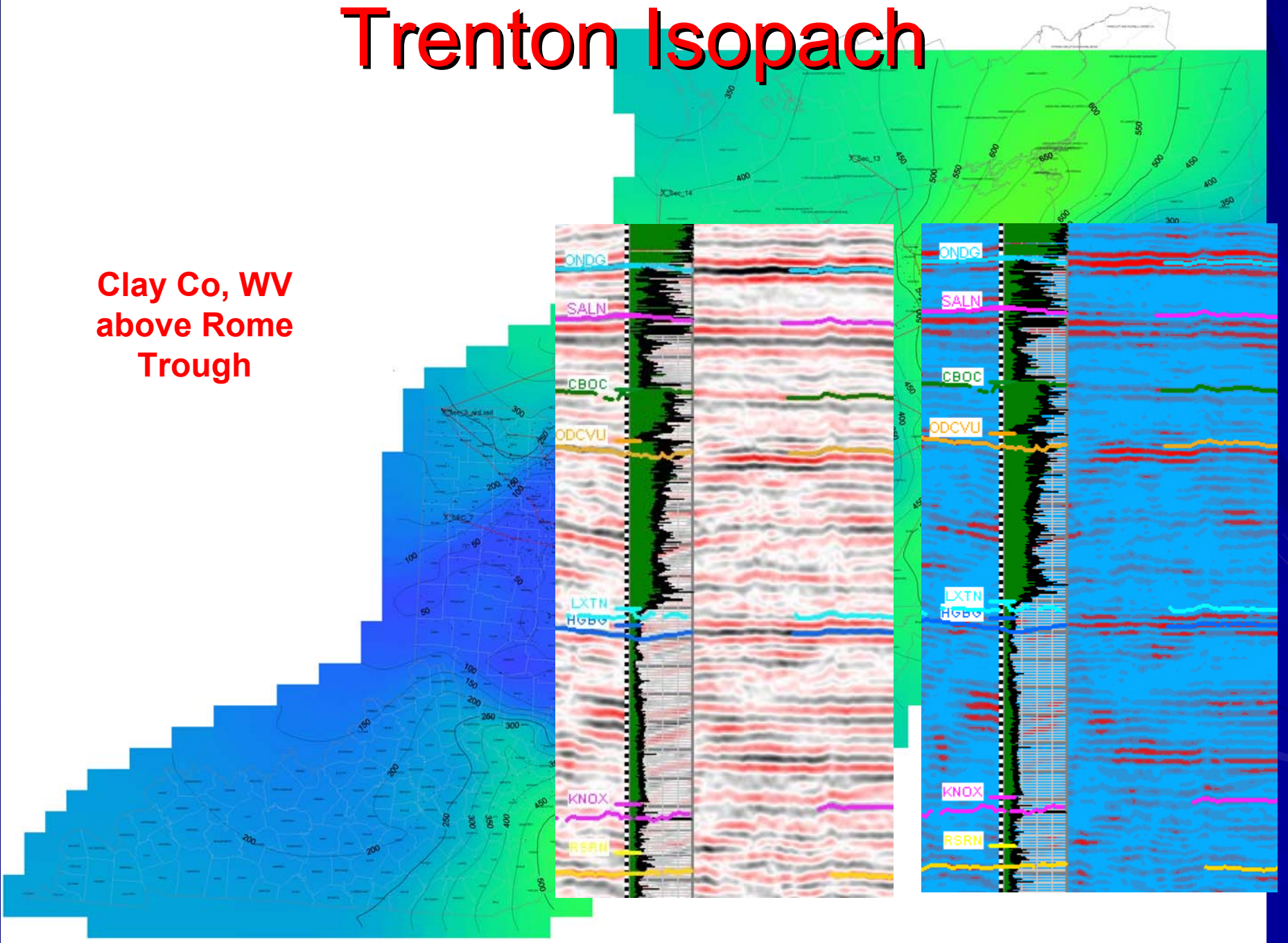
Trenton Isopach

Harrison Co, OH near eastern Trenton shelf



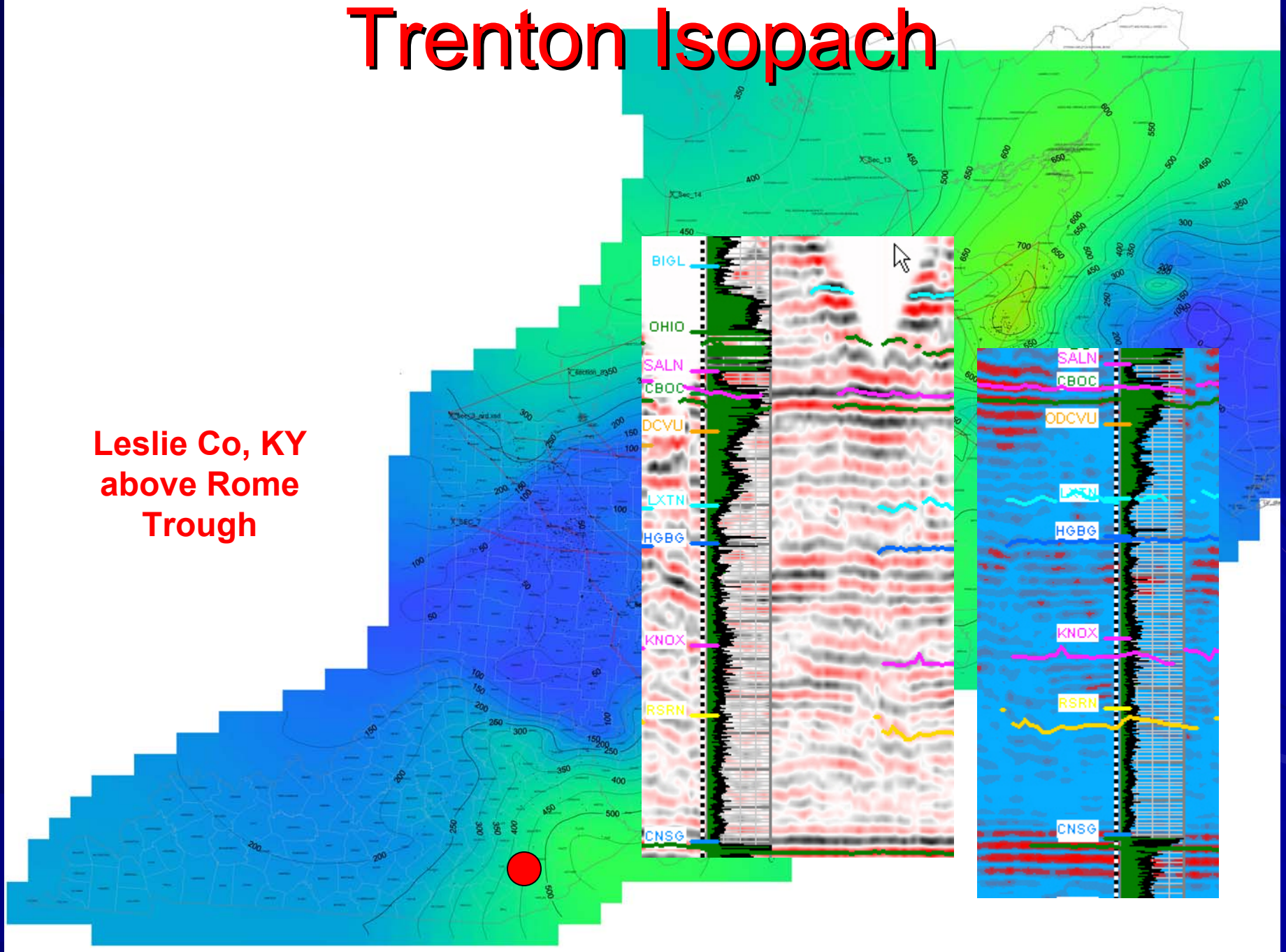
Trenton Isopach

