Evaluating Seal Integrity for the CO_2 Storage Complex at Patterson Oil Field, Southwest Kansas

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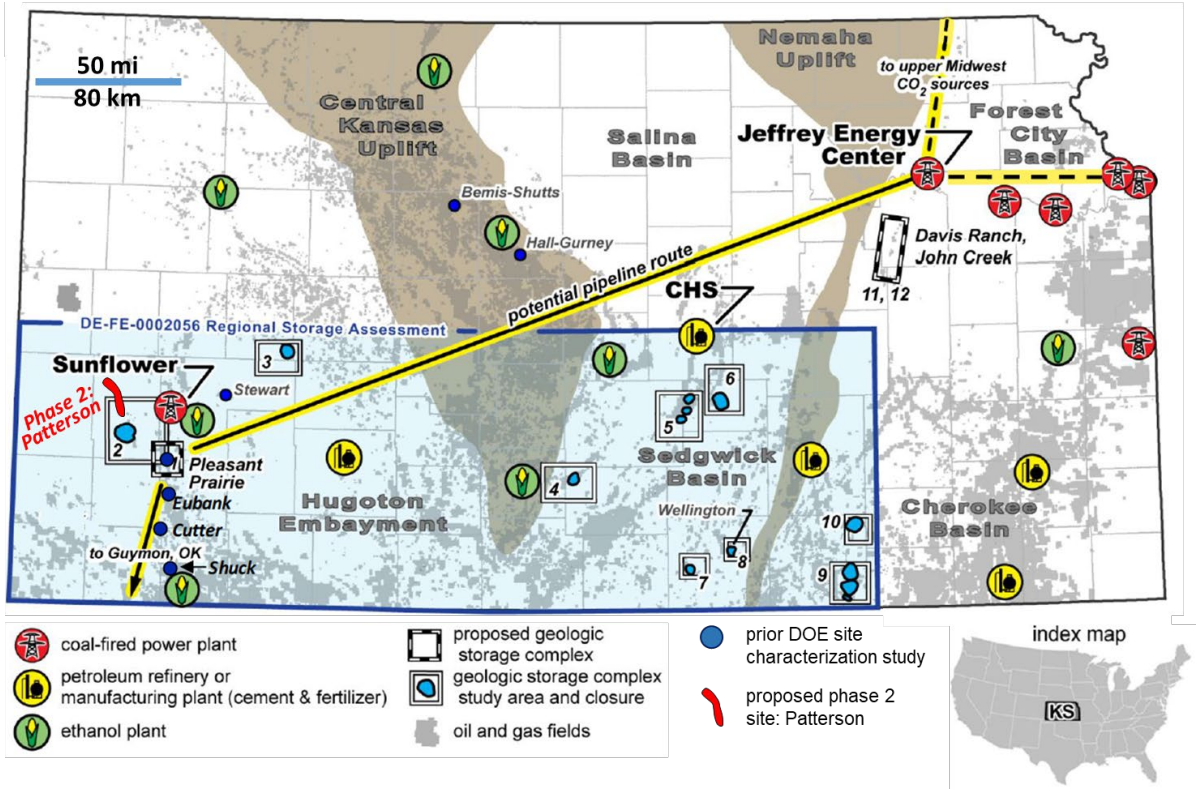
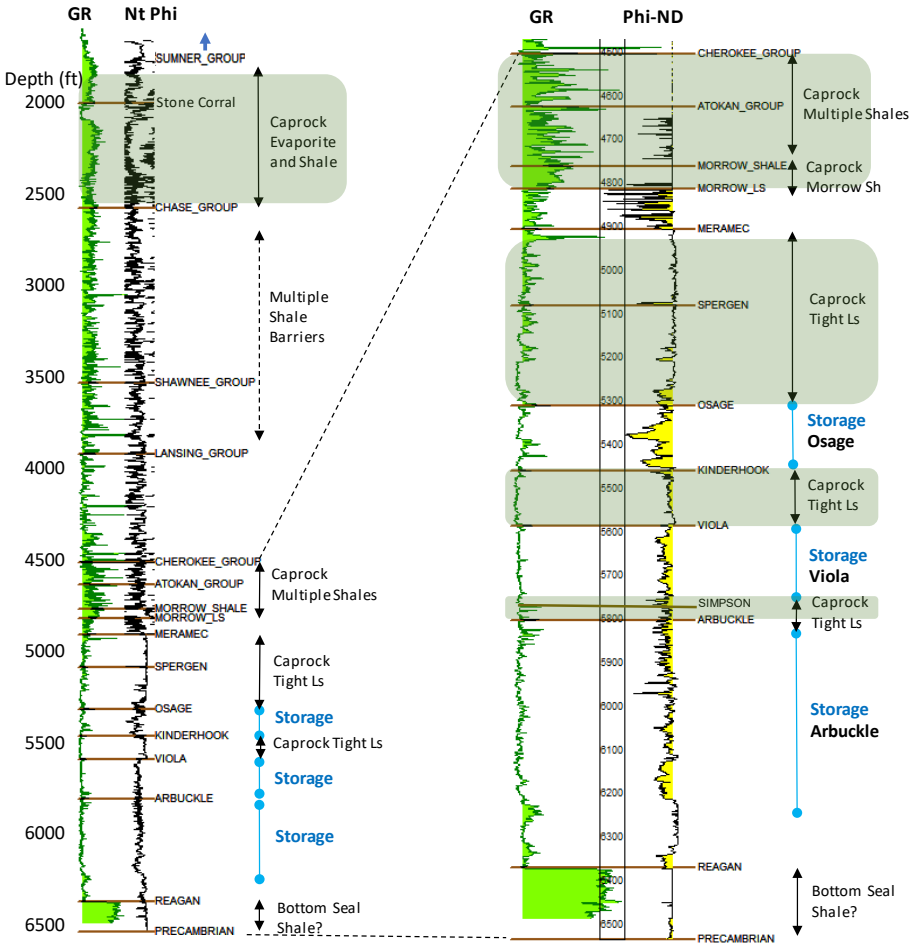
CCUS in Kansas



- Multiple sources and possible geologic complexes for commercial-scale carbon capture utilization, and storage (CCUS) in Kansas.
- More than 50 million tonnes (Mt) of CO_2 storage potential in a set of stacked saline aquifer reservoirs in the Patterson Field.
- Ensure the seal integrity and maximize the storage permanence in CCUS projects.

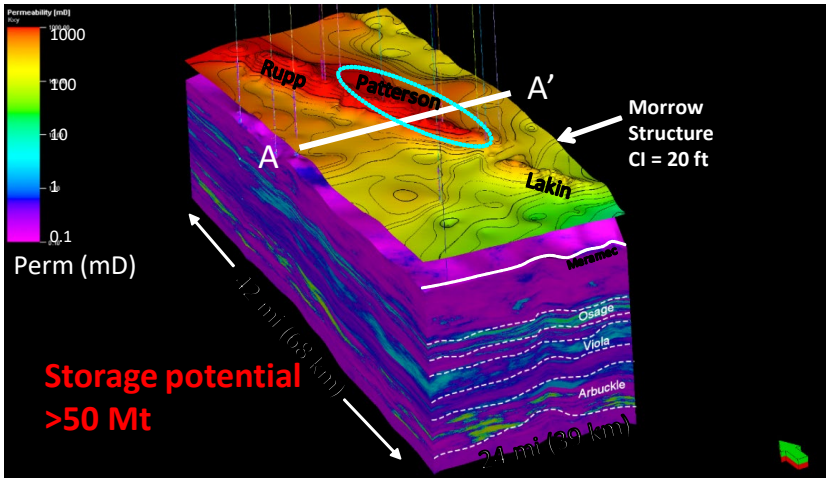
Kansas map showing location of the Patterson site proposed for Phase II, a variety of CO_2 sources, possible CO_2 pipeline routes, other possible CO_2 injections sites (numbered 1-12). Figure modified from ICKan Project Final Report (DEFE0029474)

