Geologic Characterization for CO_2-EOR Simulation: A Case Study of the Farnsworth Unit, Anadarko Basin, Texas*

Dylan Rose-Coss[1], William Wampomah[1], Ashley C. Hutton[1], Evan Gragg[1], Peter Mozley[1], Robert S. Balch[1], and Reid Grigg[1]

Search and Discovery Article #80484 (2015)**
Posted October 19, 2015

*Adapted from oral presentation given at AAPG Annual Convention & Exhibition, Denver, Colorado, May 31-June 3, 2015
**Datapages © 2015 Serial rights given by author. For all other rights contact author directly.

[1]Petroleum Recovery and Research Center, New Mexico Tech, Socorro, New Mexico (dylan435@gmail.com)

Abstract

The once prolific hydrocarbon reservoirs of the Pennsylvanian Morrowan sequence of northwest Texas through Southeast Colorado in the United States currently presents an opportunity for Carbon Dioxide (CO_2) enhanced oil recovery (EOR) and carbon sequestration. The Farnsworth Unit (FWU) of Ochiltree County, Texas operated by Chaparral Energy L.L.C. is the site of a CO_2-EOR project using anthropogenic CO_2 and a Southwest Regional Partnership on Carbon Sequestration carbon capture, utilization and sequestration project sponsored by the Department of Energy's National Energy Technology Laboratory. The target reservoir is the Upper Morrow sandstone (Morrow-B). Cores and associated thin sections were analyzed to interpret mineralogy, provenance, diagenetic history, depositional environment and porosity types. This information, combined with legacy well log data and a new 3D seismic survey, was used to create a fine scale lithofacies based geologic model of the field. Forty-eight wells with permeability and porosity core data were then used for property modeling. In addition, 7 wireline logs were interpreted for porosity and incorporated into the modeling. A variety of geostatistical techniques were used to populate reservoir rock properties. Quality checks were performed to ascertain which geostatistical technique resulted in the best property distribution. The geological model was upscaled for numerical flow simulation. A history match of the waterflood was constructed as the basis for the CO_2-EOR study. The performance of the current CO_2-flood patterns was analyzed and optimized for CO_2 storage and EOR. The lithofacies based geologic model was successfully used to constrain the porosity and

permeability distributions. The quality check procedure ensured the well log and core data were honored in the property modeling. The results from the simulation show a great potential for CO_2 storage and prolific oil production from the FWU. This study can serve as a benchmark for potential CO_2-EOR projects in the Anadarko Basin.

References Cited

Blakey, Ron. https://www2.nau.edu/rcb7/globaltext2.html (Web accessed September 9, 2015)

Bowen, D., and P. Qeimer, 2003, Regional sequence stratigraphic setting and reservoir geology of Morrow incised valley sandstones (Lower Pennsylvanian), eastern Colorado and western Kansas: AAPG Buletin, v. 87/5, p. 781-815.

Puckette, Jim, Abdalla Azhari, Aaron Rice, and Z. Al-Shaieb, 1996, The Upper Morrow reservoirs: complex fluvial-deltaic depositional systems: Oklahoma Geol. Survey, Circ. 98, p. 47-84.

Puckette, James, and Z. Al-Shaieb, 2008, Sequence stratigraphy, lithofacies, and reservoir quality, Upper Morrow sandstones, Northwestern Shelf, Anadarko Basin: Oklahoma Geol. Survey, Circ. 111, p. 81-96.

Gallagher, S., P.S. Mozley, S.M. Cather, 2014, Depositional and diagenetic controls on reservoir heterogeneity: Upper Morrow Sandstone, Farnsworth Unit, Ochiltree County, Texas: Thesis, New Mexico Institute of Mining and Technology.

U.S. Department of Energy, 2012, Carbon Utilization and Storage Atlas, Fourth Edition.

Geologic Characterization for CO2-EOR Simulation: a Case Study of the Farnsworth Unit, Anadarko Basin, Texas

Authors: Dylan Rose-Coss, William Ampomah, Ashley C. Hutton, Peter Mozley, Robert Balch, Martha Cather, Reid Grigg.

NEW MEXICO TECH

SCIENCE • ENGINEERING • RESEARCH • UNIVERSITY

PRRC

SOUTHWEST PARTNERSHIP

U.S. DEPARTMENT OF ENERGY

NETL National Energy Technology Laboratory

Chaparral ENERGY

Outline

- Location and Farnsworth field and dataset overview.
- Geologic setting; tying Farnsworth field into the regional depositional model.
- Reservoir depositional and structural architecture.
- Recent developments on geologic model to be used in flow simulations.

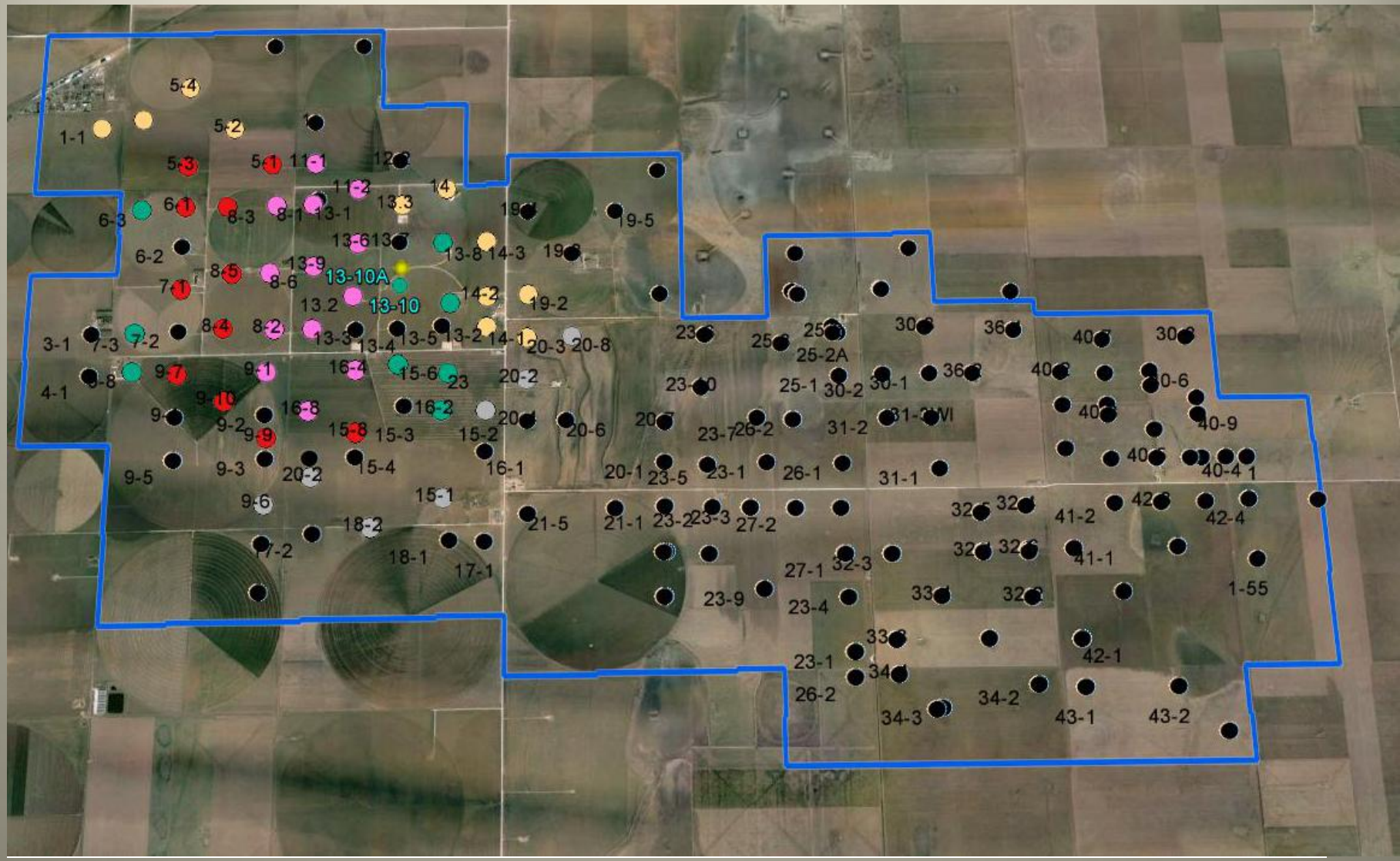
Farnsworth Field and Anthropogenic sources

- Farnsworth Field
  Site of EOR-CCUS
- Arkalon
  Ethanol Plant
  Liberal, Kansas
- Agrium
  Fertilizer Plant
  Borger, Texas

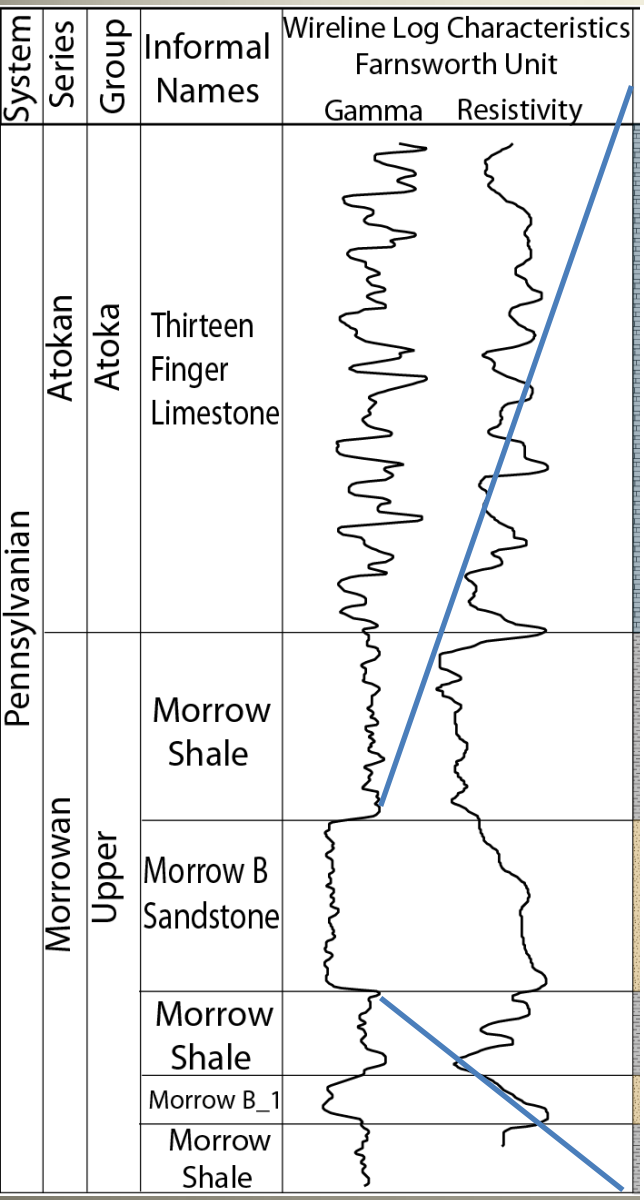
Project's goal is to inject 1 million tonnes of Anthropogenic CO2

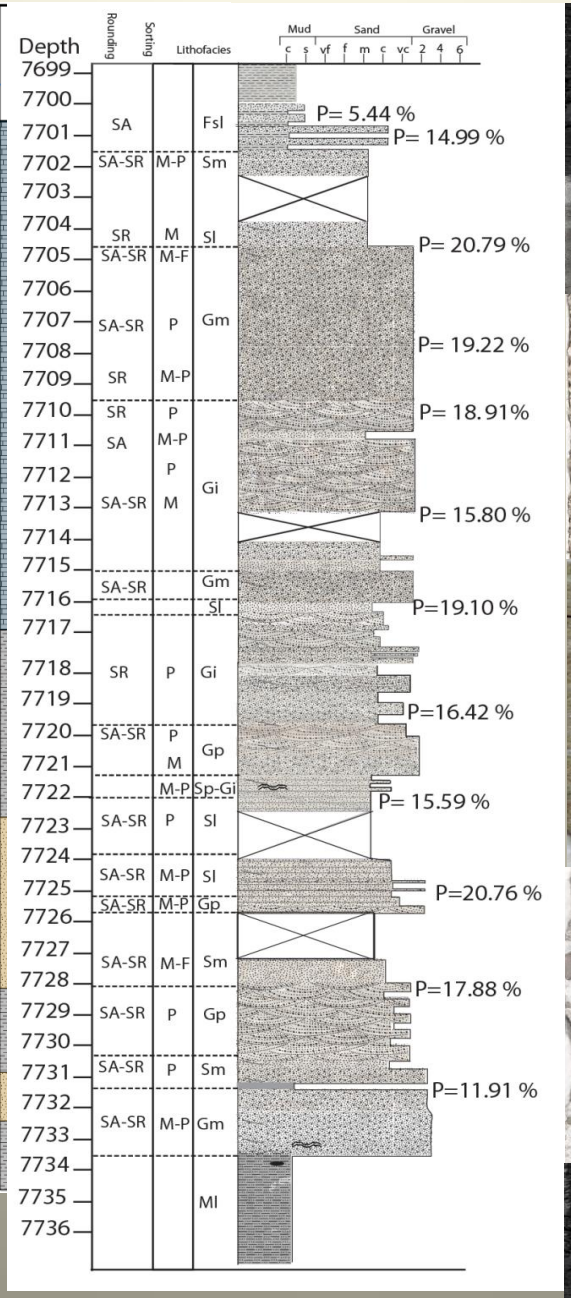
drillinginfo.com/anadarko-basin-oklahoma-oil-and-gas-industry-ok