Clay Co, WV above Rome Trough



Trenton Isopach

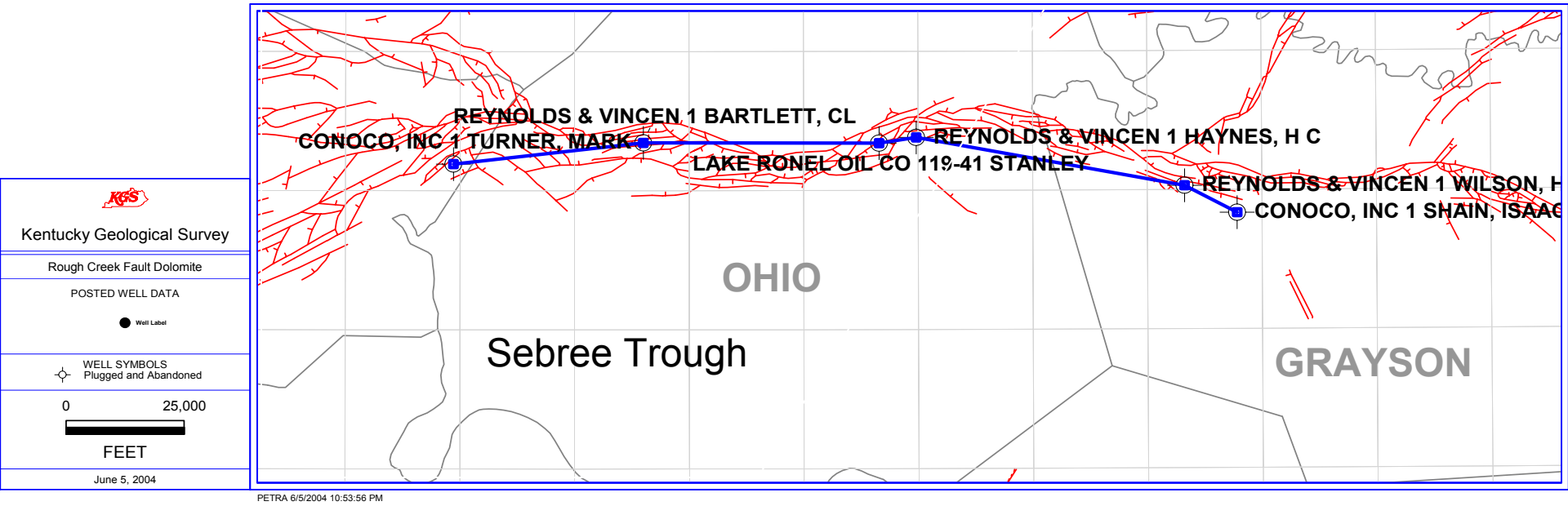
Leslie Co, KY above Rome Trough



What's Next?

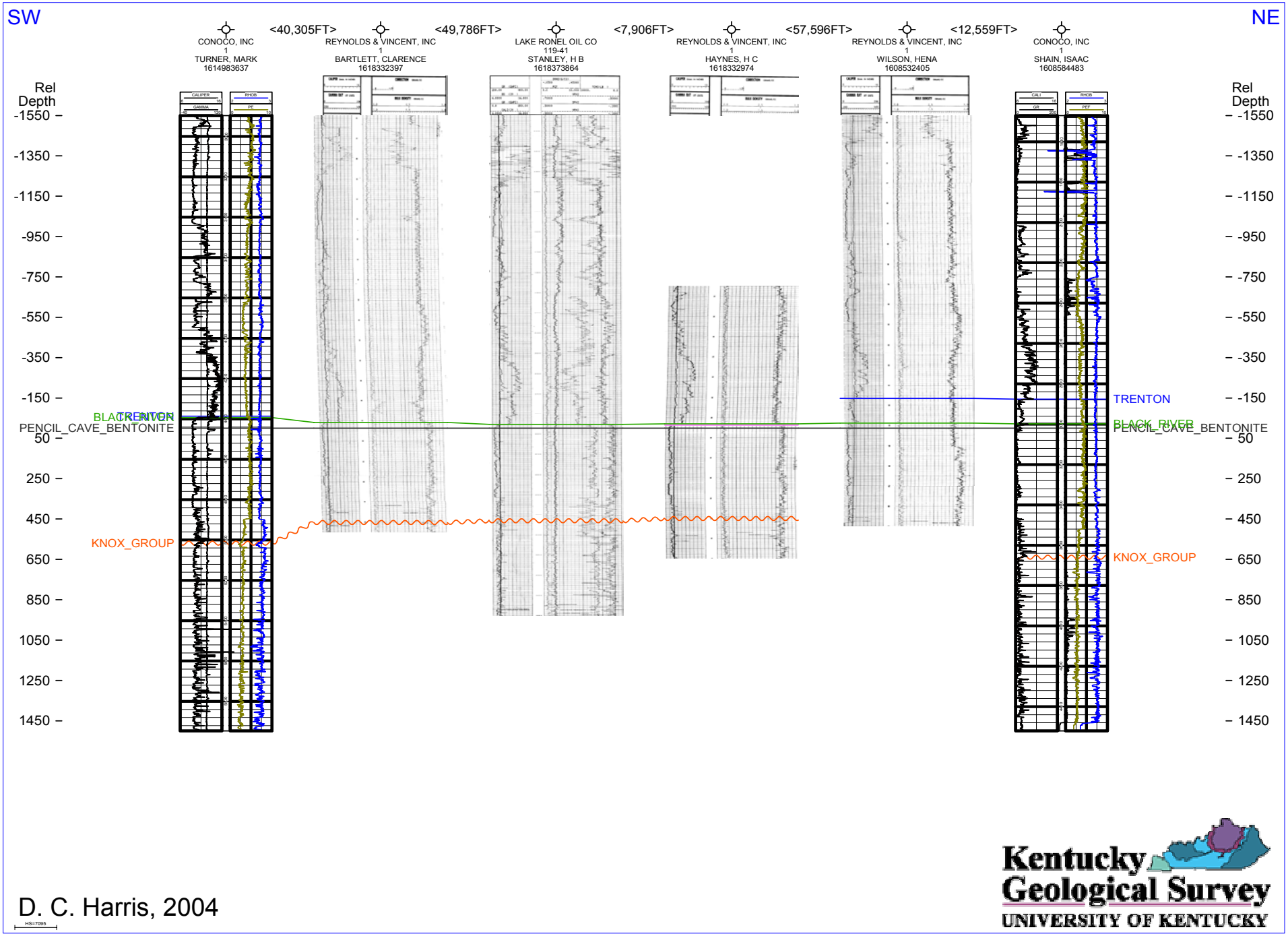
- Create regional fault trend maps
- Interpret magnitude and age of movement along fault trends
- Assist with interpretation of possible fairways of high reservoir potential