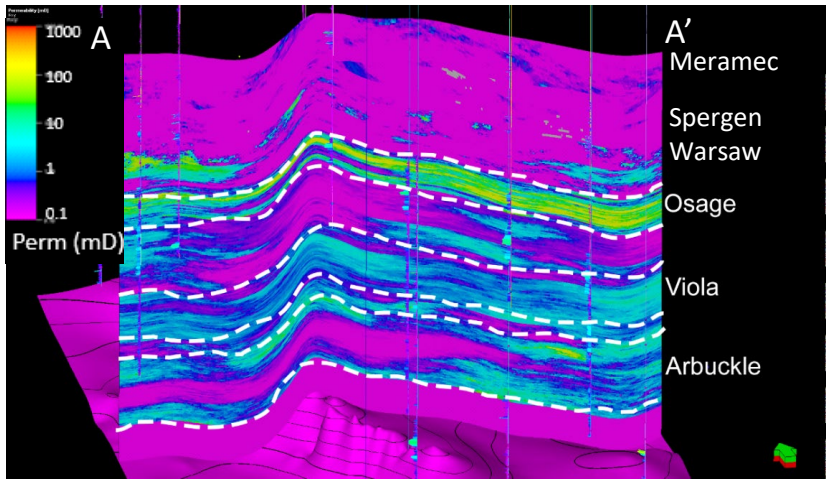
Storage units



Stratigraphy illustrated by wireline log from a key well in the Patterson Site, the Longwood Gas Unit #2 well. Modified from ICKan Project Final Report (DEFE0029474)

Sealing intervals



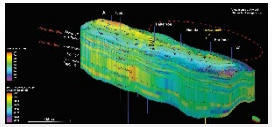


3-D volume of permeability from the top of the basement to Meramec; map above the is the top of the Morrow; map at the base of the cross section is the top of the basement. Modified from ICKan Project Final Report (DEFE0029474)

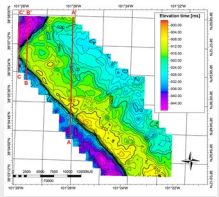
Data and workflow

Data:
-363 wells penetrate the primary seal.
-Existing and newly obtained 3D seismic at storage site.
-Existing Cores from key wells.
-2 new appraisal wells at Patterson and Hartland area.

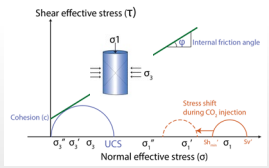
Seal characterization

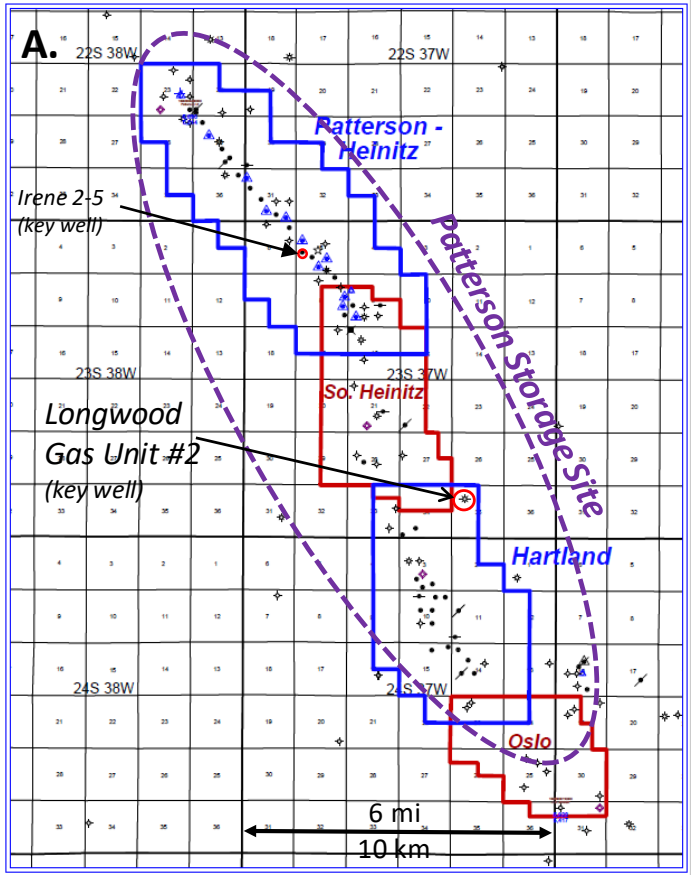


Structural and fault analyses



Geomechanical test and modeling

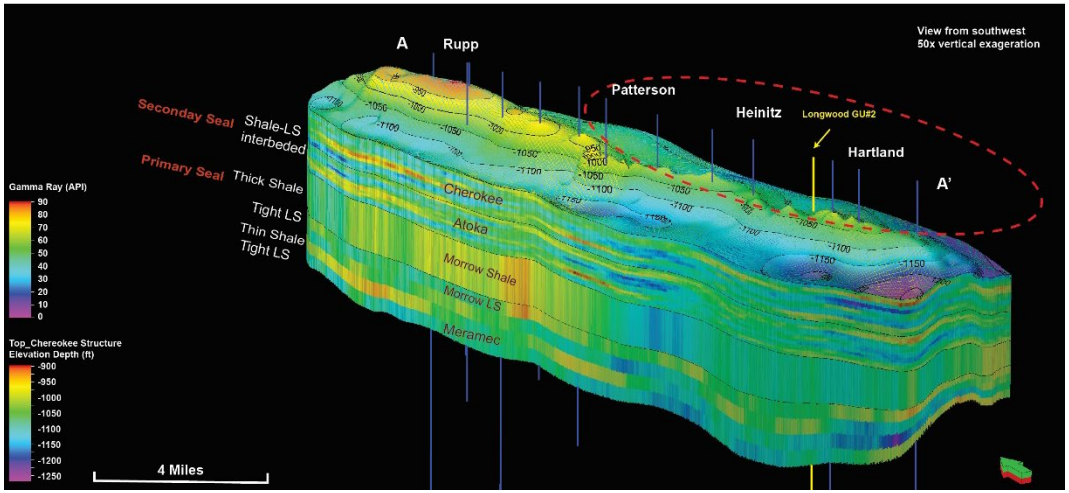


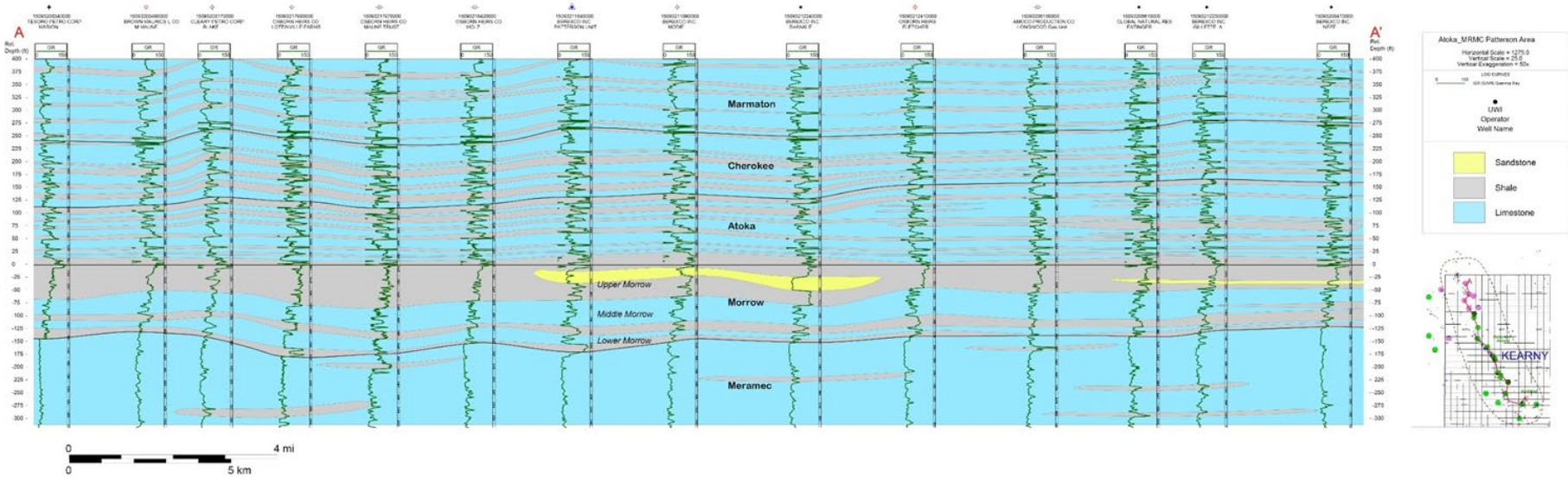


Patterson storage site available 3D seismic and wells. Newly acquired 3D seismic for Phase II is outlined in blue. Legacy 3D shoots outlined in red.