Farnsworth Field



Farnsworth Type Section





Mudstone

Fine grained sandstone

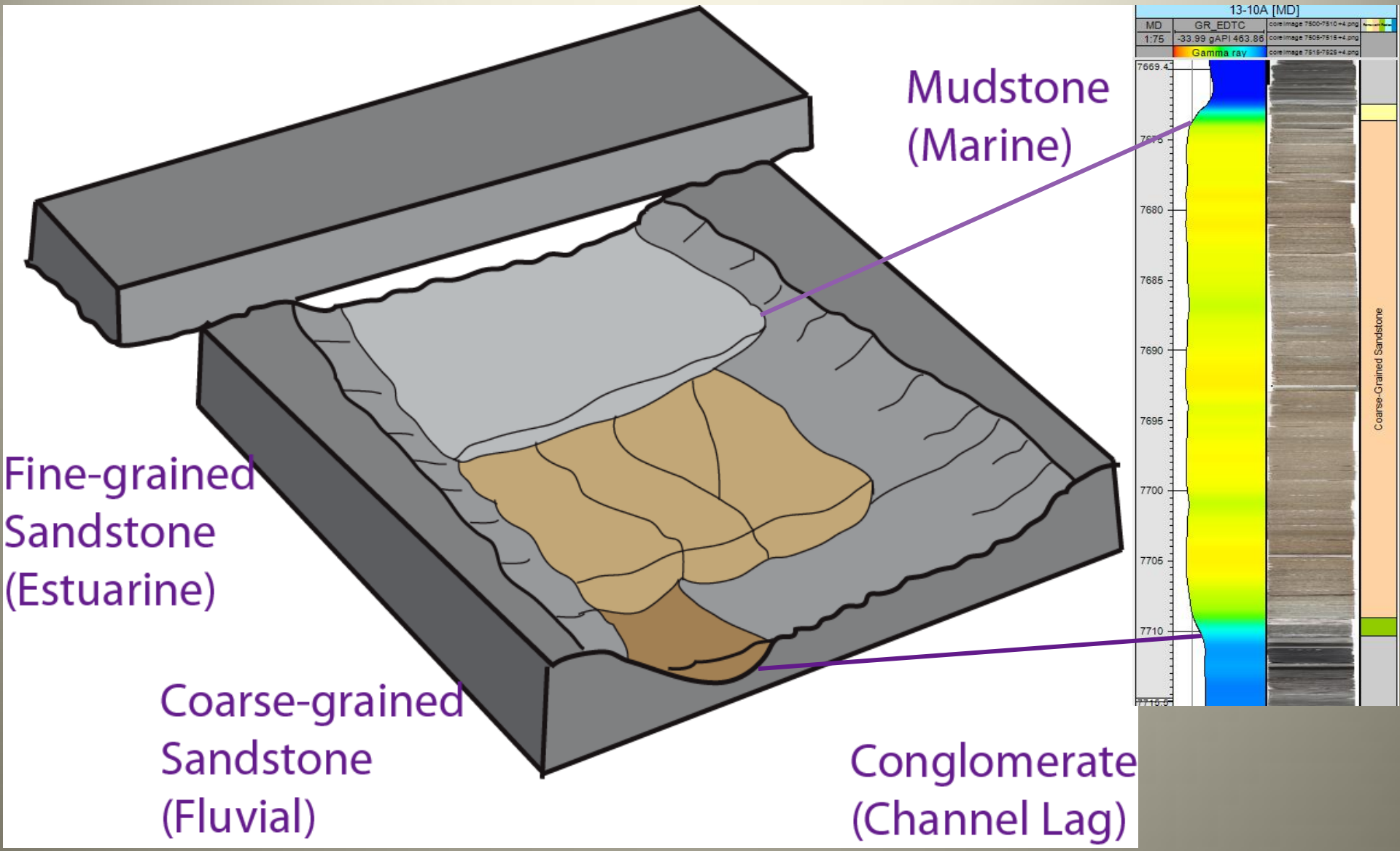
Coarse grained sandstone

Cross bedded sandstone

Conglomerate

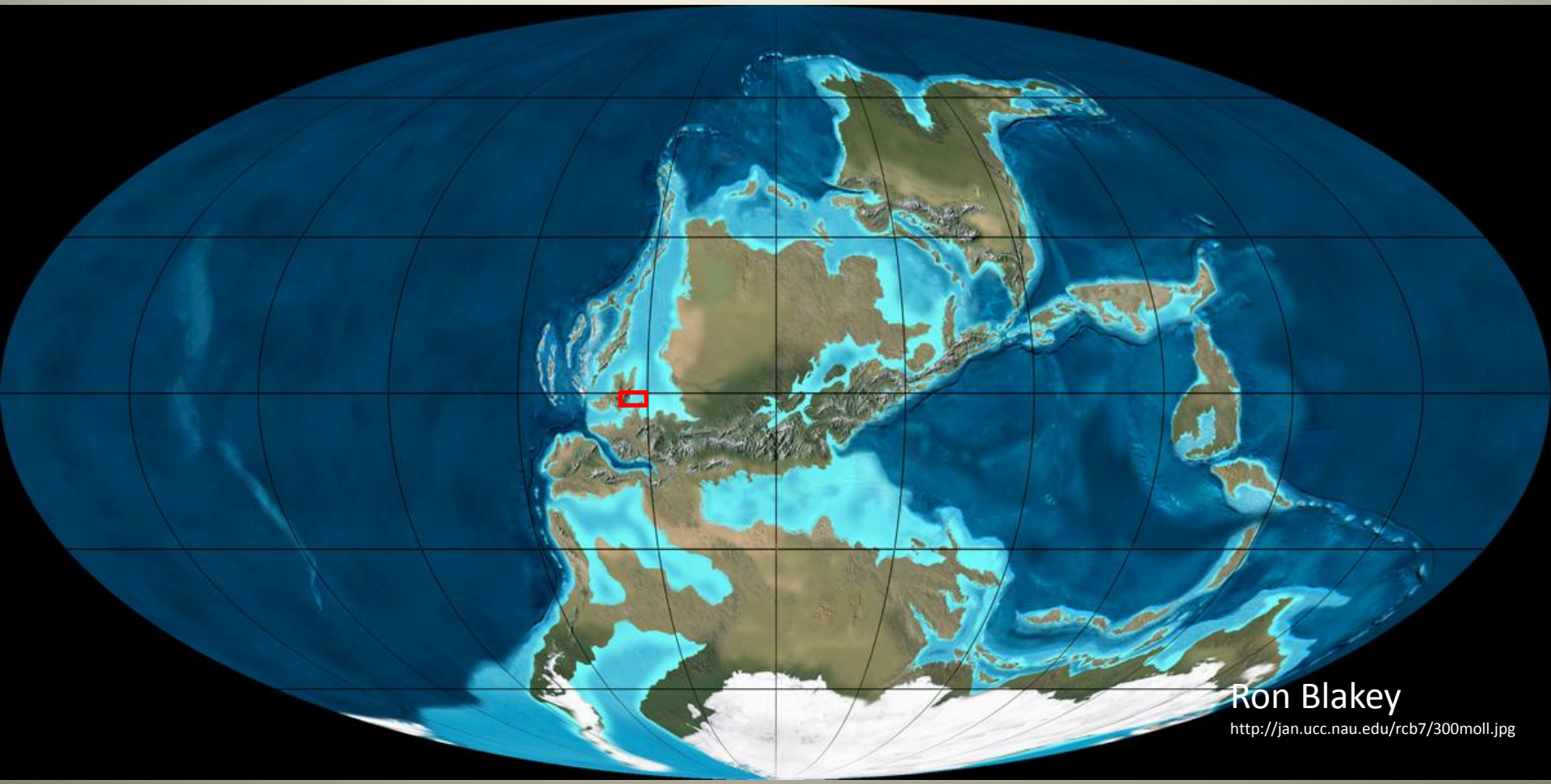
Mudstone

Incised River Depositional Model

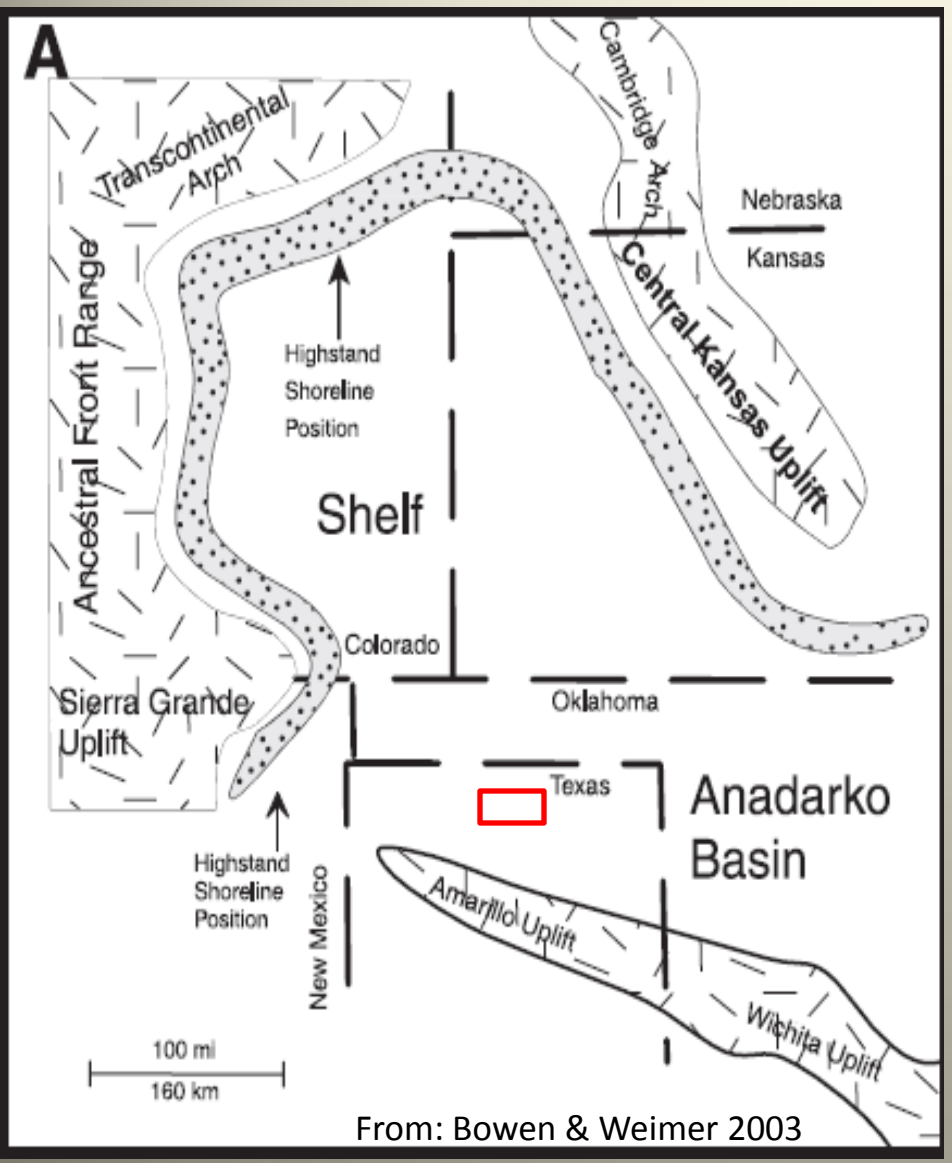


From Gallagher, 20014. Modified from Puckette, et , al., 2008

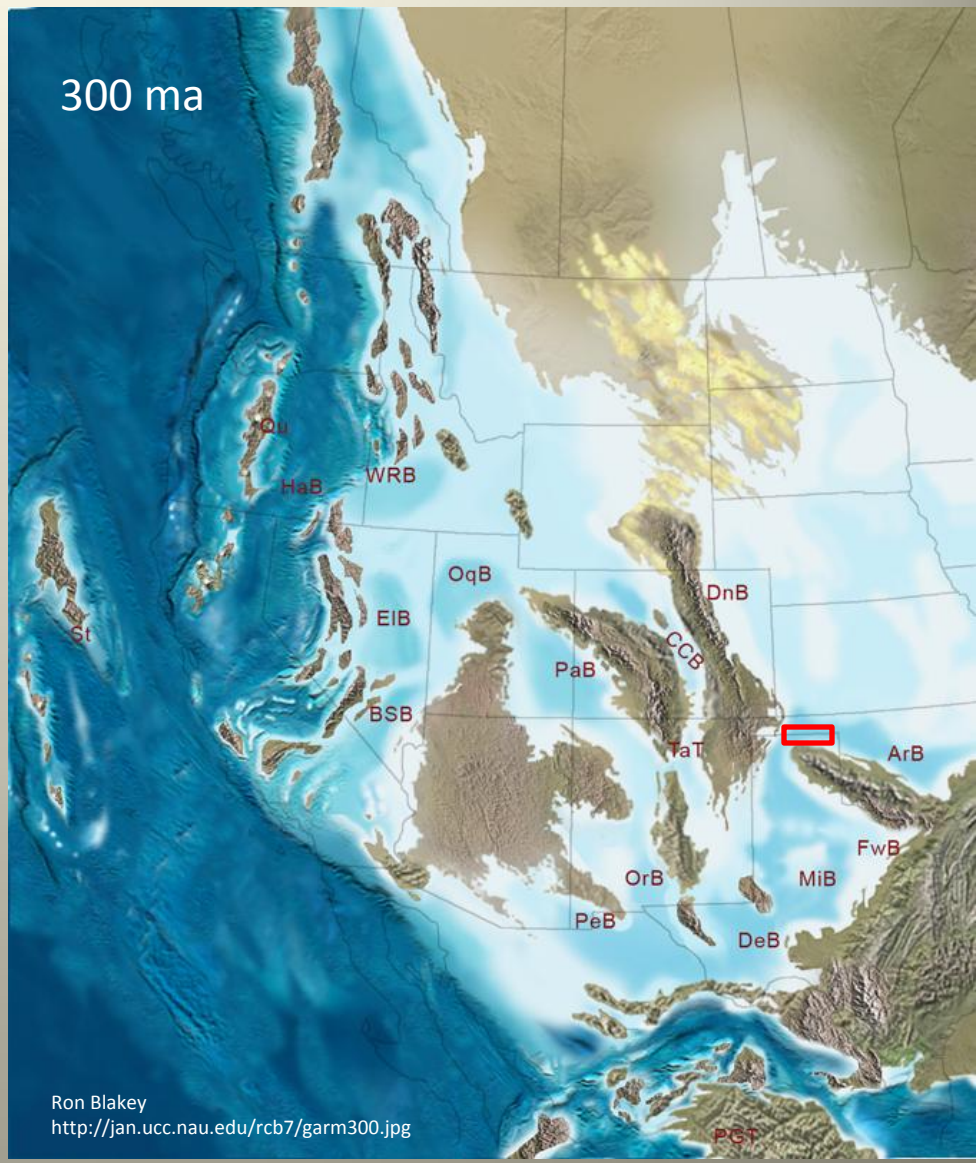
The World during the Pennsylvanian 300 ma.