Tectonic Dolomitization, Rough Creek Fault Zone
Ohio and Grayson Counties, Ky.



D. C. Harris, 2004

Kentucky Geological Survey
UNIVERSITY OF KENTUCKY

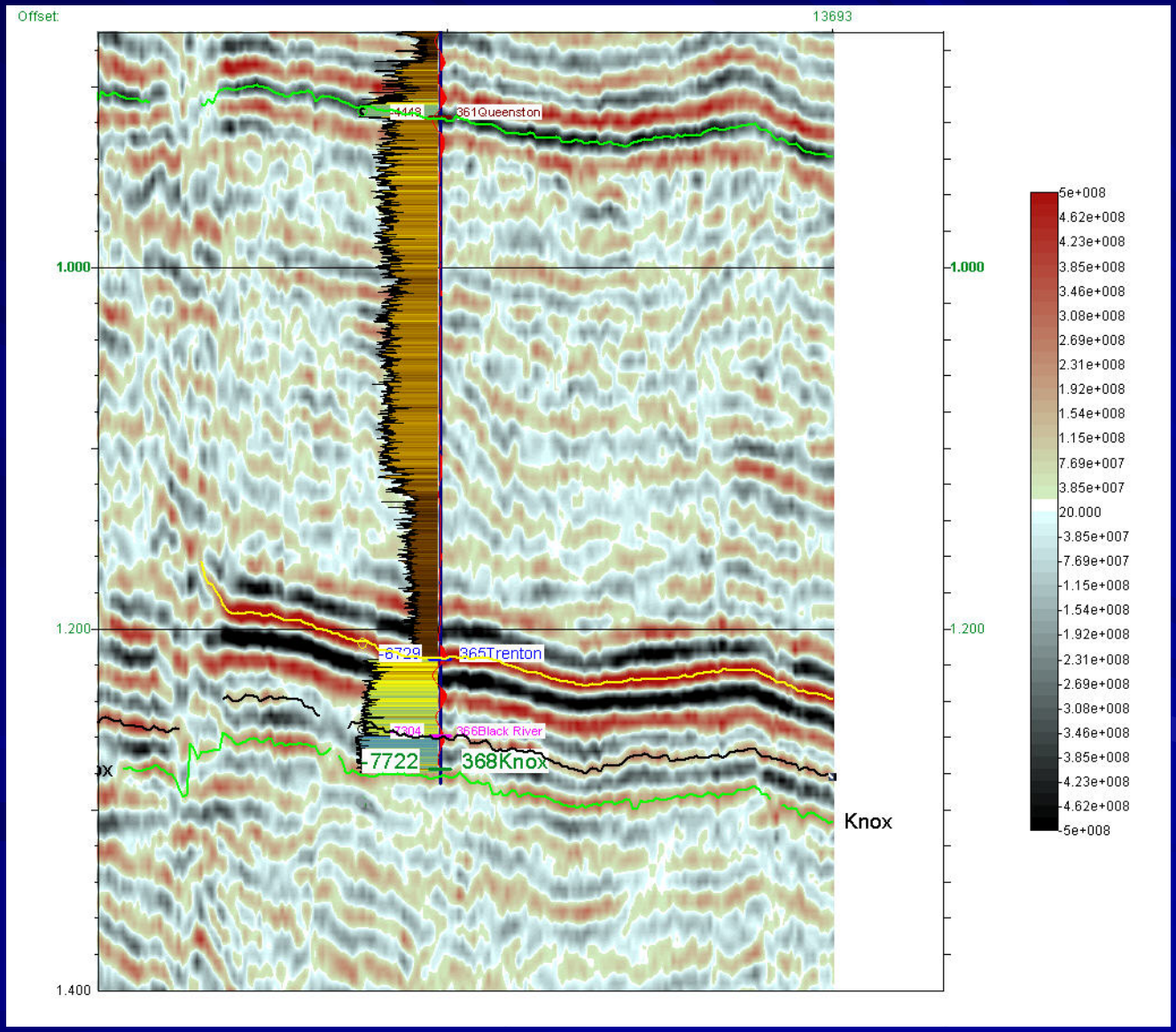


D. C. Harris, 2004

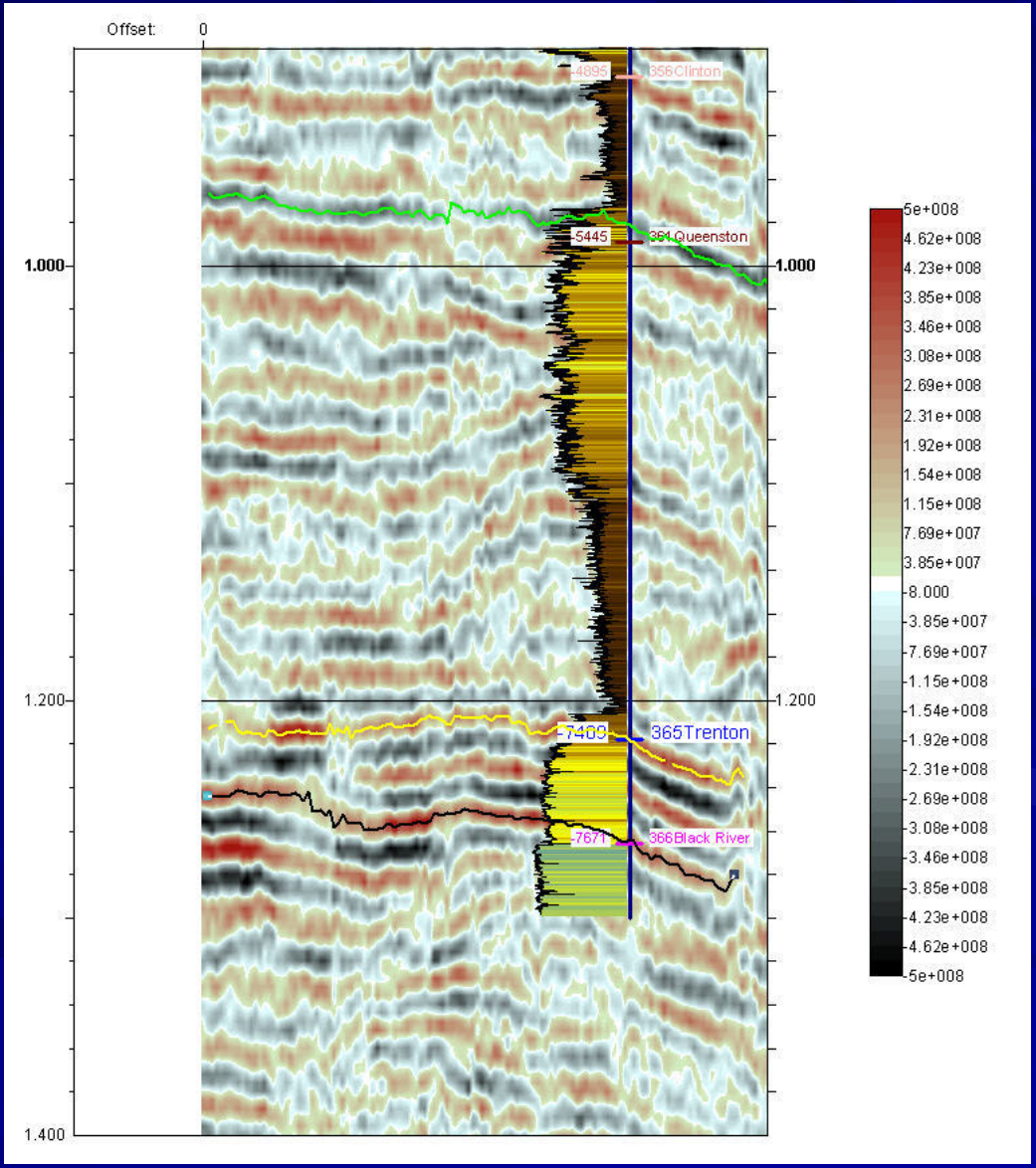
Kentucky Geological Survey
UNIVERSITY OF KENTUCKY