Seal distribution

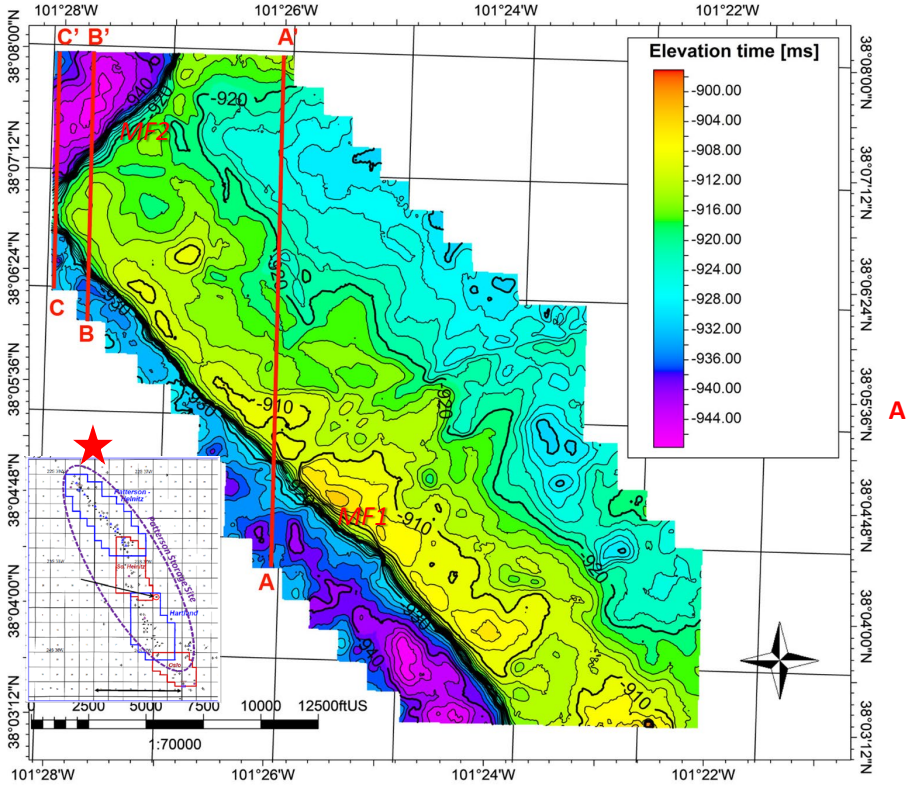
- Two laterally continuous shale in Morrow Group
- Upper Morrow shale (up to ~100 ft); Lower Morrow shale (up to ~25 ft)
- Interbedded shale-nonporous limestone in Atoka-Cherokee Group





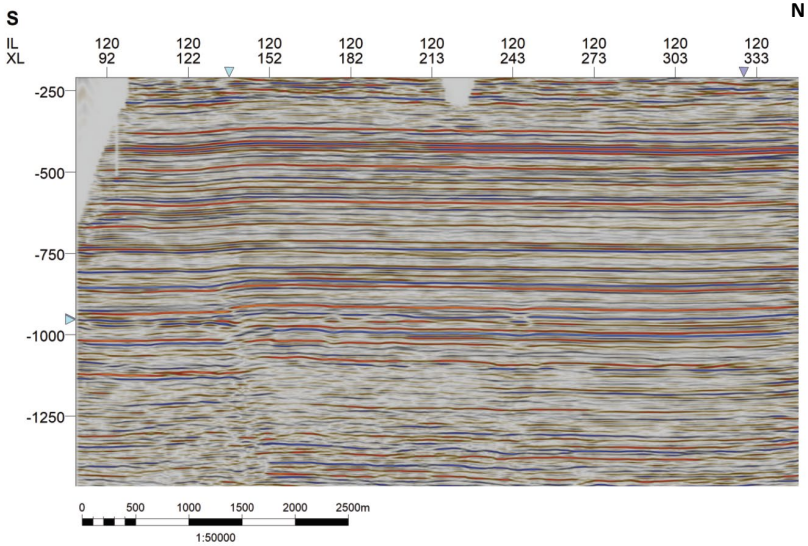
Lithological model and Cross-section (A-A') in the study area show the seal distribution of the potential reservoirs.

Structural framework

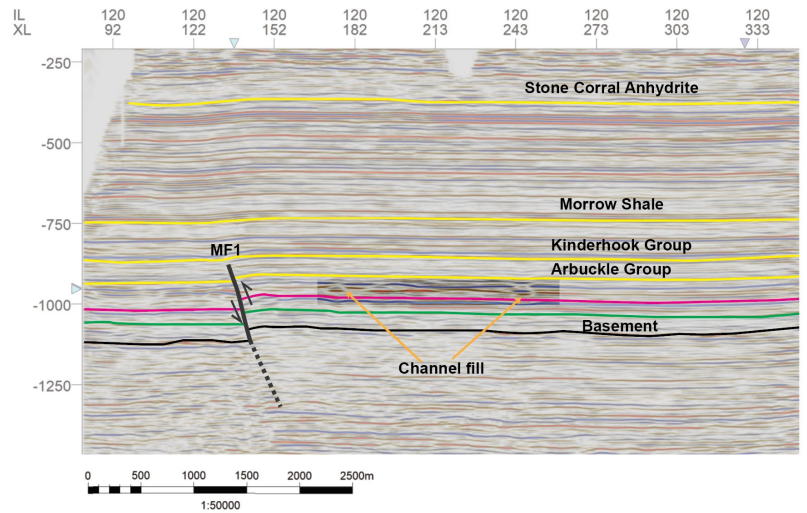


A

A

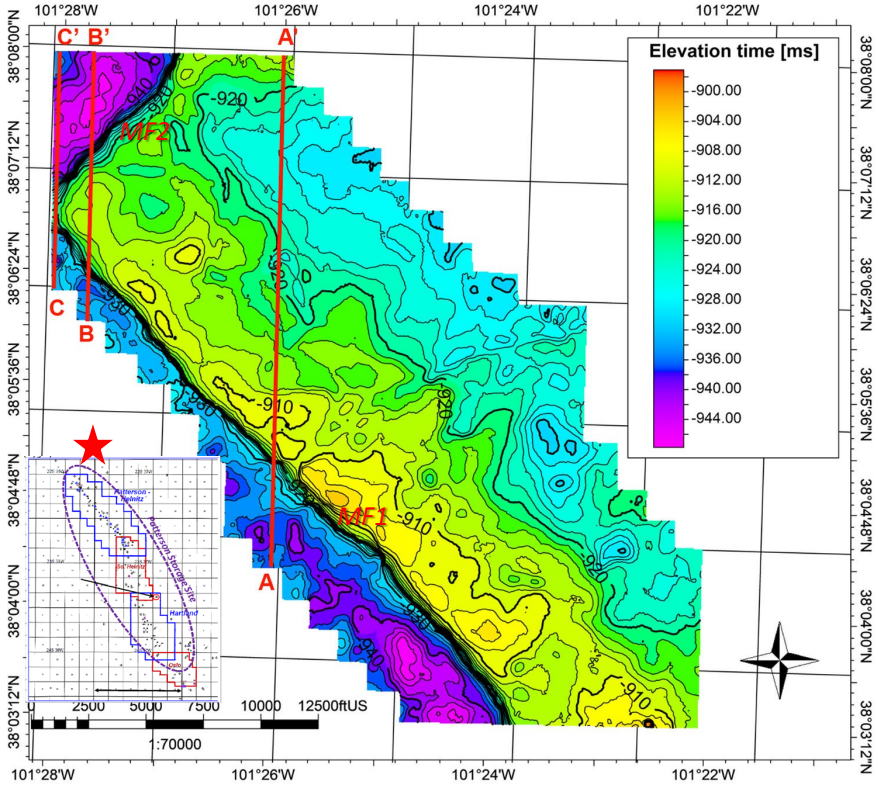


A'



Time structure map on top of the Arbuckle Group of the Patterson area.