Field area during high stand system track

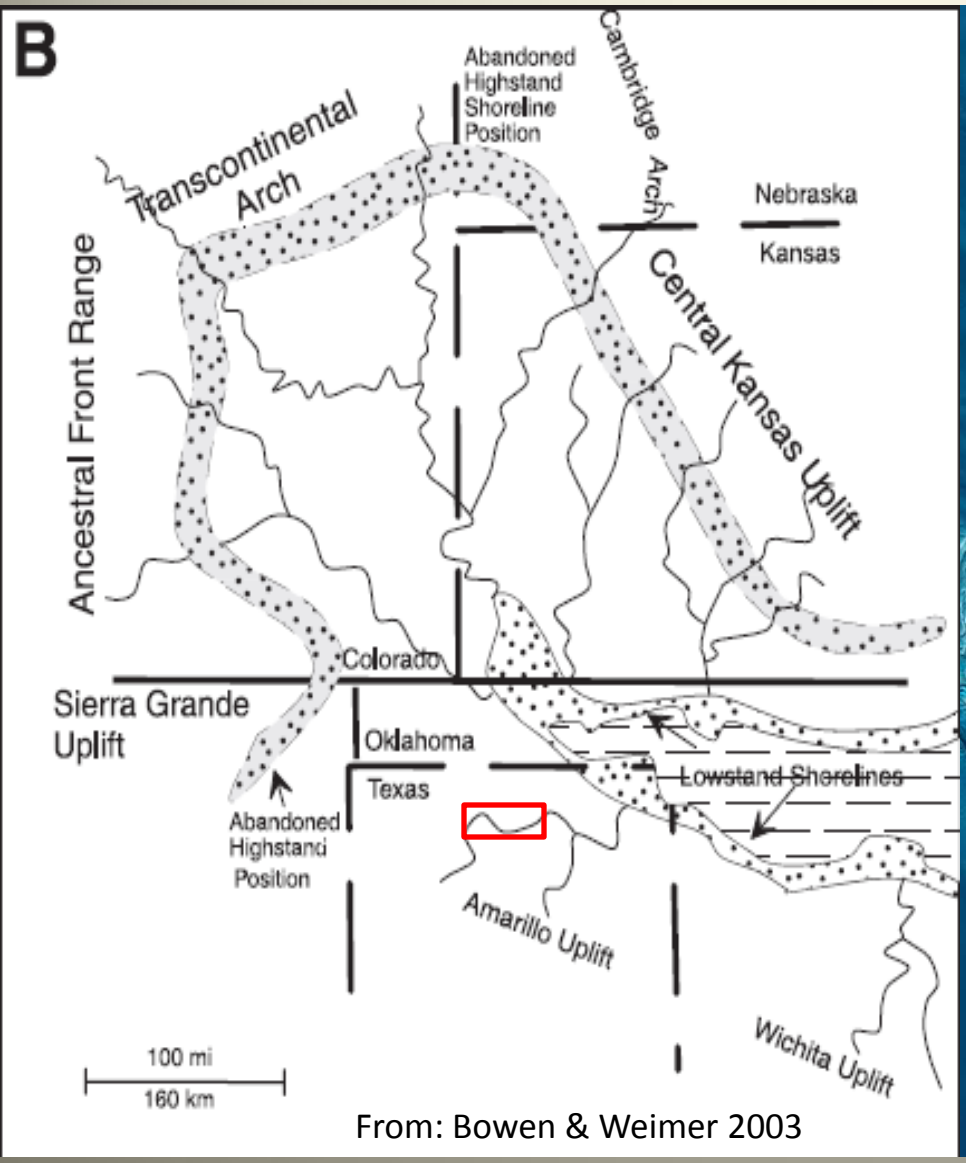


From: Bowen & Weimer 2003

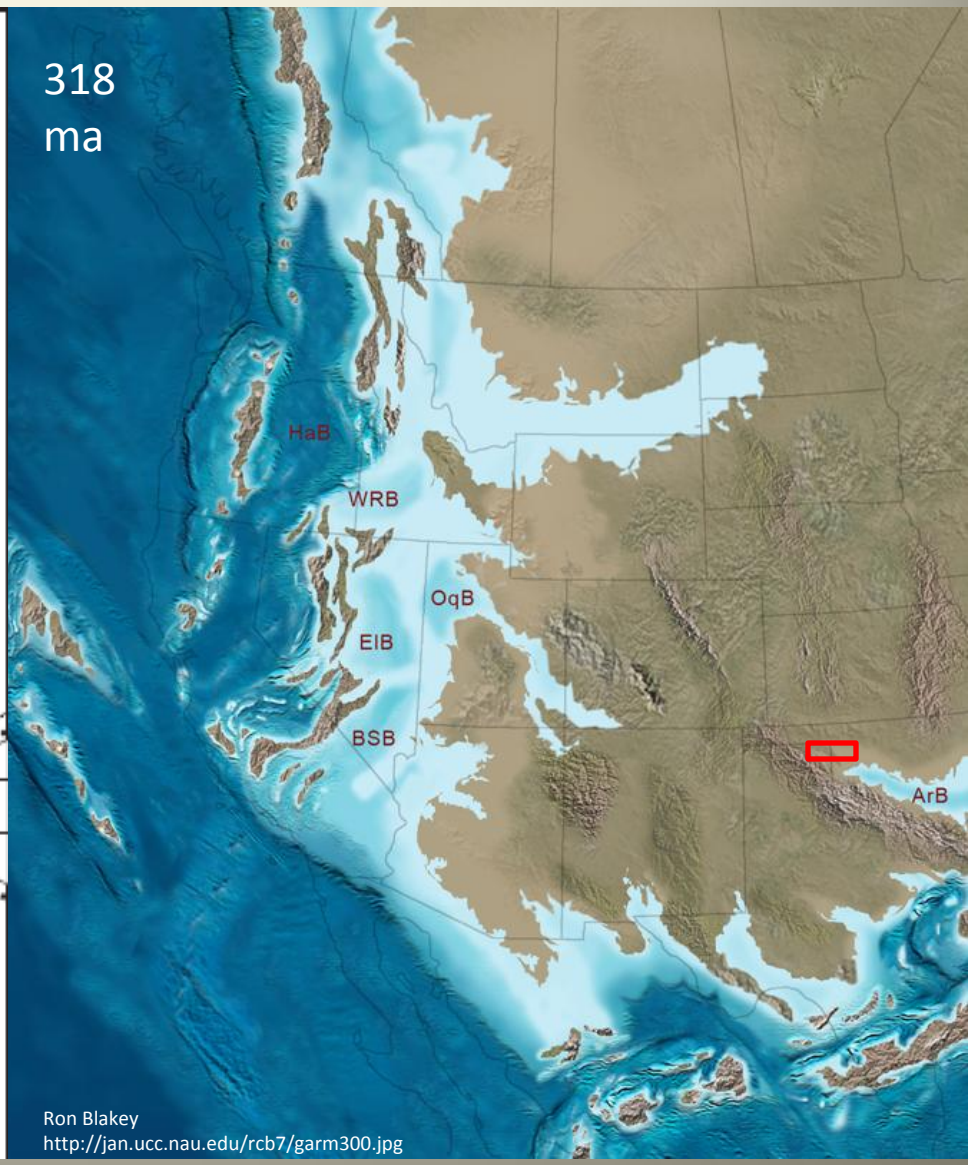


Ron Blakey
http://jan.ucc.nau.edu/rcb7/garm300.jpg

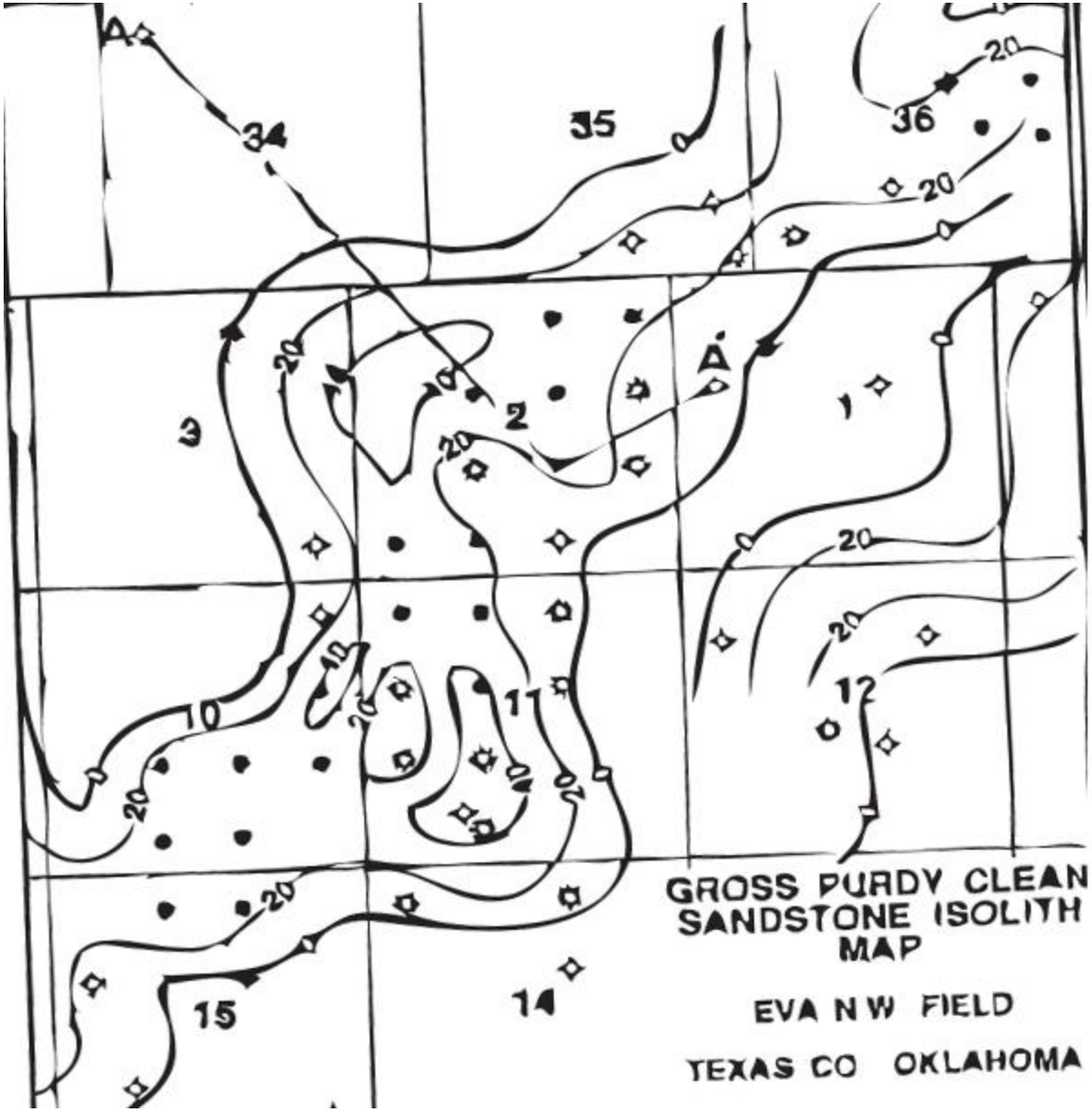
Field area during low stand system track



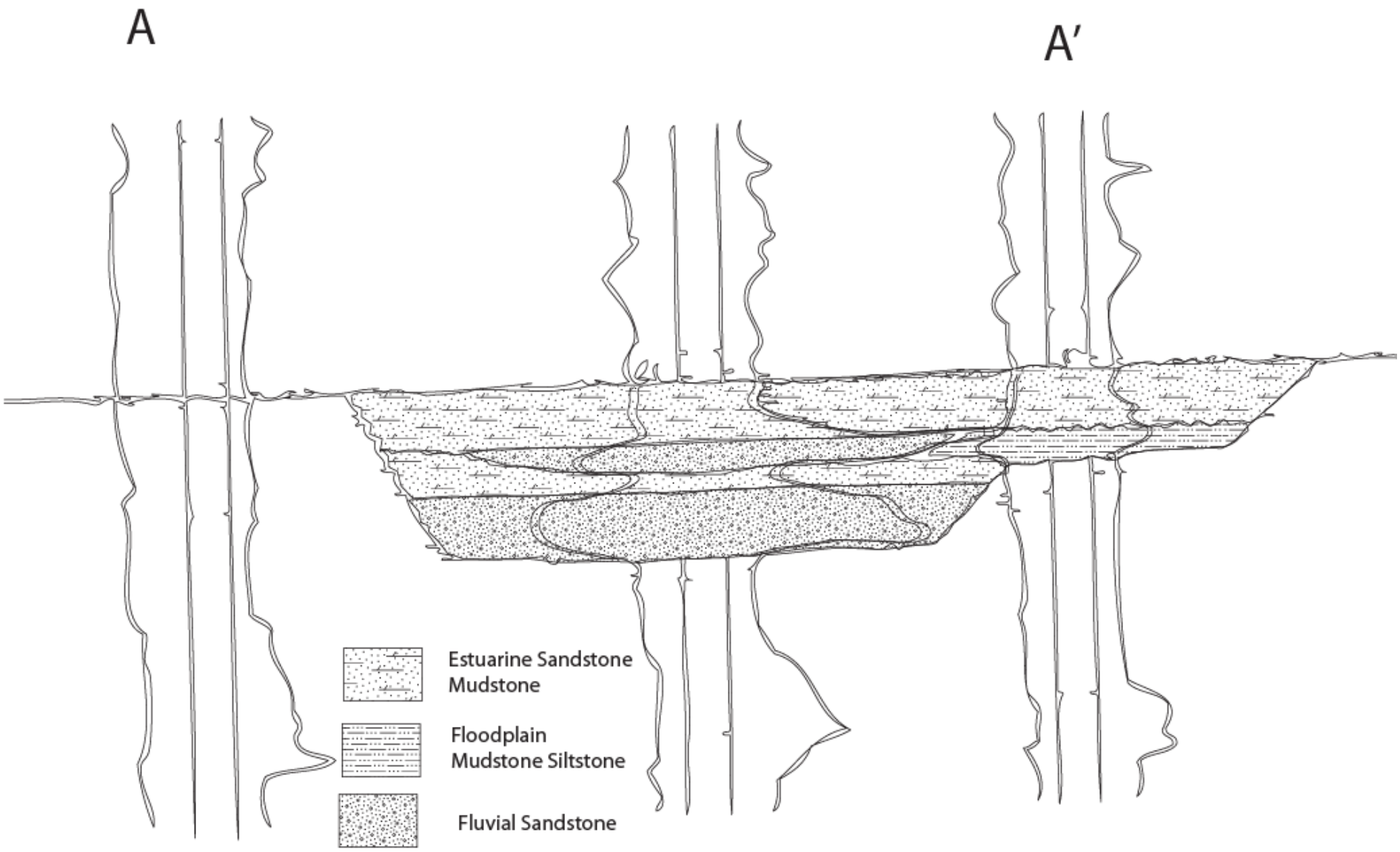
From: Bowen & Weimer 2003



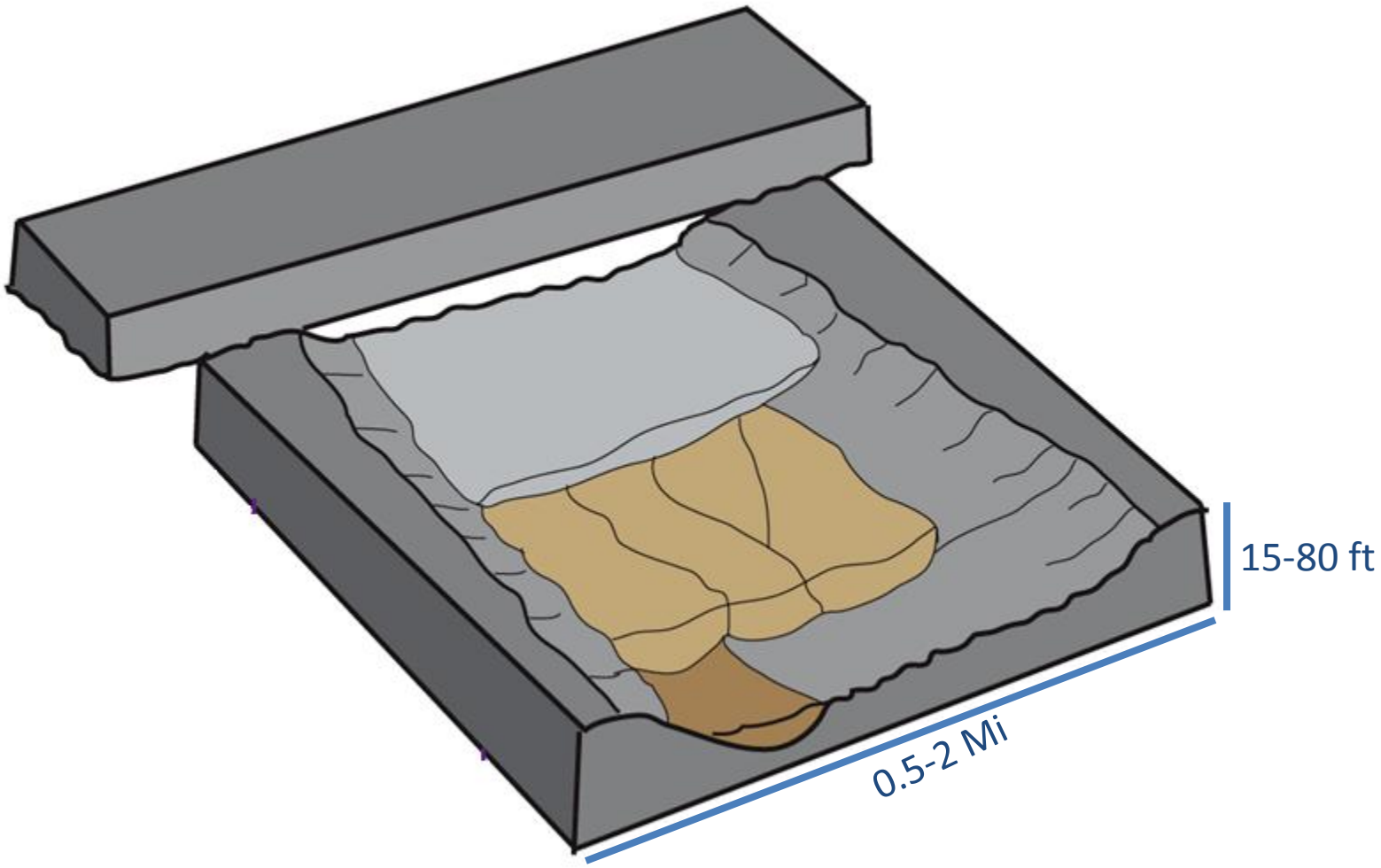
Ron Blakey
http://jan.ucc.nau.edu/rcb7/garm300.jpg