PETRA 6/5/2004 10:19:50 PM

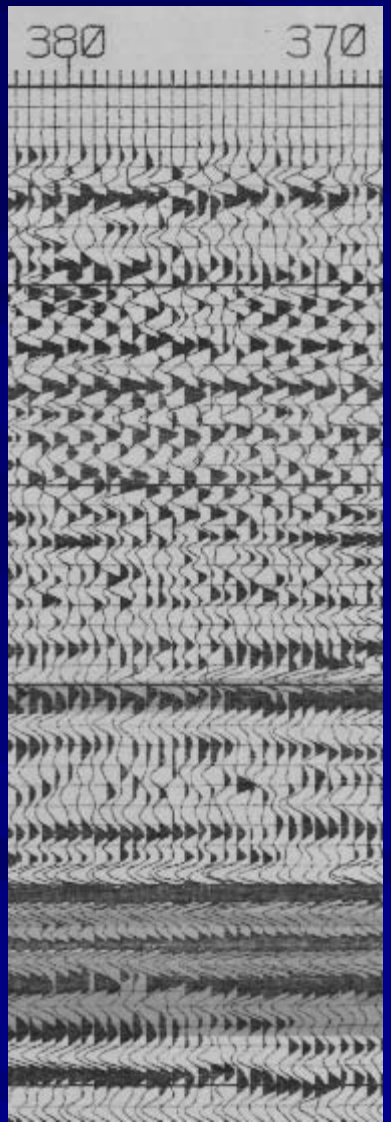
Central Southern New York



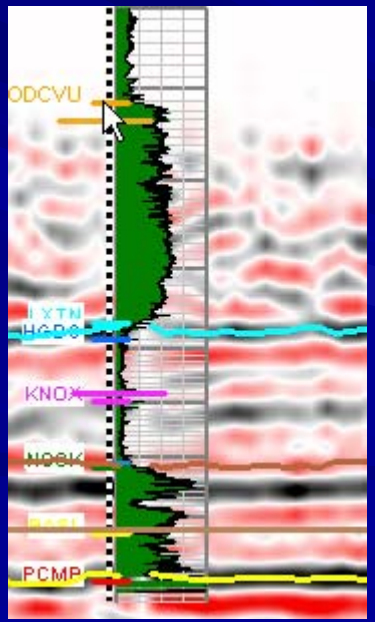
South-Southeast New York