Structural framework



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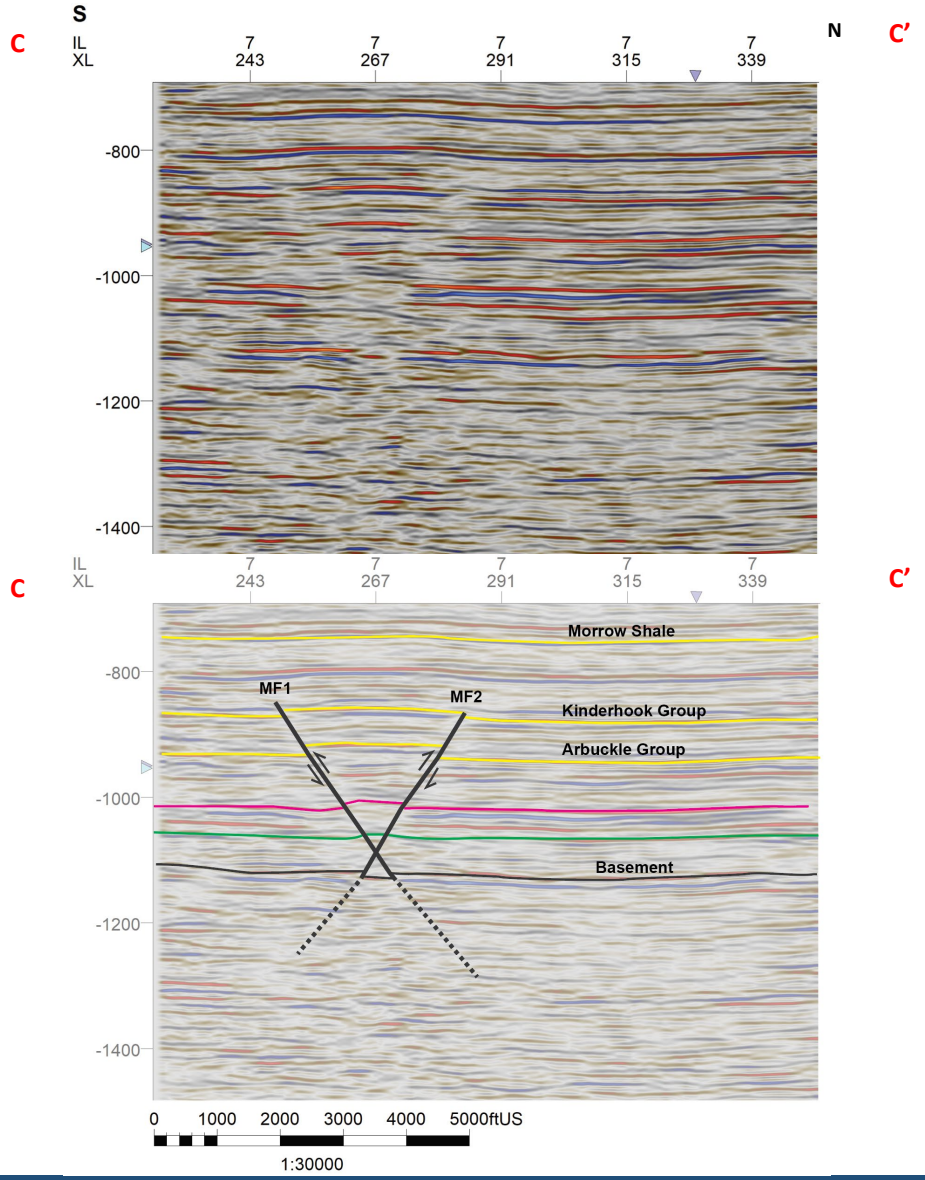

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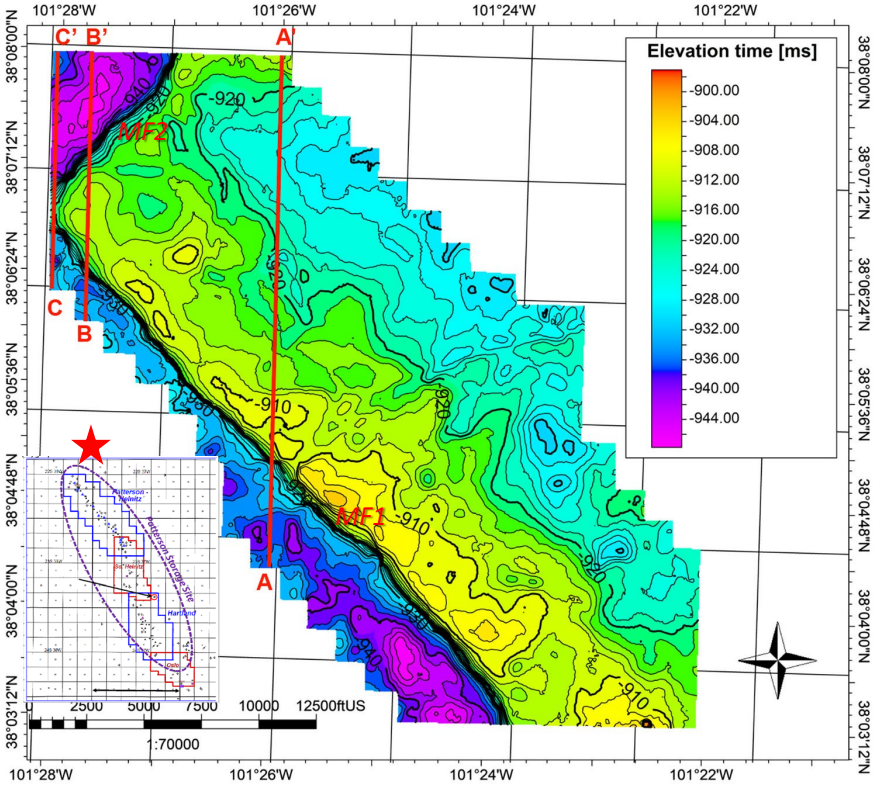