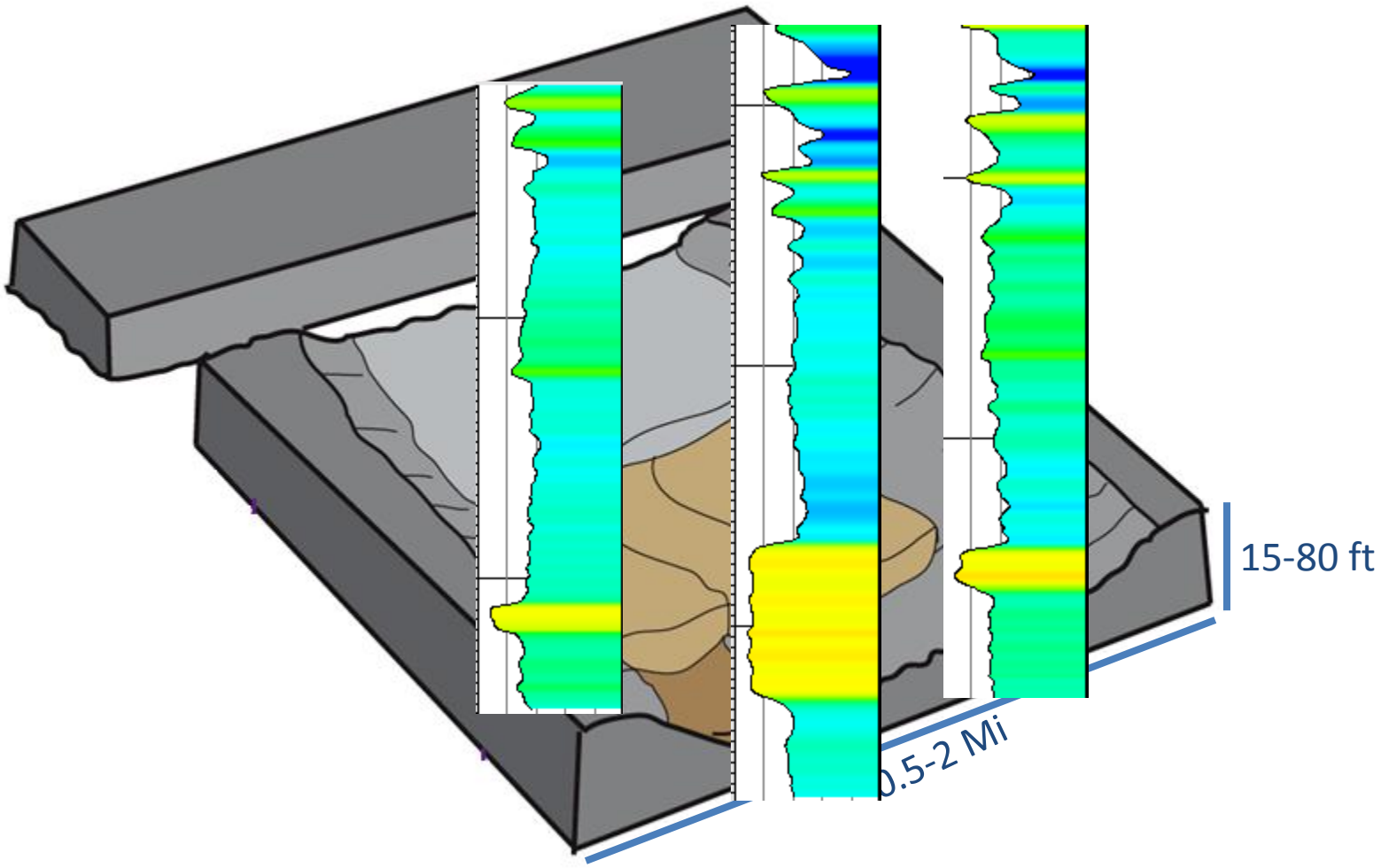
From Puckette et. al, 1996, 2001, 2008



From Puckette et. al, 1996, 2001, 2008

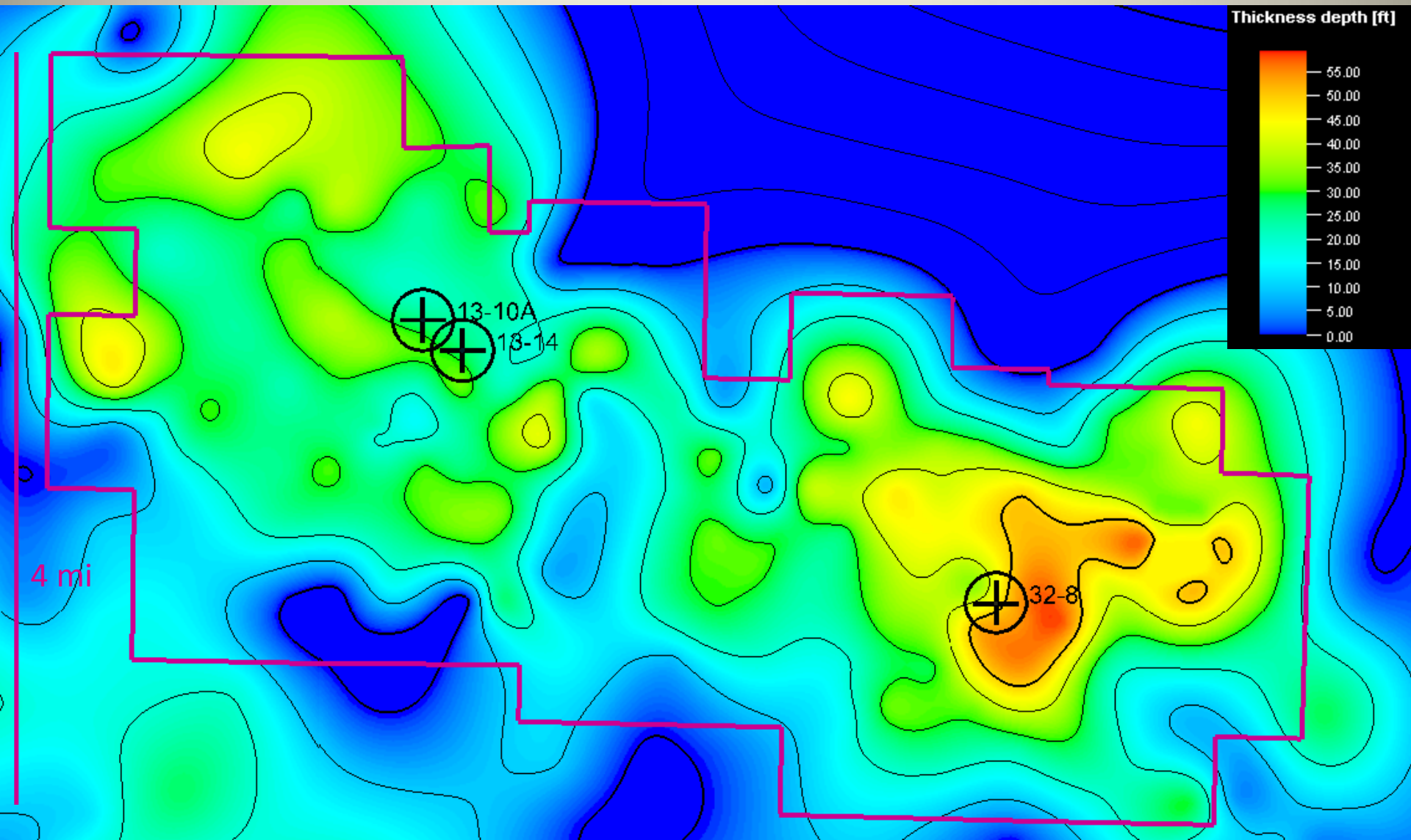


From Puckette et. al, 1996, 2001, 2008

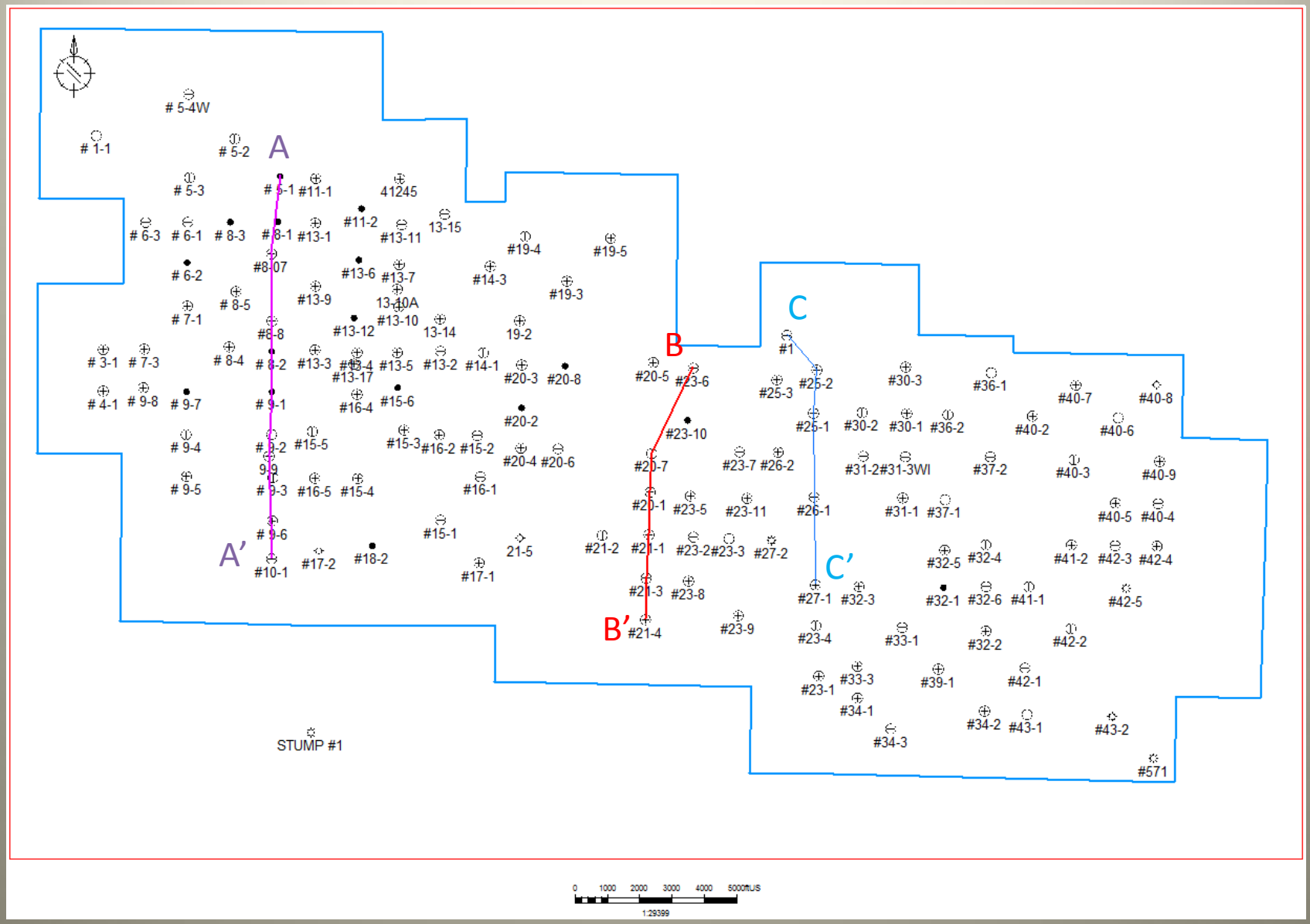


From Puckette et. al, 1996, 2001, 2008

