Chemostratigraphy and its application to the Woodford Shale, Oklahoma

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Purpose

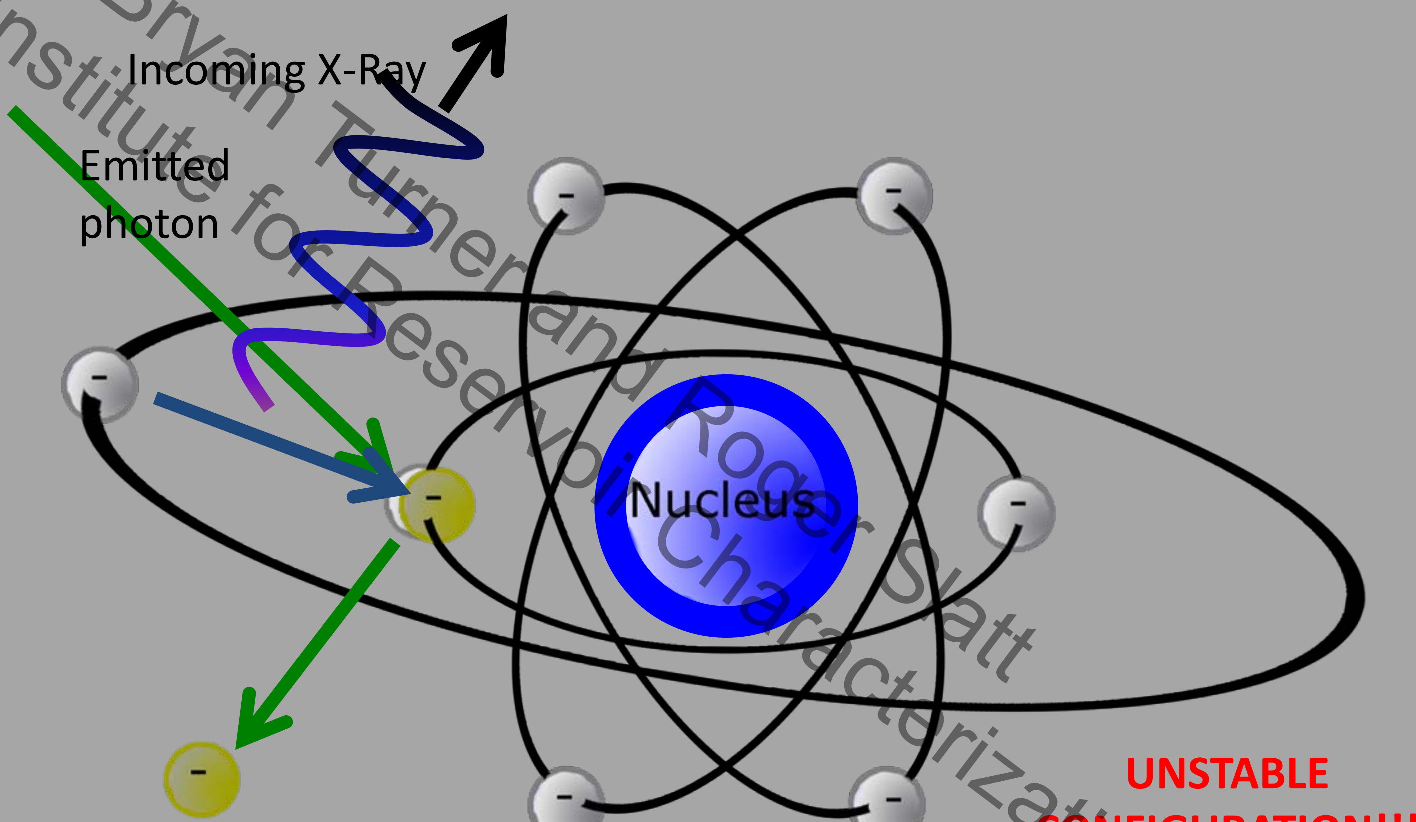
- To utilize a series of elemental proxies to develop a sequence stratigraphic framework that can be used to correlate fine-grain lithologies.
  - Lateral facies shifts within mudrocks are subtle, but can be significant and pervasive.
  - Highlight these shifts with greater precision than is possible in coarser lithologies.