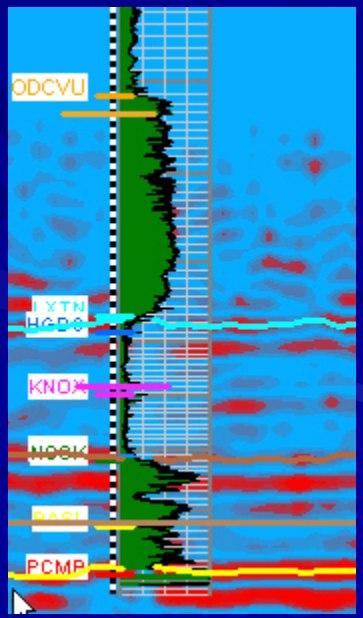


North Central Ohio

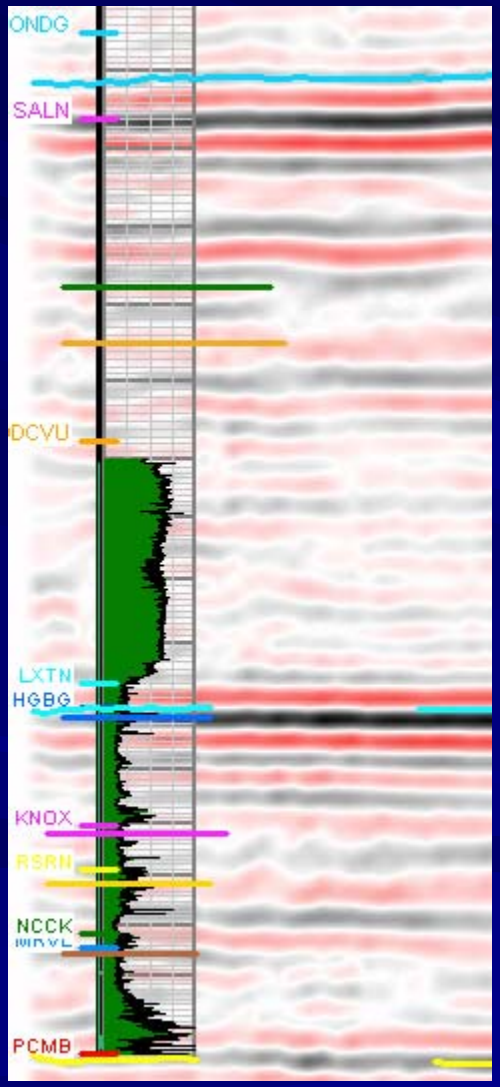


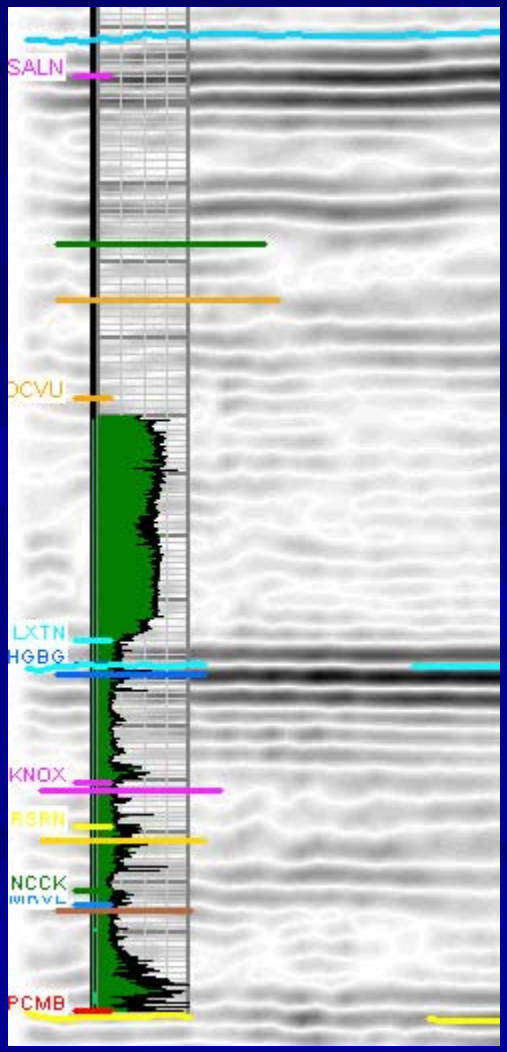
West Central Ohio