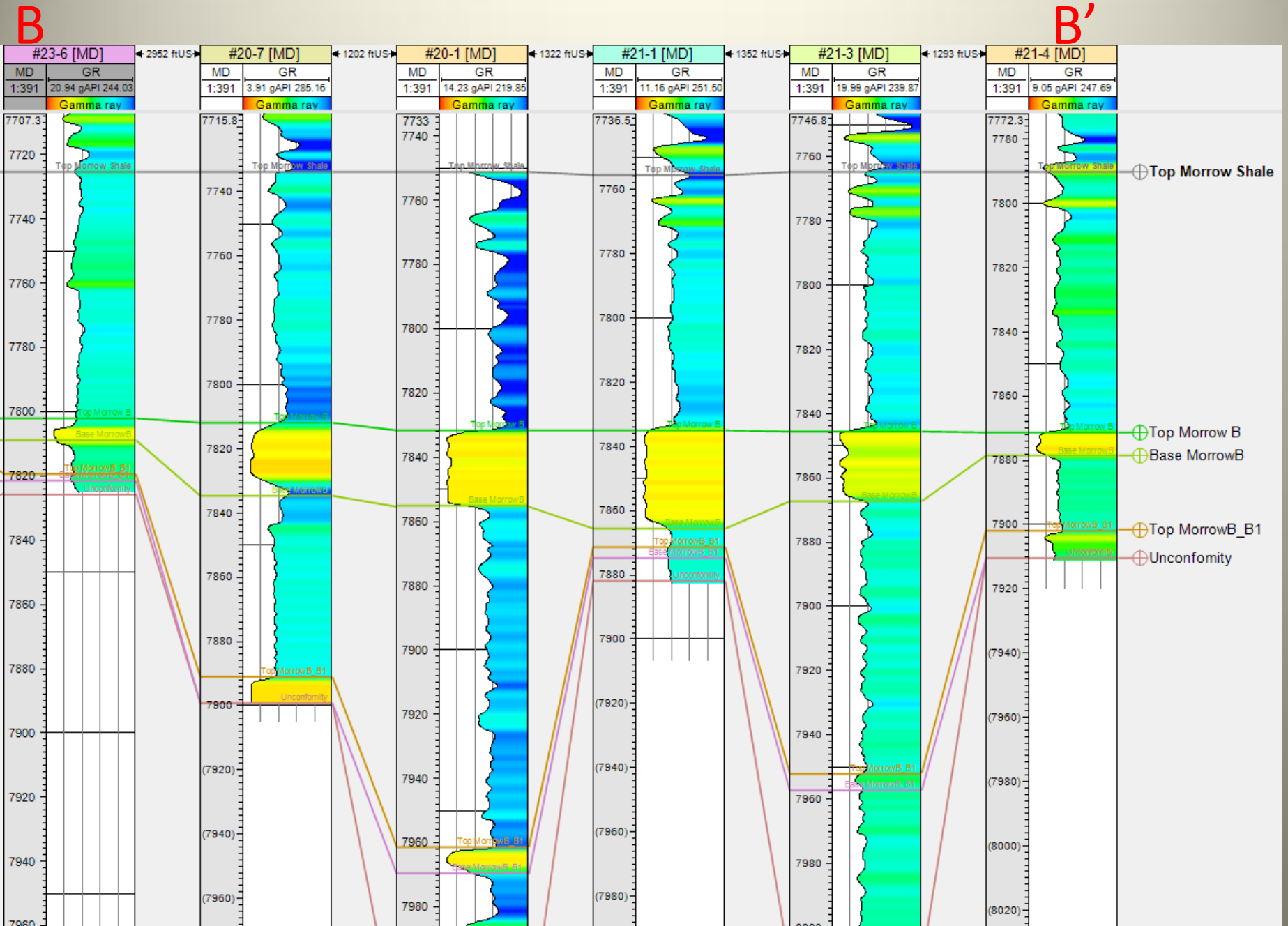
Morrow Isochore



Defining incised valley within the Field



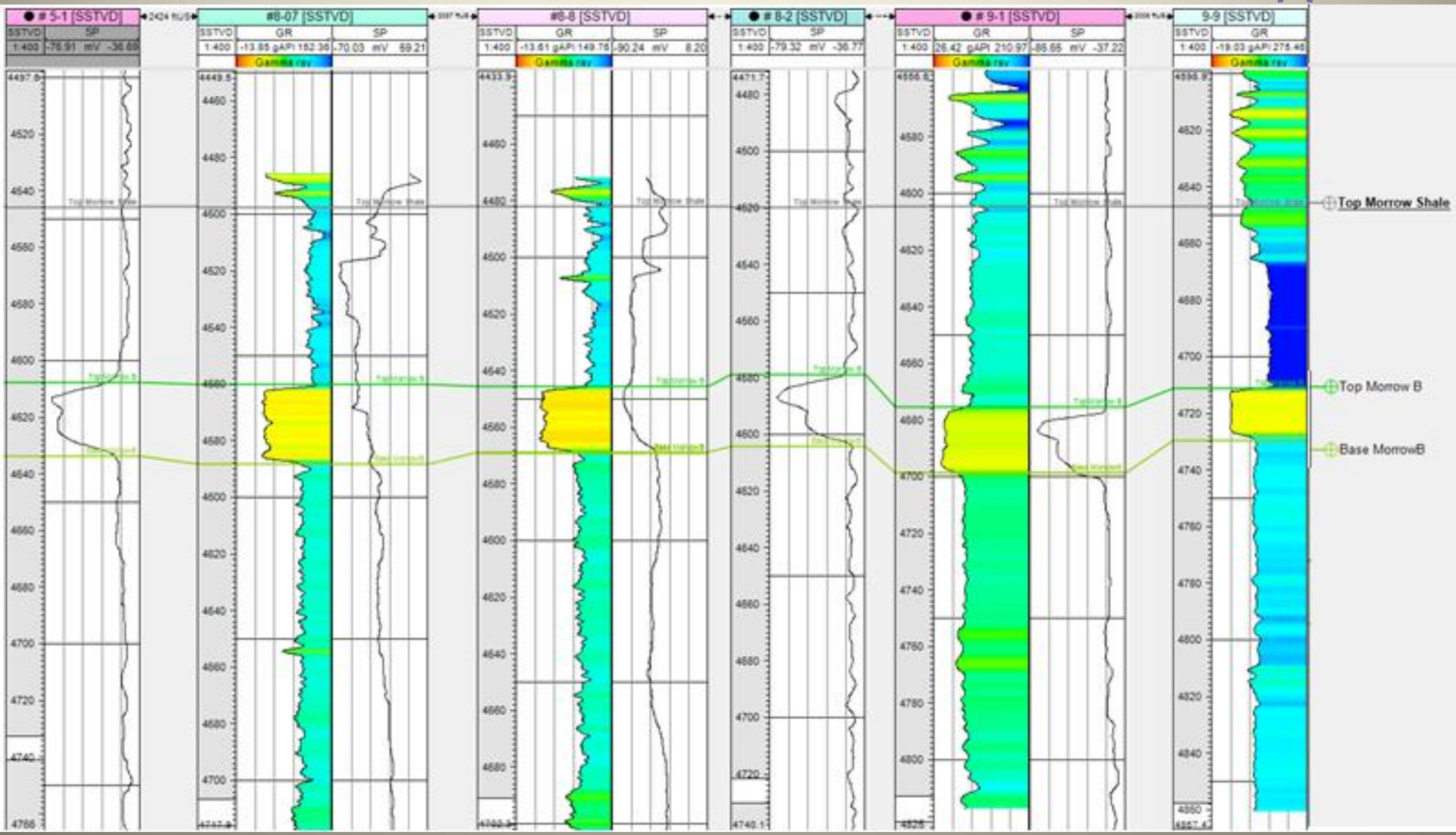
Cross section hung on Morrow shale



Cross section hung on Morrow Shale

A

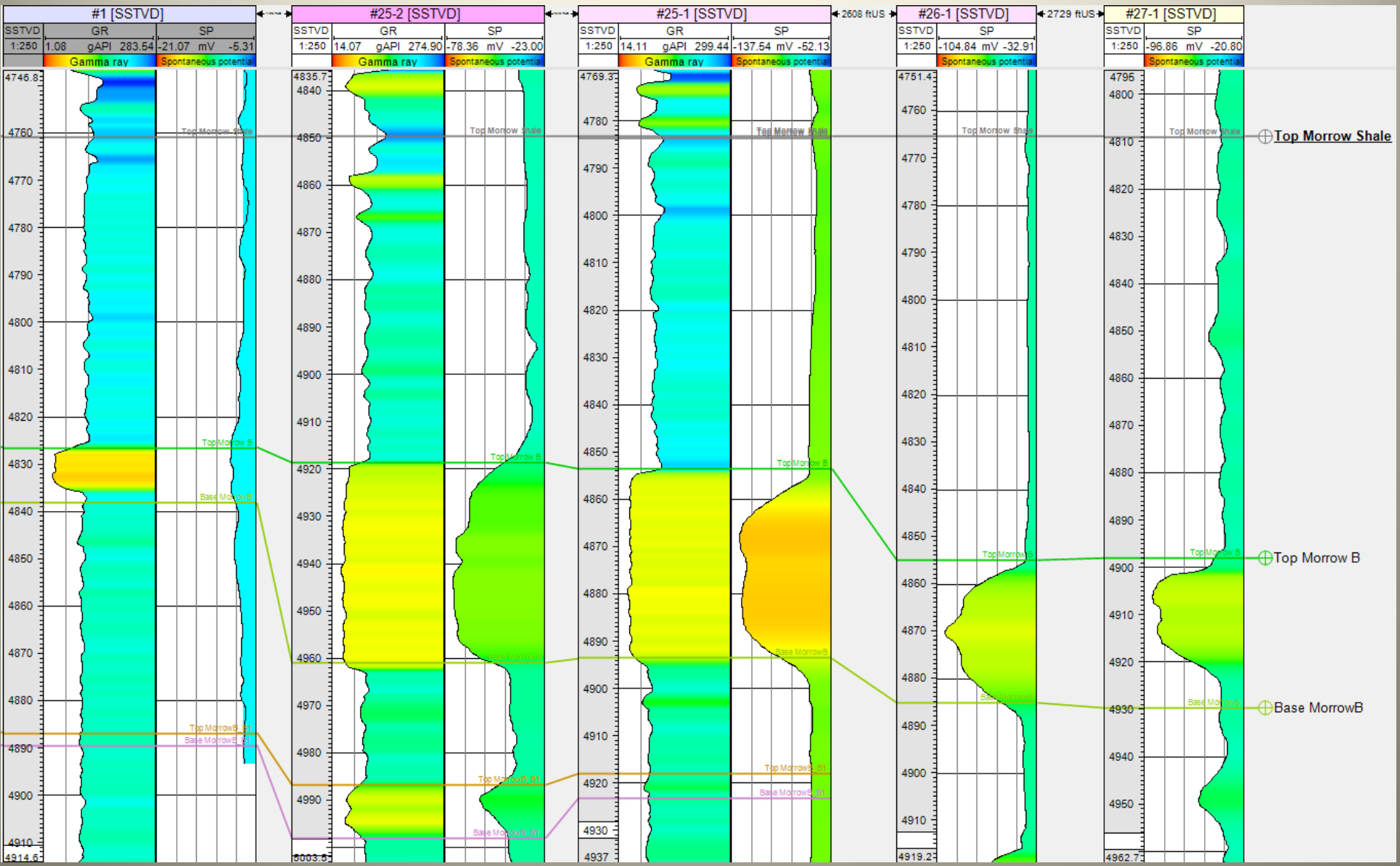
A’