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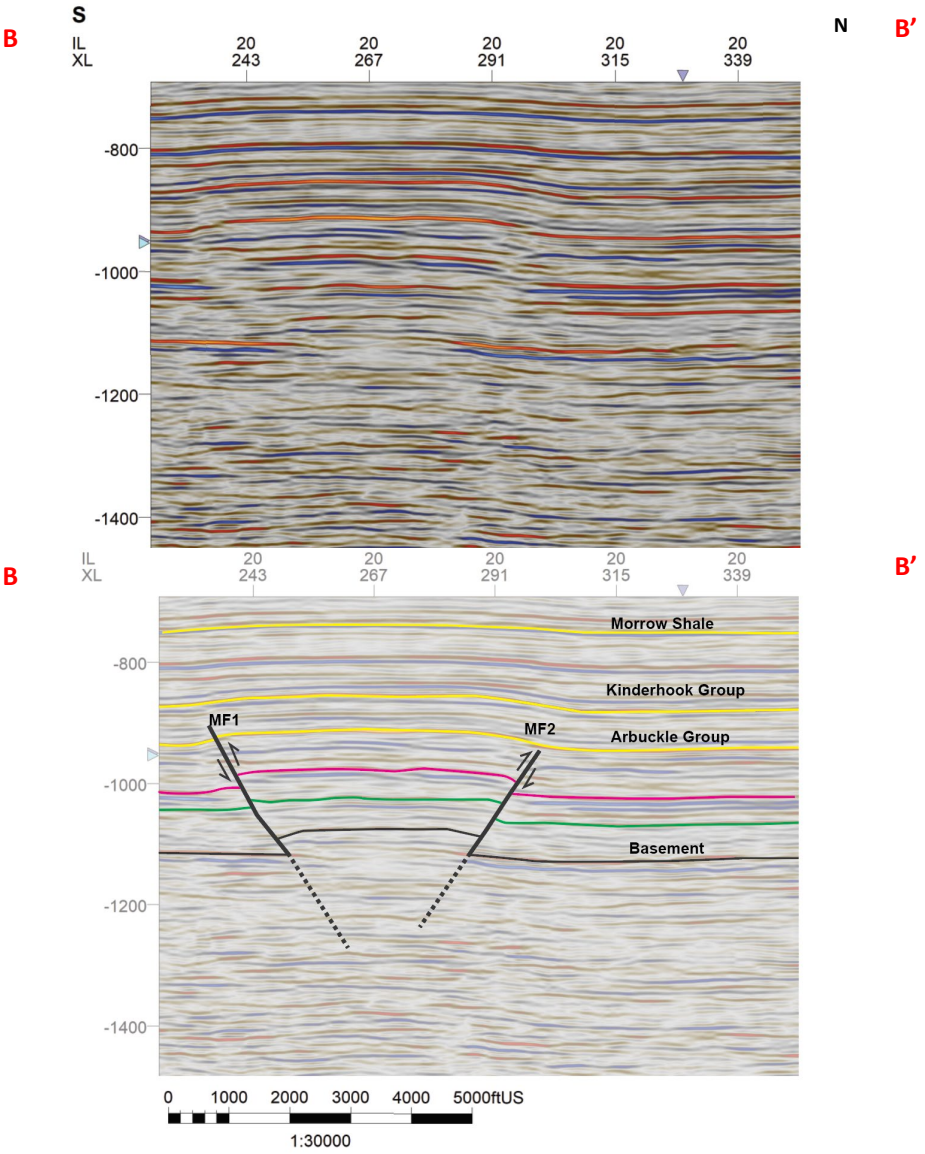

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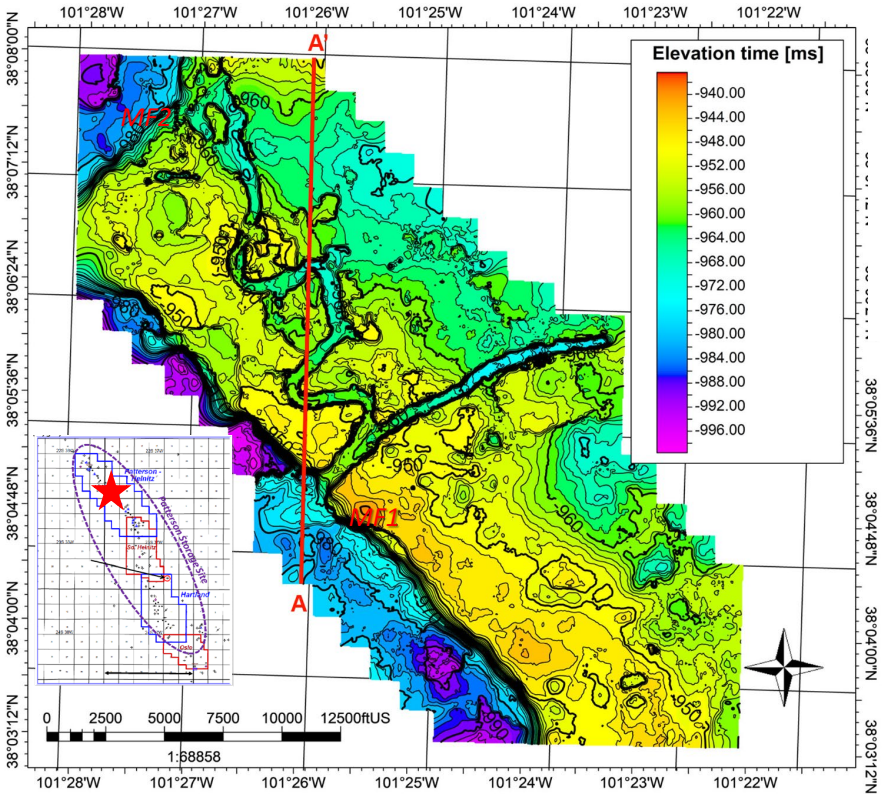
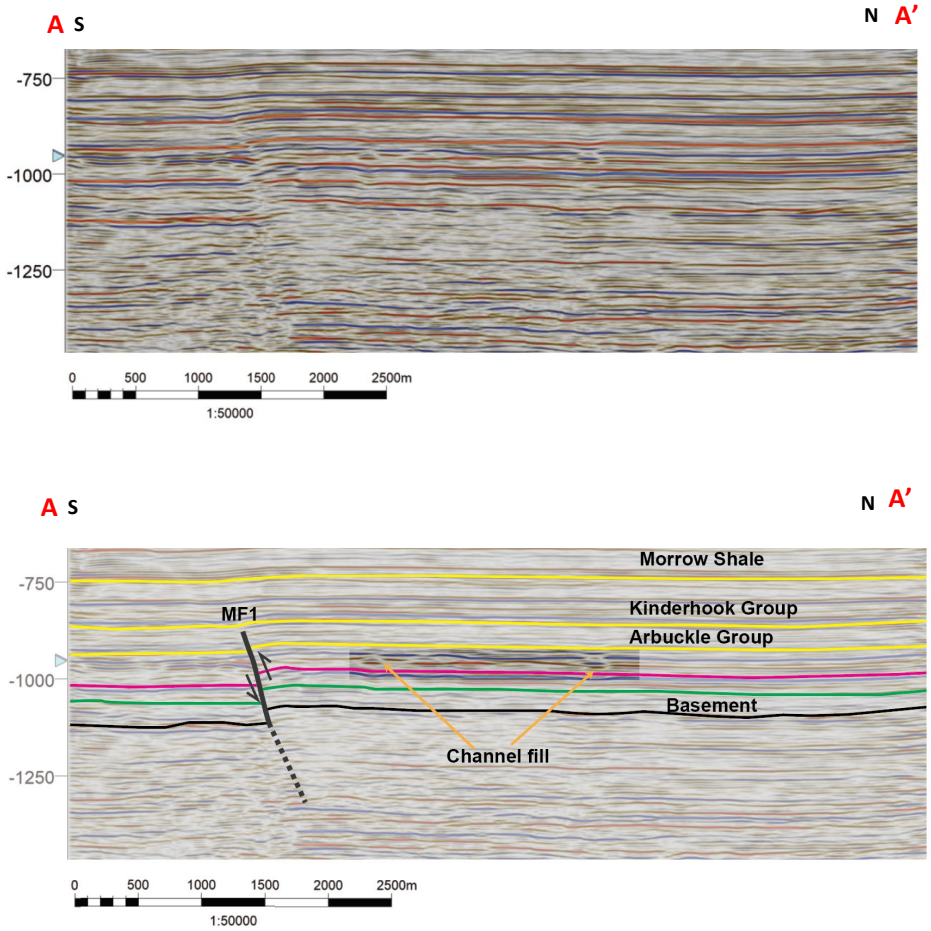
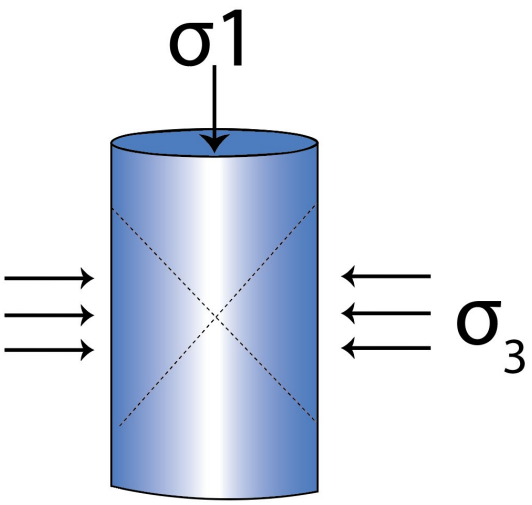