Significance

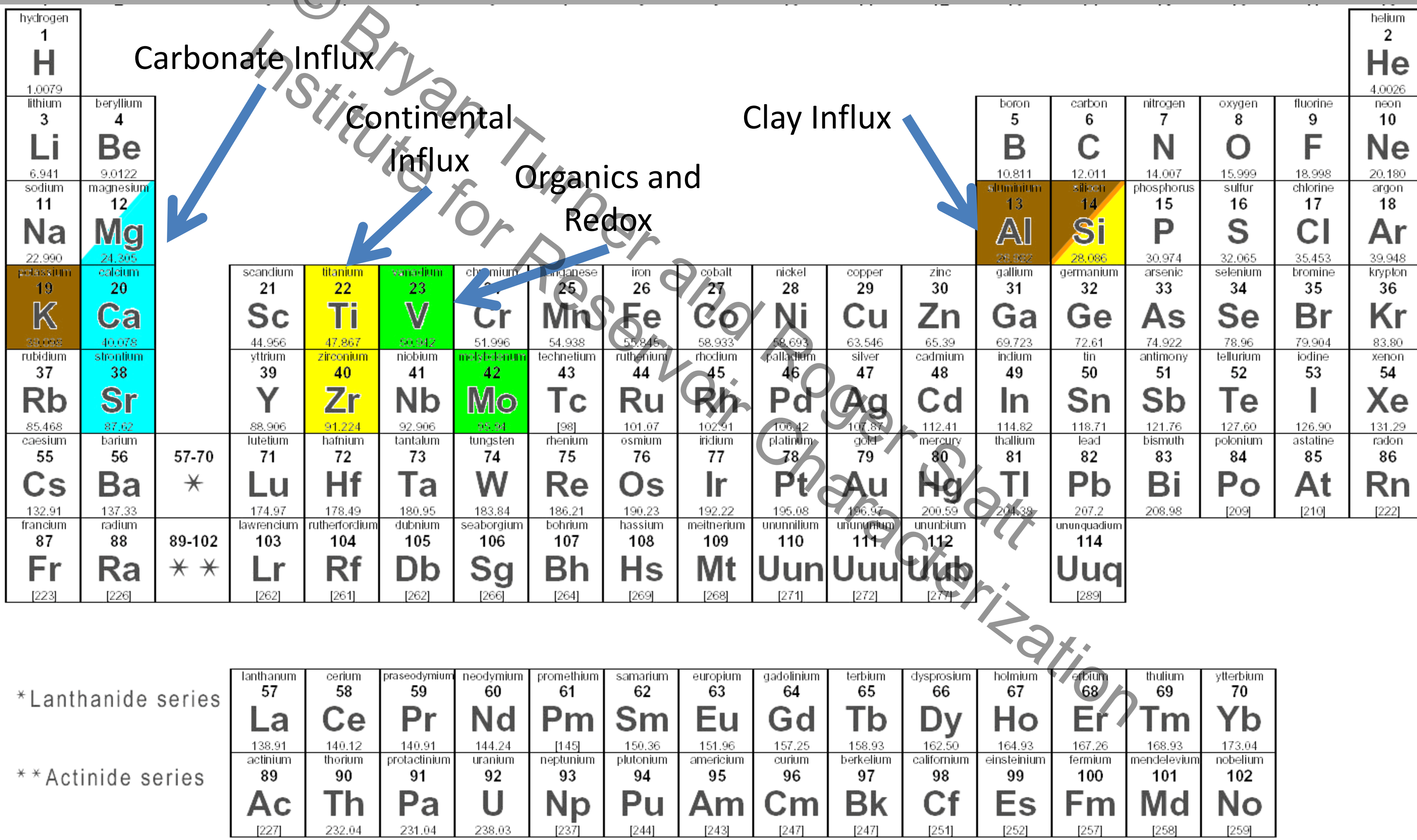
- Allows greater confidence in locating landing zones for production.
- Highlights regions where conditions will favor hydrocarbon production.
- Allows for high resolution correlation of mudrock reservoirs.