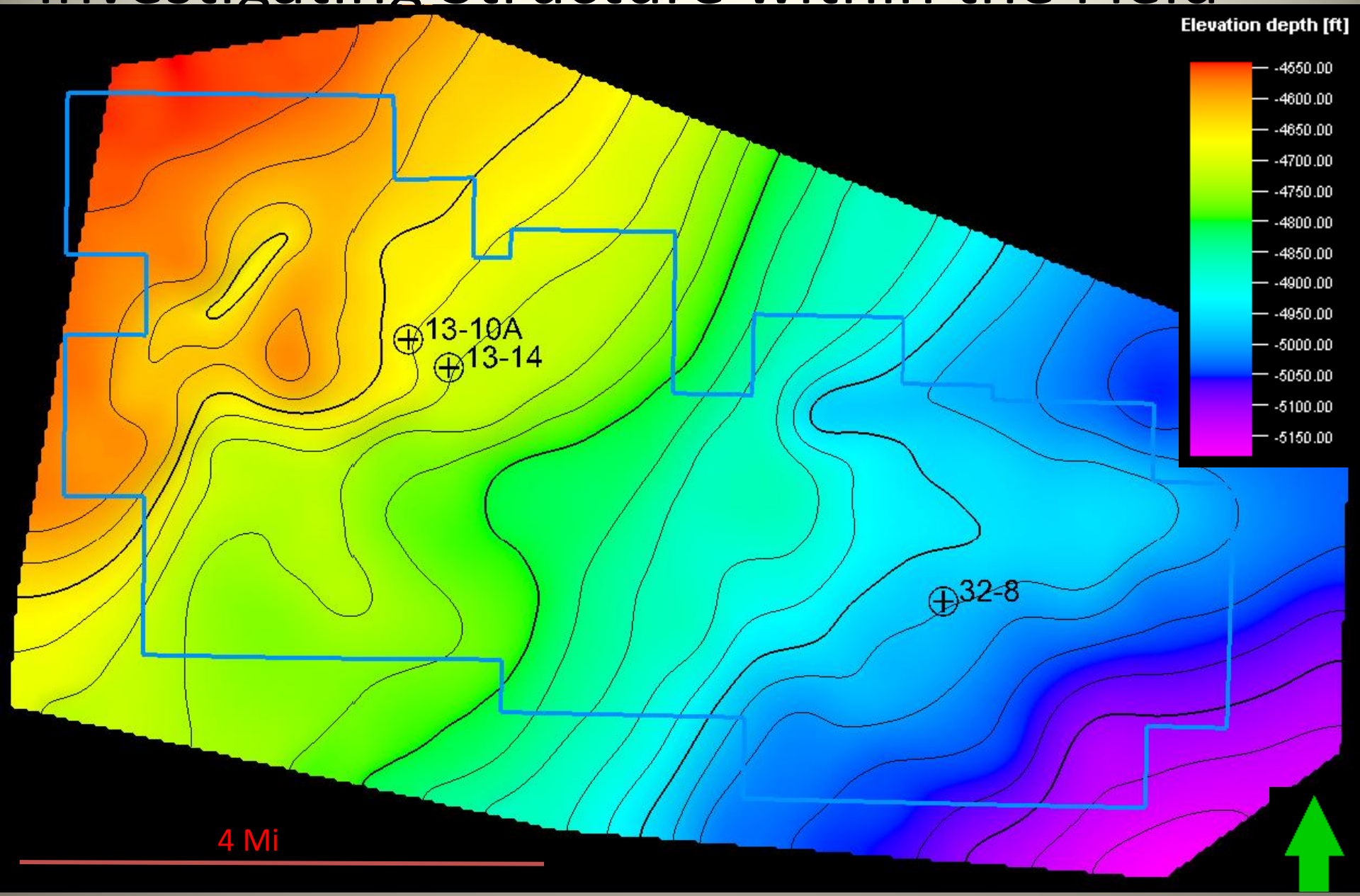
Cross section hung on Morrow Shale

C

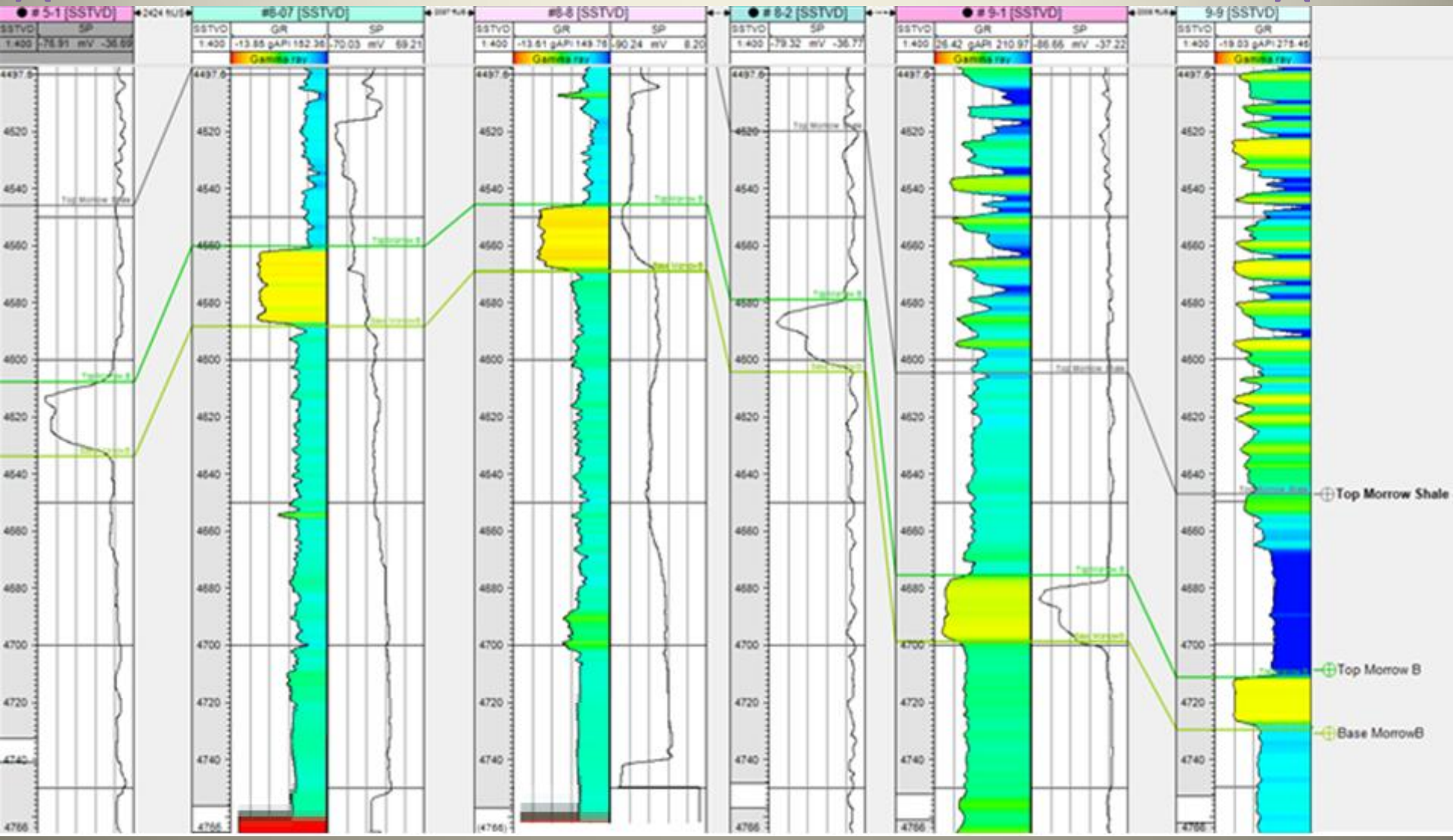
C’