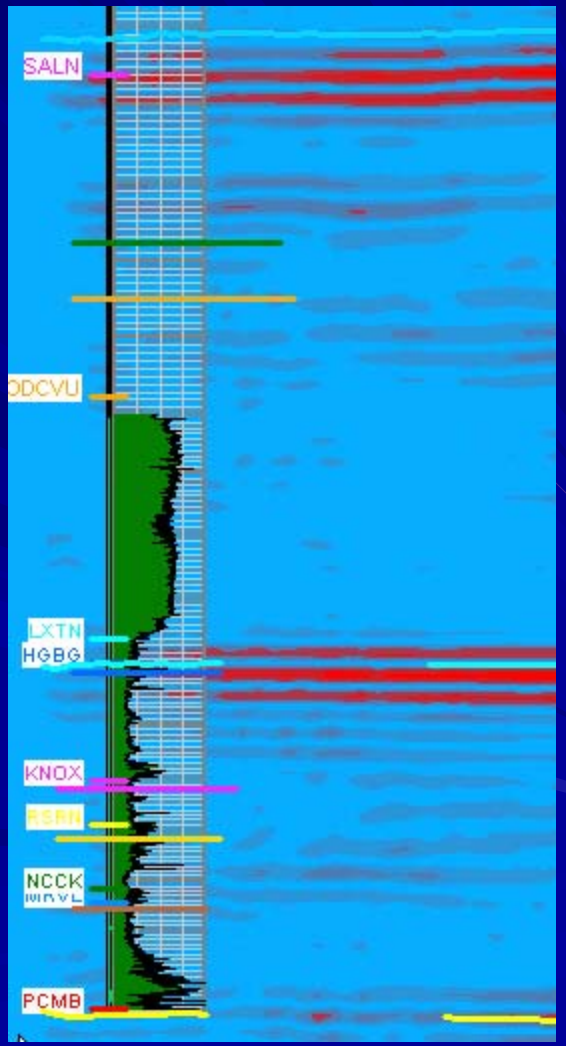




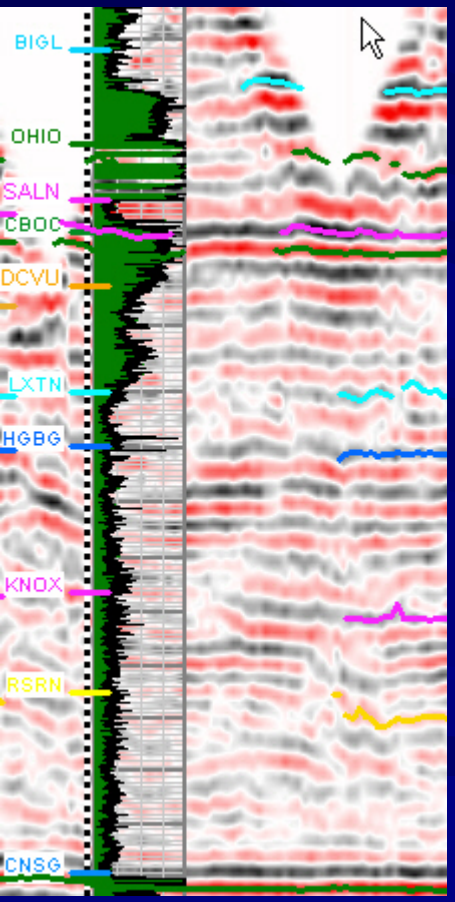
East Central Ohio

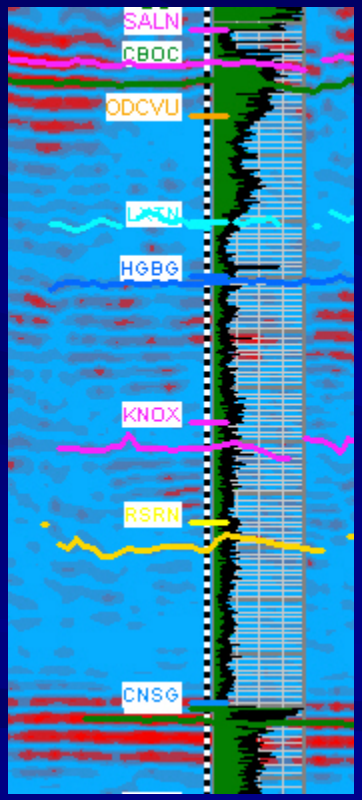






Southeastern KY





Central WV