XRF
Thermo
SCIENTIFIC

X-Ray Fluorescence (Conceptually)



An Abridged List of Elemental Proxies



(Algeo and Maynard, 2004; Brumsack, 2006; Tribovillard et al., 2006; Rowe et al., 2012)

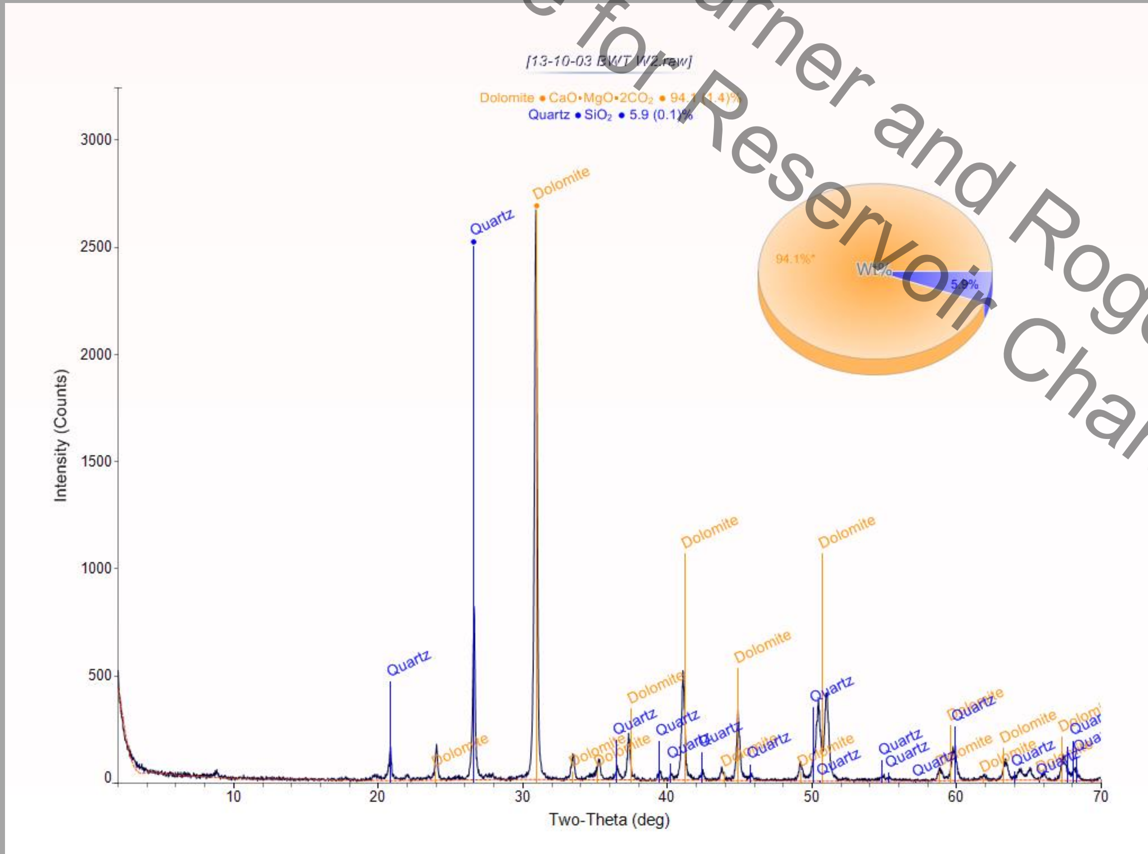
The Special Case for Si

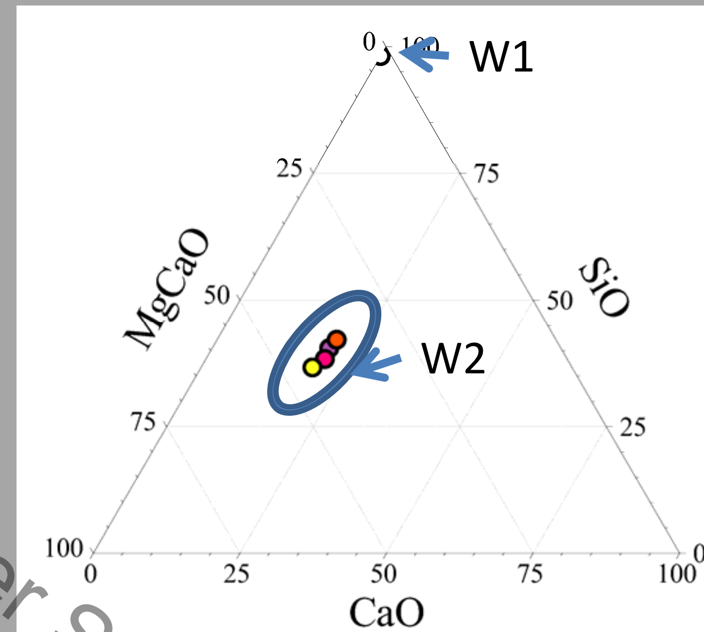
- Si: Quartz -> **Si**O_2
  Clay minerals (e.g. illite) -> KAl_2**Si**$_4O_{10}(OH)_2$
  Radiolarians -> amorphous **Si**O_2
  (may recrystallize during diagenesis)
- To estimate clastic input
  – Divide by Al to remove the clay component
- To estimate biogenic input
  – Compare to other continental influx proxies (such as Ti)