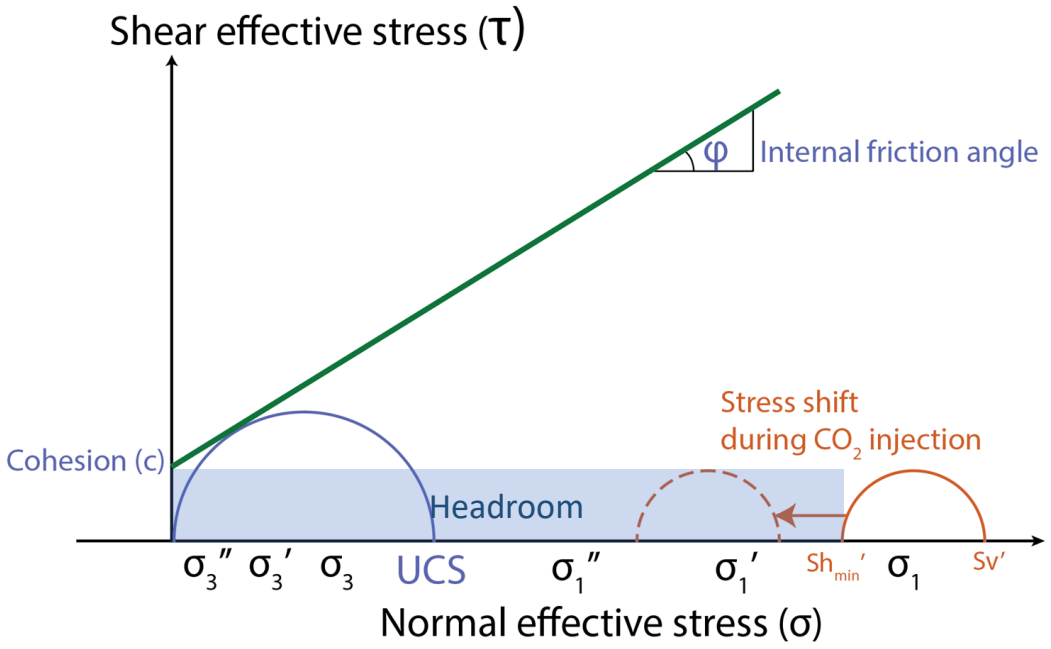
Time structure map on the channel fill of the Patterson area.