Investigating Structure within the Field



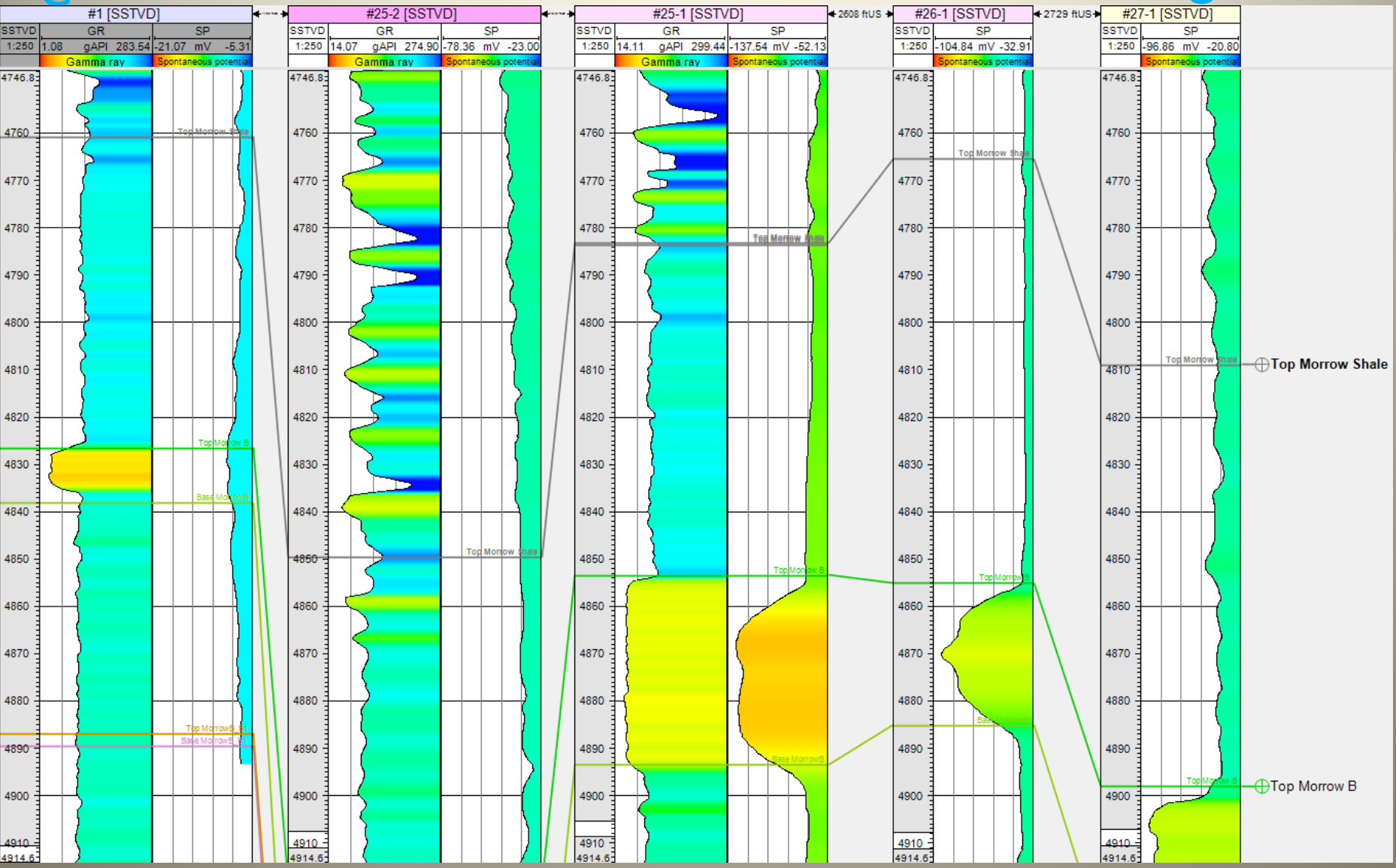
Cross sections hung at true depth



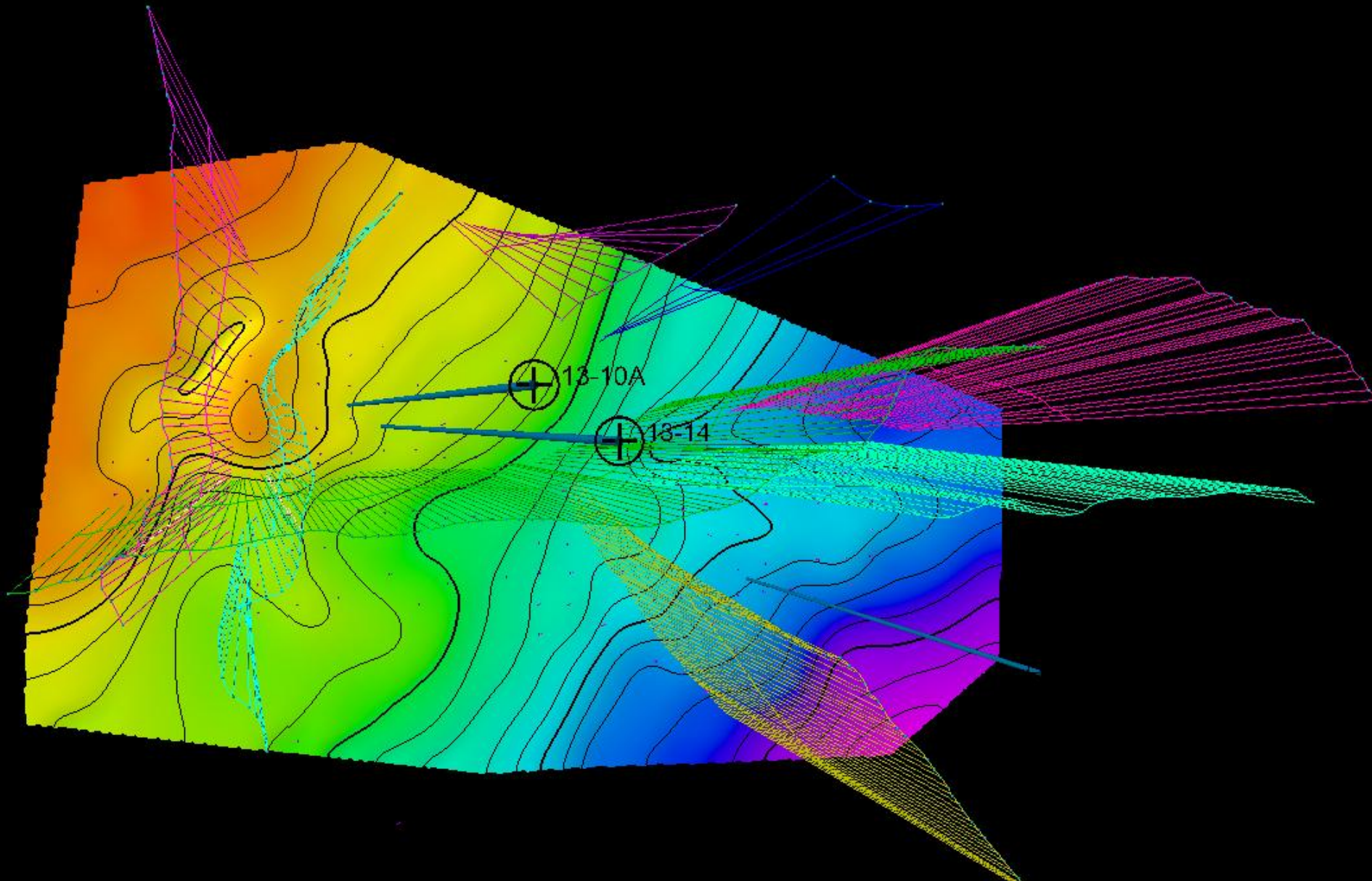
Cross sections hung at true depth

C

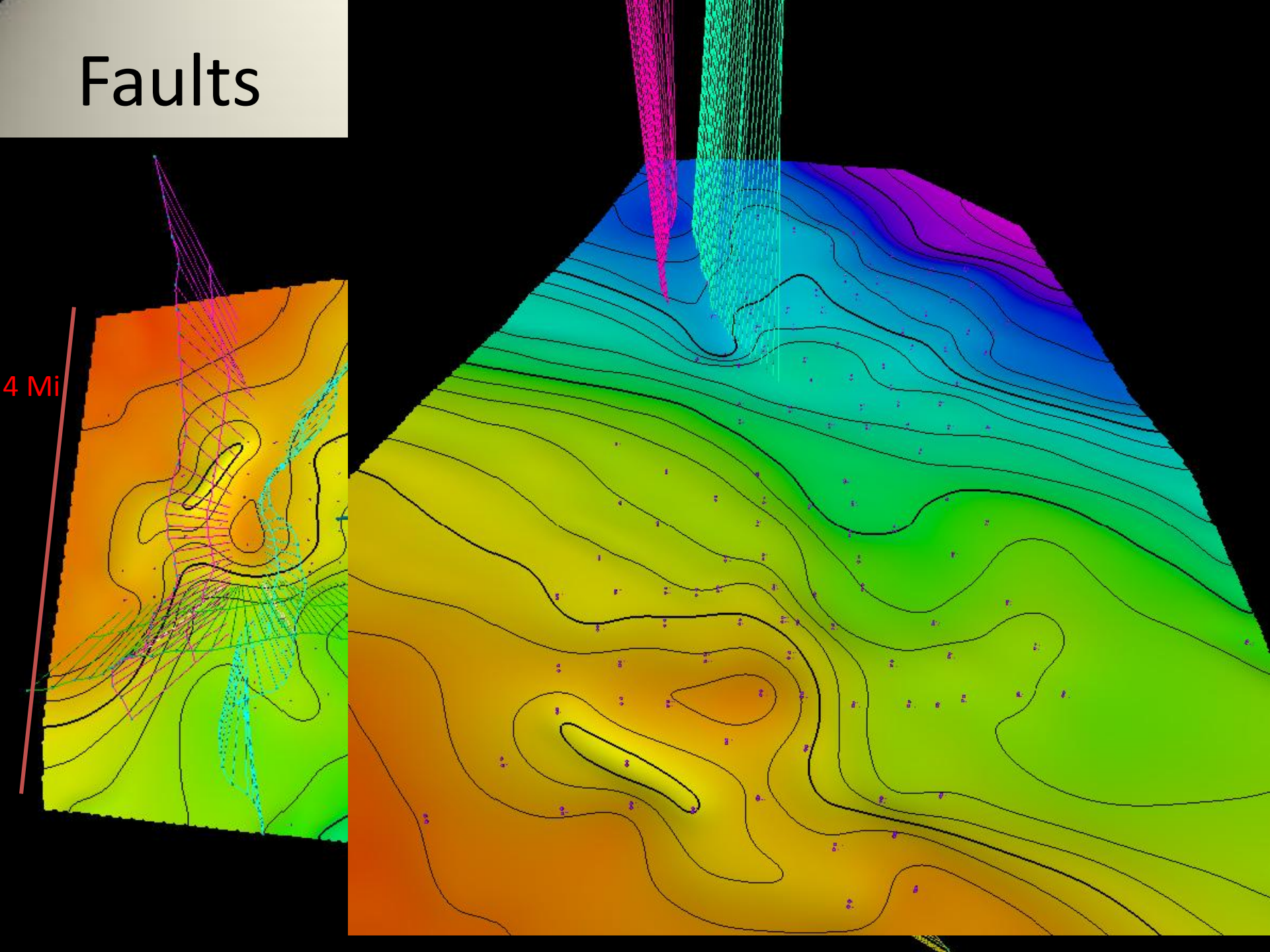
C’



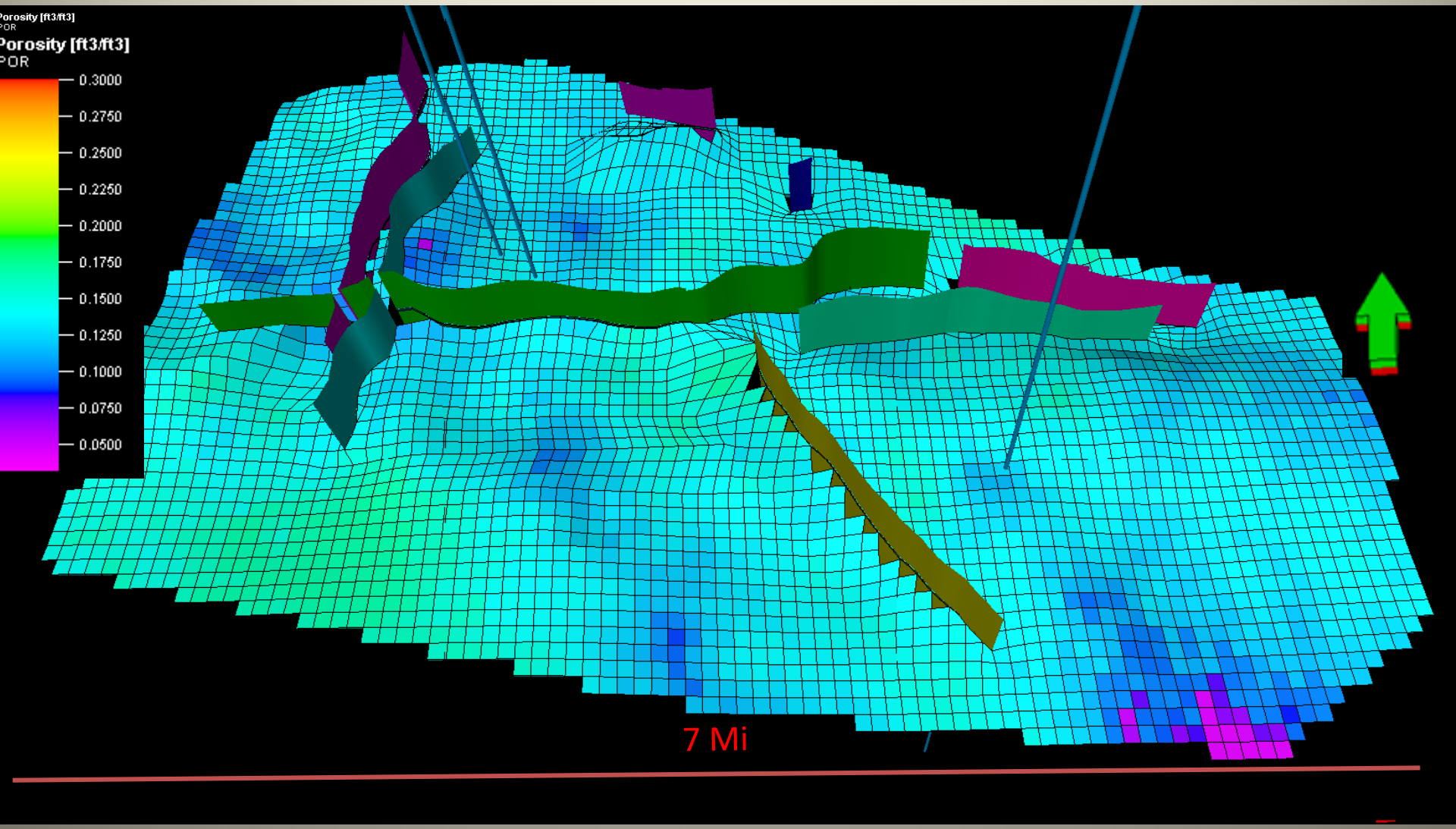
Faults



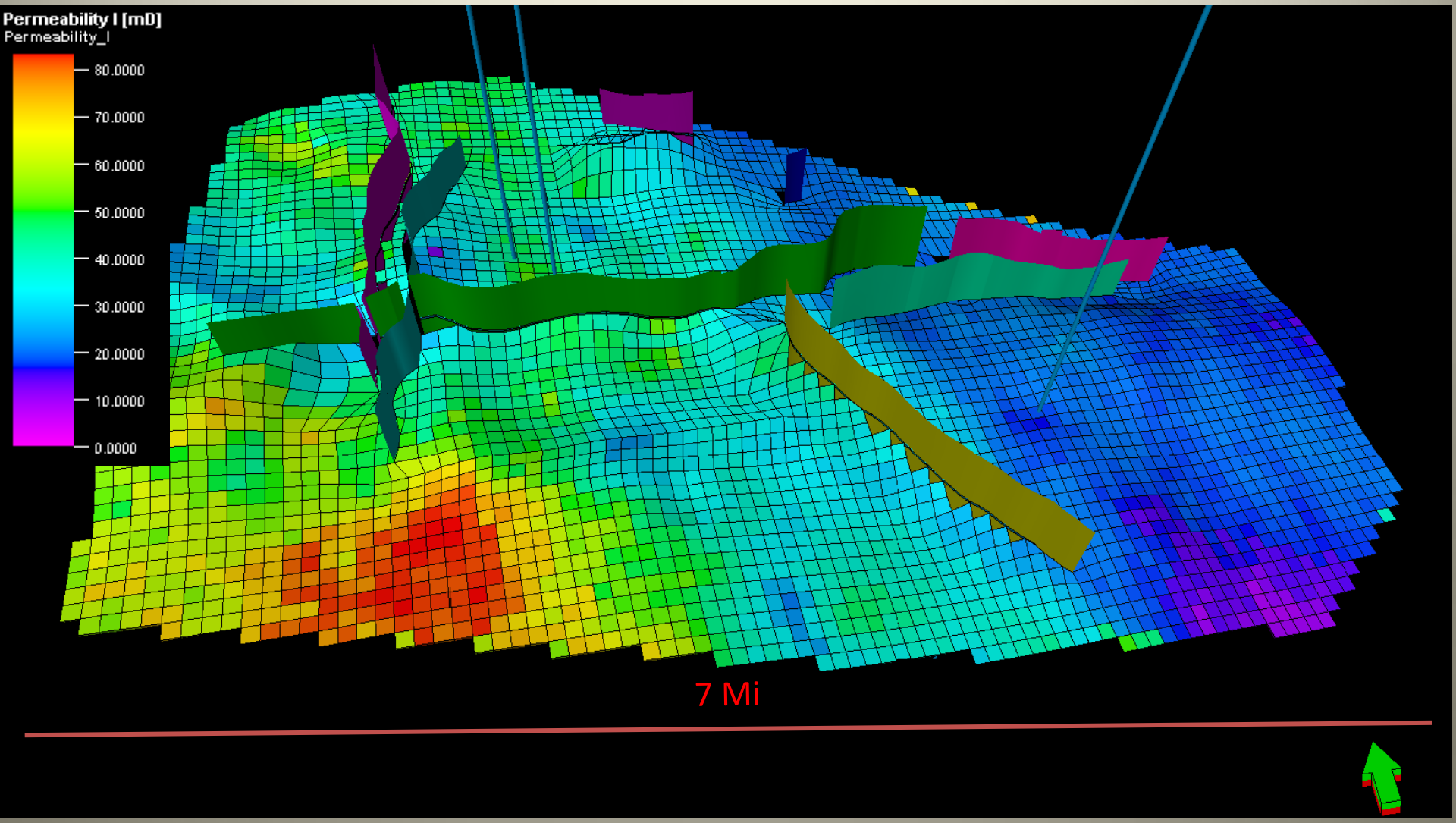
Faults



Porosity of the Morrow-B



Permeability trends within the Morrow-B



Conclusions

-Farnsworth Field is the site of an ongoing large scale CCUS project.

-Core and wire-line log analysis corroborate the incised valleys regional depositional model.

-However cross sections and surface contour mapping suggest syn to post depositional deformation.

-The geologic characterization of Farnsworth Field can help better constrain and improve simulation efforts to monitor CO_2, determine storage capacity and guide reservoir development.

Acknowledgments

- Bob Will (Schlumberger Carbon Services)
- Paige Czoski (NMTech Graduate)
- Sarah Gallagher (NMTech Graduate)
- Evan Gragg (NMTech masters student)

SOUTHWEST PARTNERSHIP
U.S. DEPARTMENT OF ENERGY
NETL National Energy Technology Laboratory
Chaparral ENERGY