XRD CONFIRMATION

XRD vs. XRF

XRD: 94% Dolomite
6% Quartz





XRF: 60-70% Carbonate
30-40% Quartz

W2:Dolomite

W1:Radiolarian horizon

*: These examples all use light elements and may be difficult to detect with HHXRF

HHXRF Utility

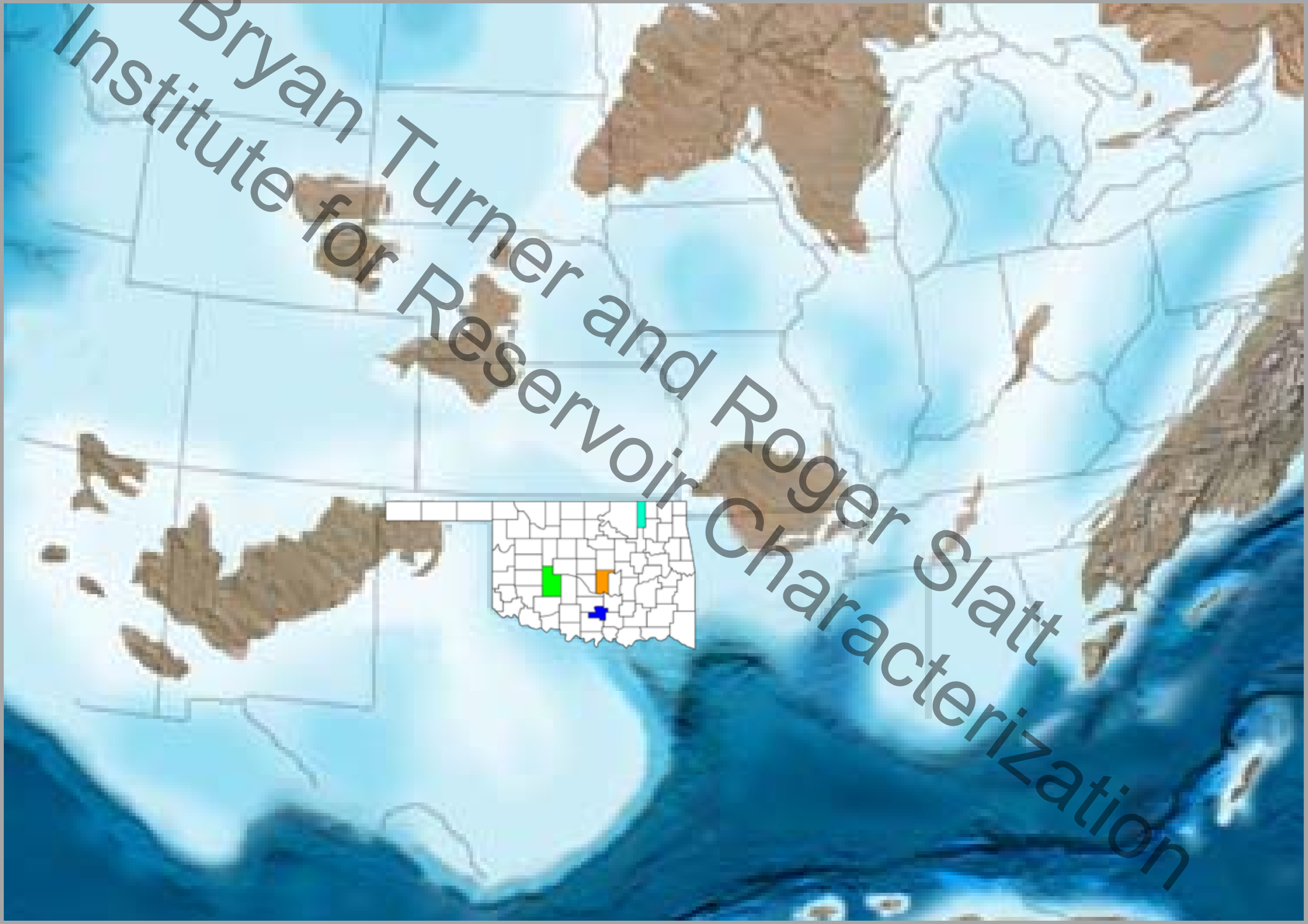
- "All models are wrong, some models are useful" –George E.P. Box