Geomechanical Analysis

- Rock mechanics test
- Stress analysis
- Geomechanical modeling

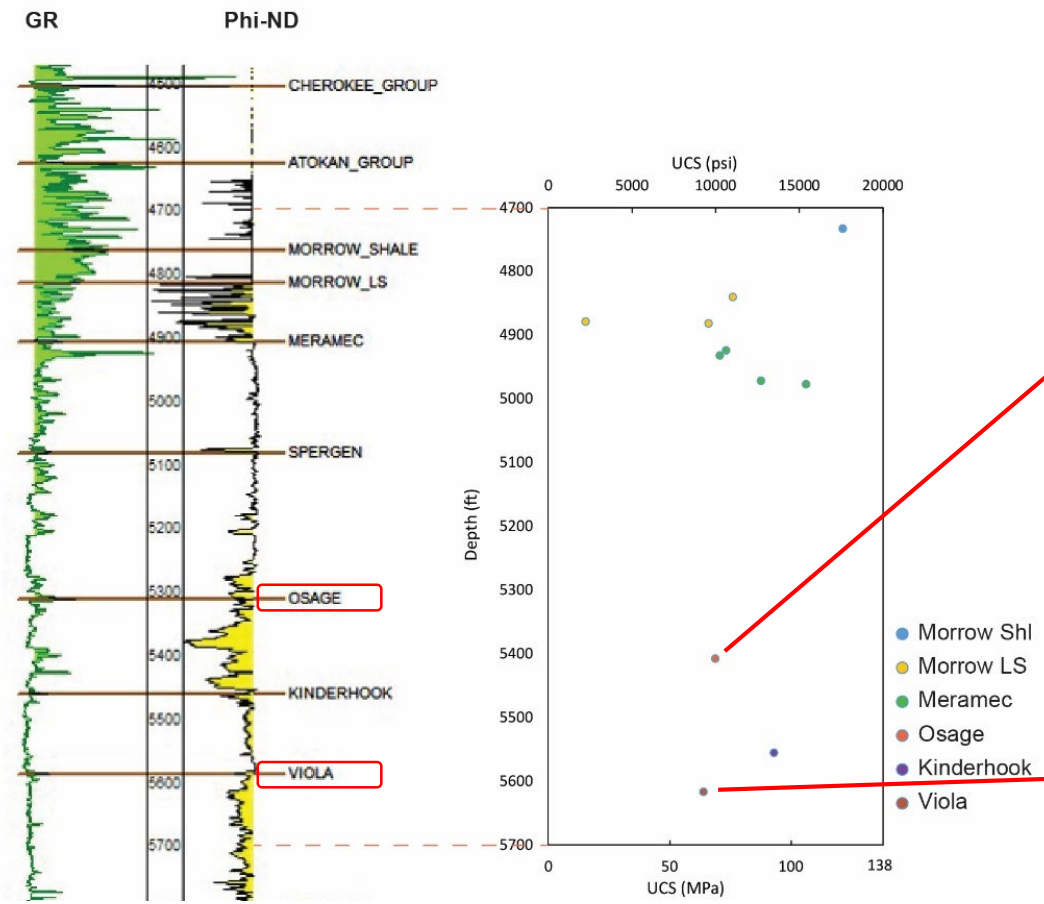


Rock mechanics test



Mohr-Coulomb Failure Envelope

Geomechanical Test

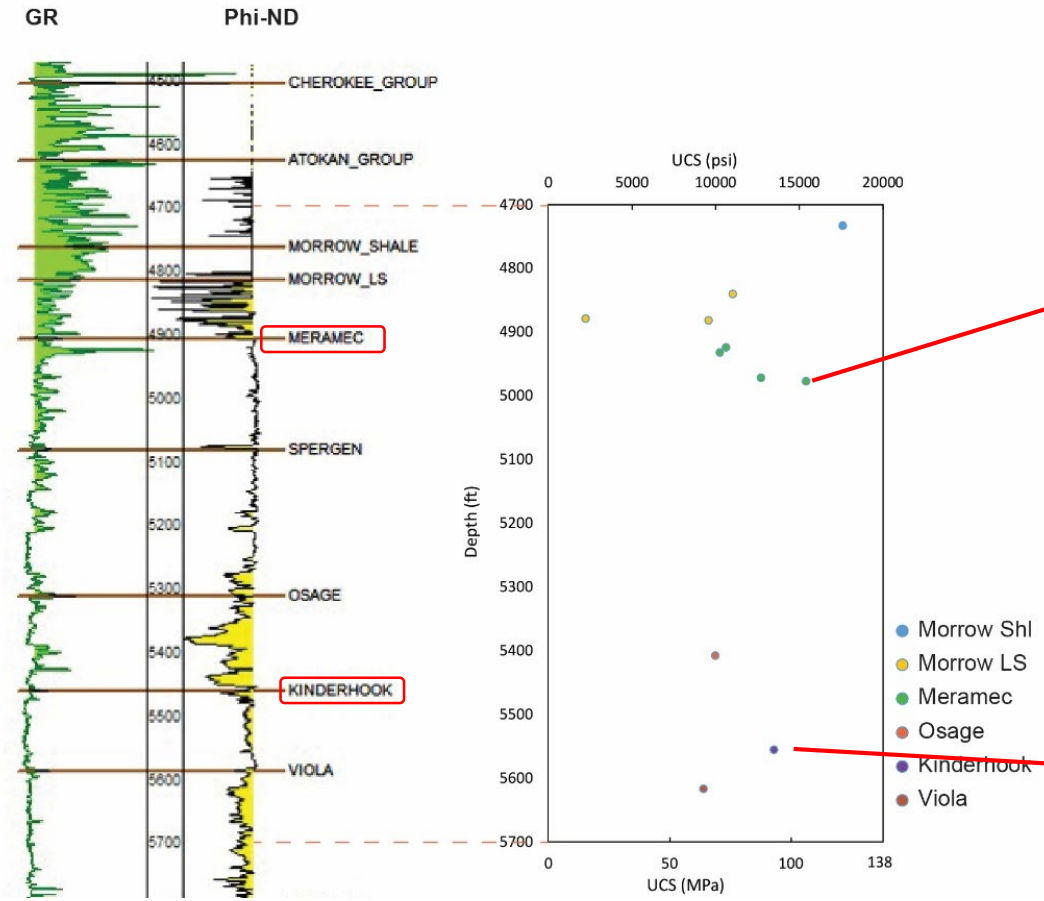


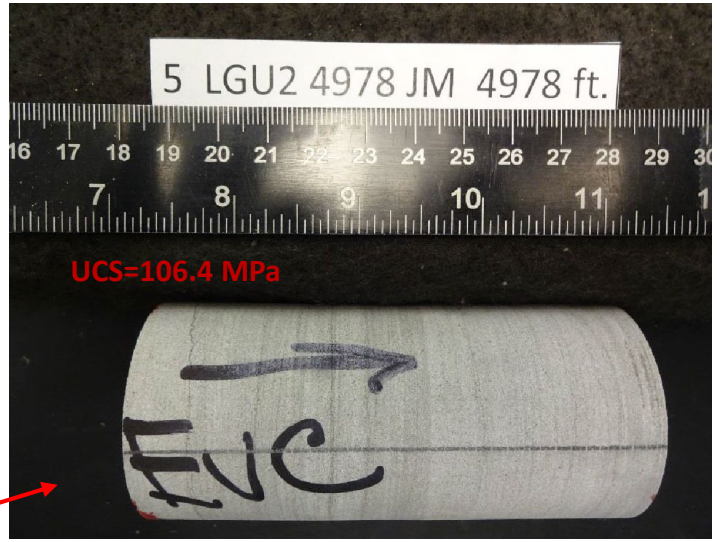
Osage Group limestone

Viola Group dolomite

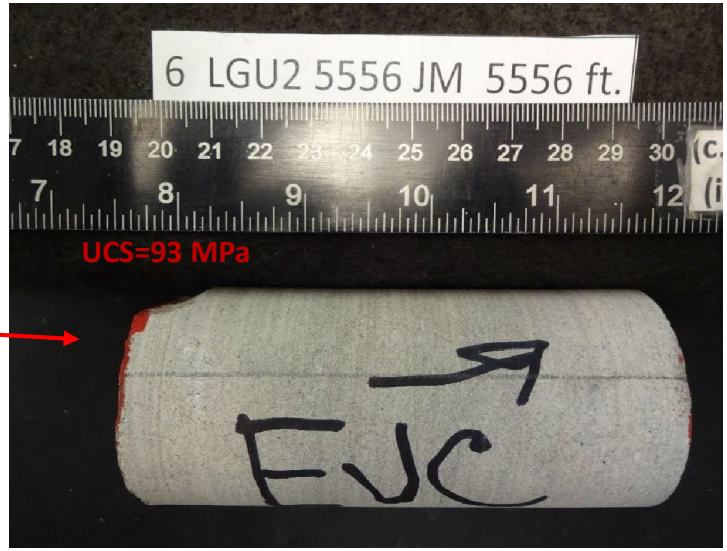
Well Longwood GU#2

Geomechanical Test





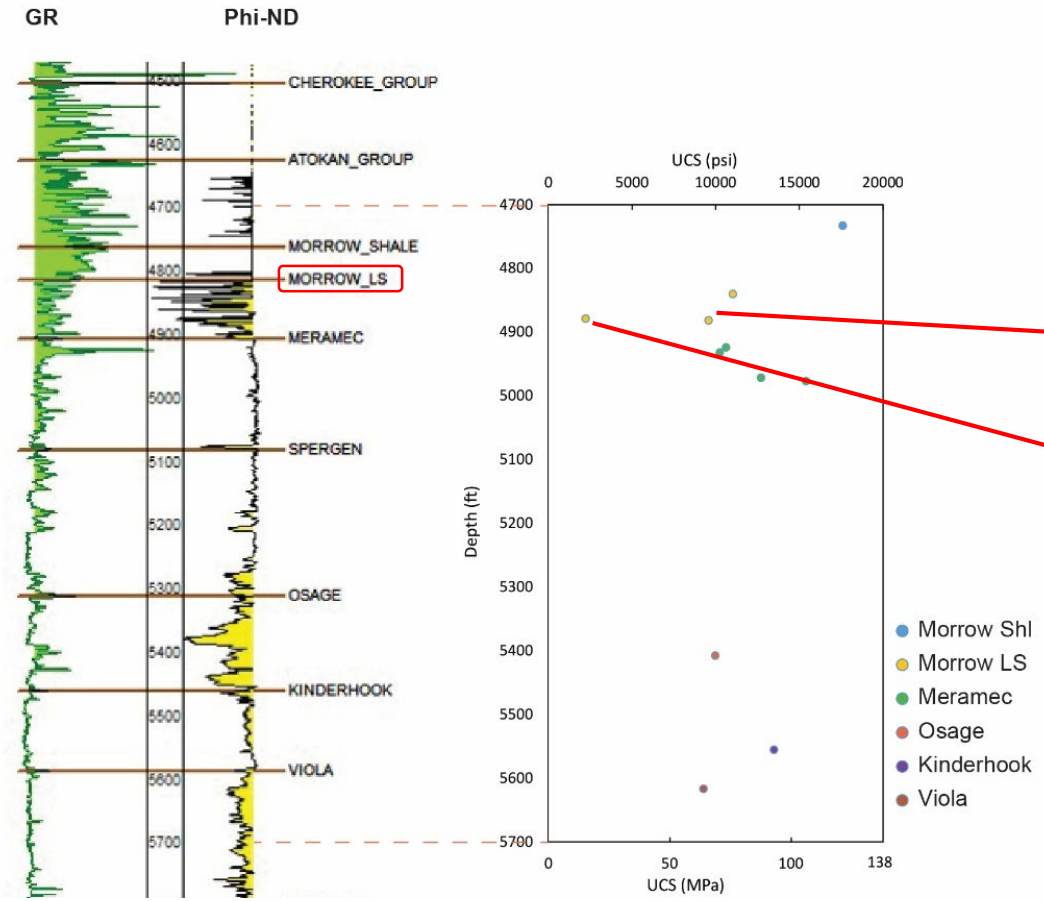
Meramec Group nonporous Limestone

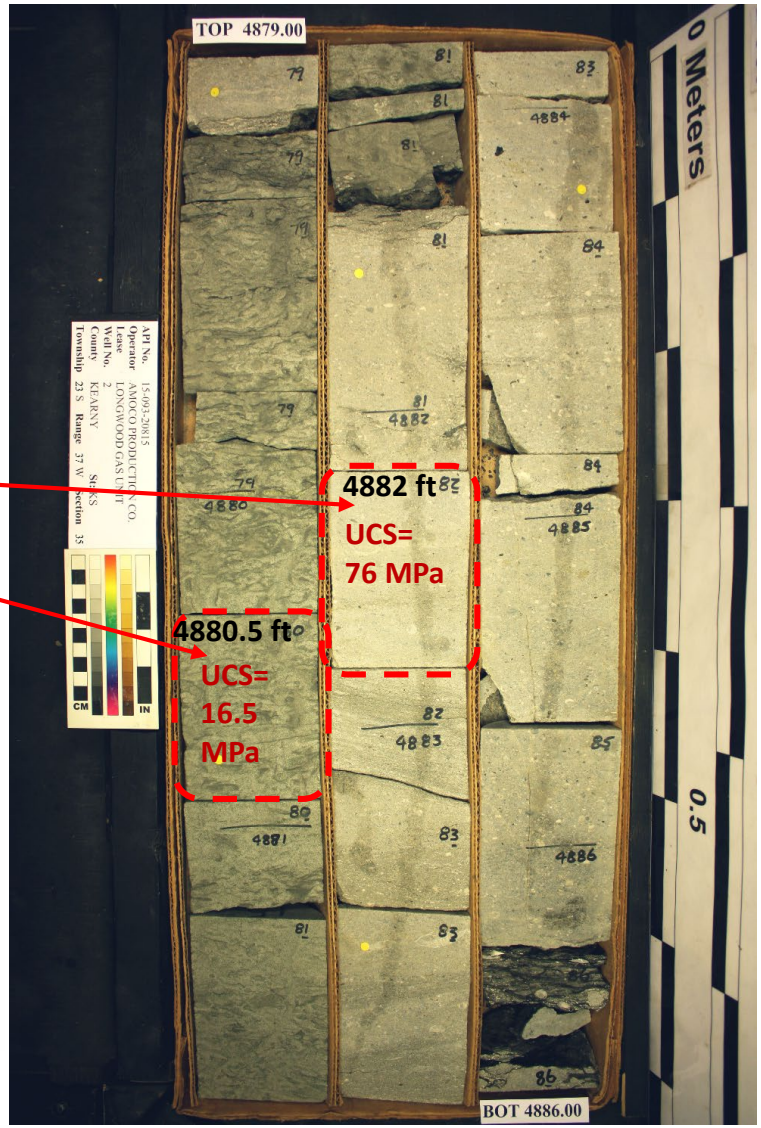


Kingderhook Group nonporous Limestone

Well Longwood GU#2

Geomechanical Test

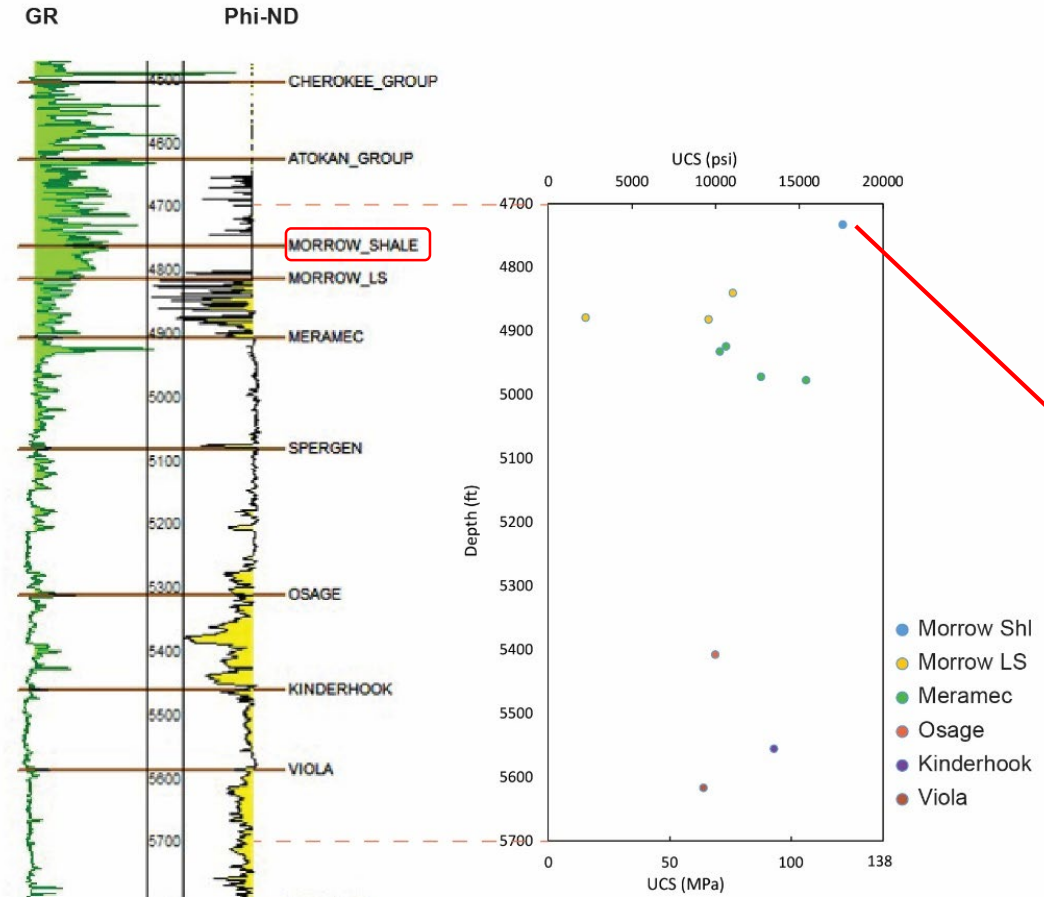


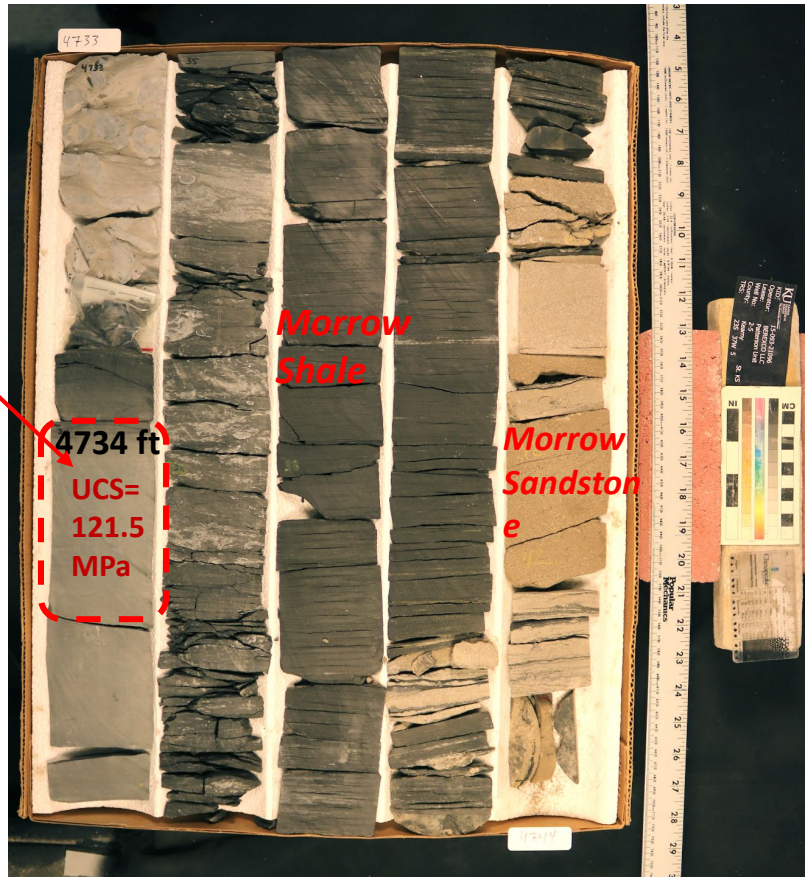


Well Longwood GU#2

Core image from Well Longwood GU#2

Geomechanical Test





Core image from Well Irene #2-5

Well Longwood GU#2

Summary

- Laterally continuous shale in Morrow Formation being effective primary seal for the reservoirs. Multiple relatively thin, but laterally continuous shales in Cherokee and Atoka Group providing additional sealing capacity.
- Reverse faults identified in the Patterson area offset the reservoir intervals, but not interrupt the Morrow Formation primary seal.
- Geomechanical test result show competent caprocks in the seal help arrest the fracture propagation from injection.
- Ongoing study is on structural modeling, fault seal properties, stress and pressure analyses, and geomechanical simulation.

Thank You!