- The HHXRF numerical values are potentially suspect.
- However the **TRENDS** are useful for interpretation.

FIELD AREAS

Paleogeography

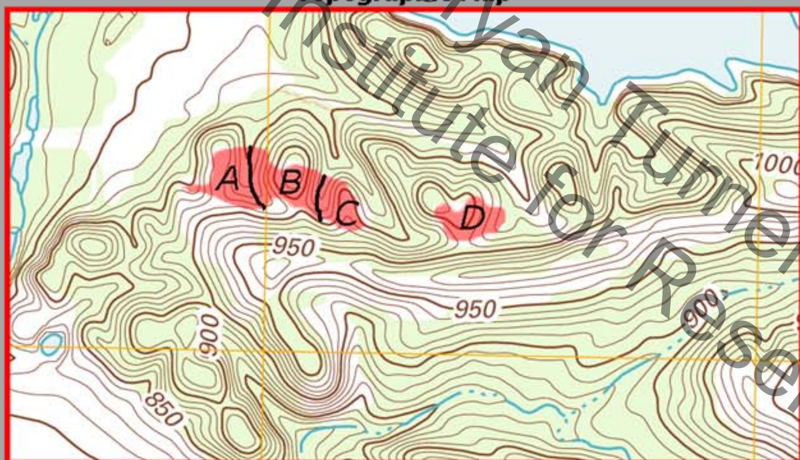
(Late Devonian)



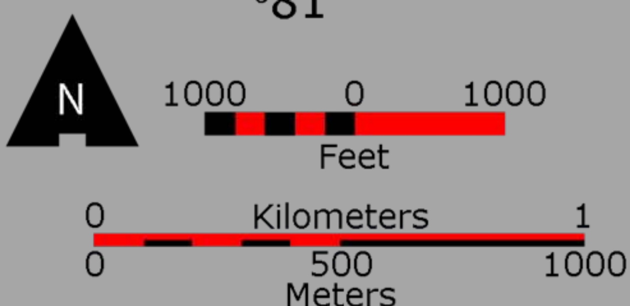
Modified from Blakey, 2011

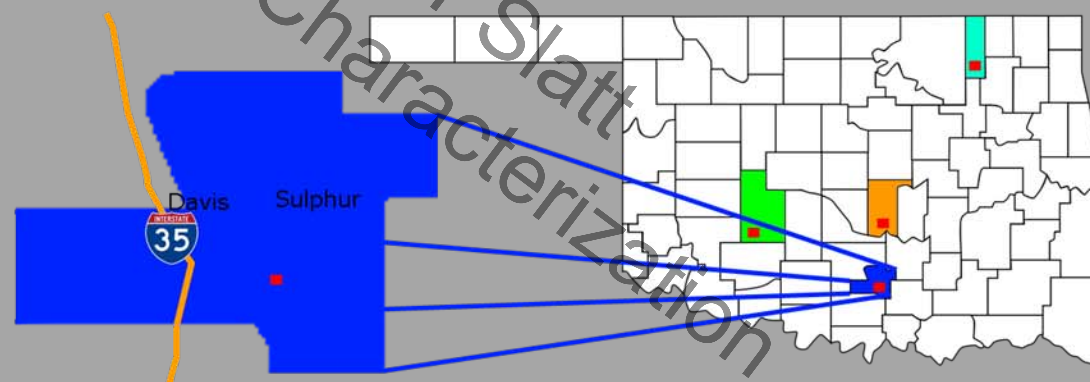
Hunton Anticline Quarry and the Three Cores

Topographic Map



Air Photo



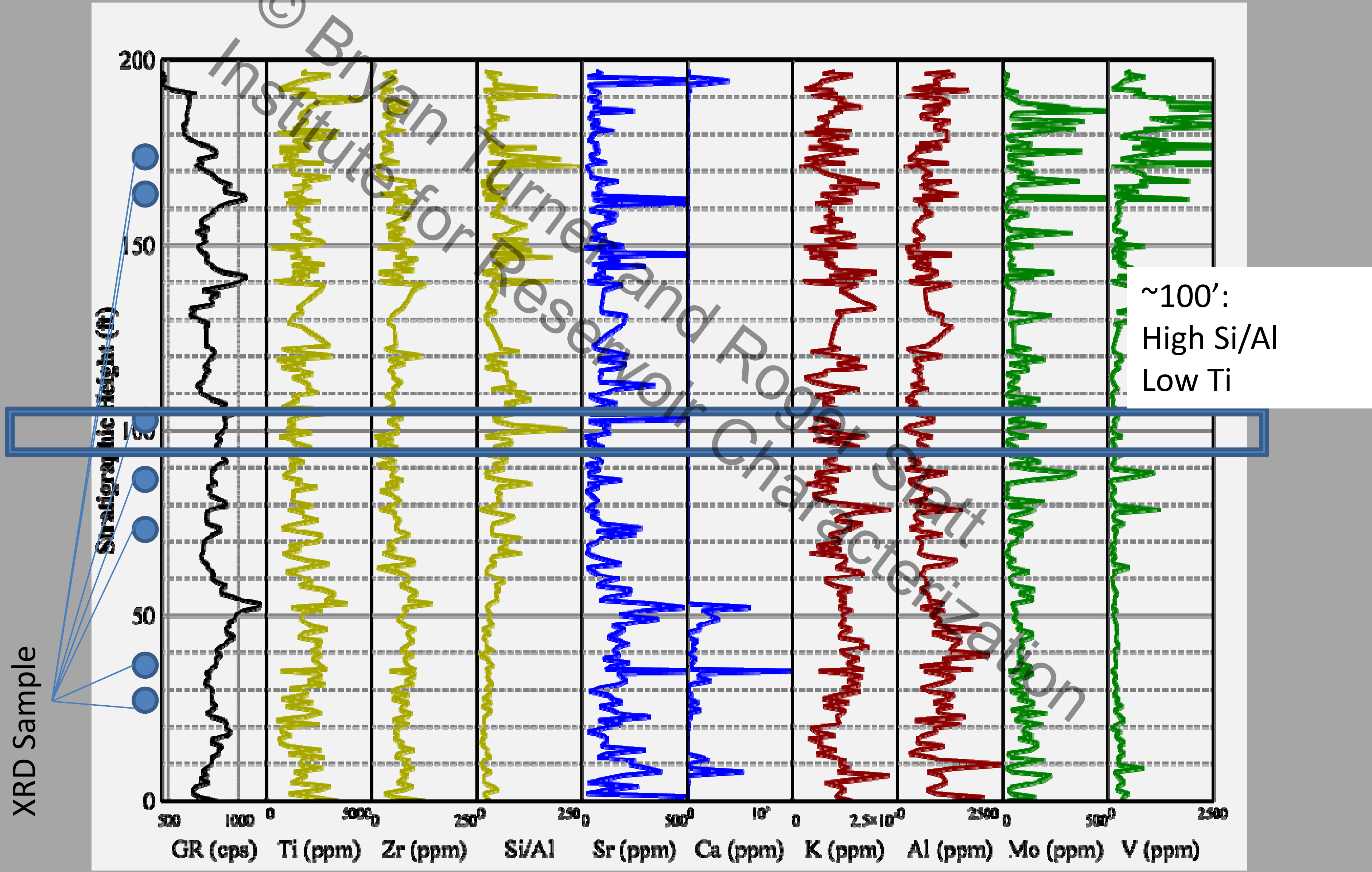


CONTOUR INTERVAL 10 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988

Quarry

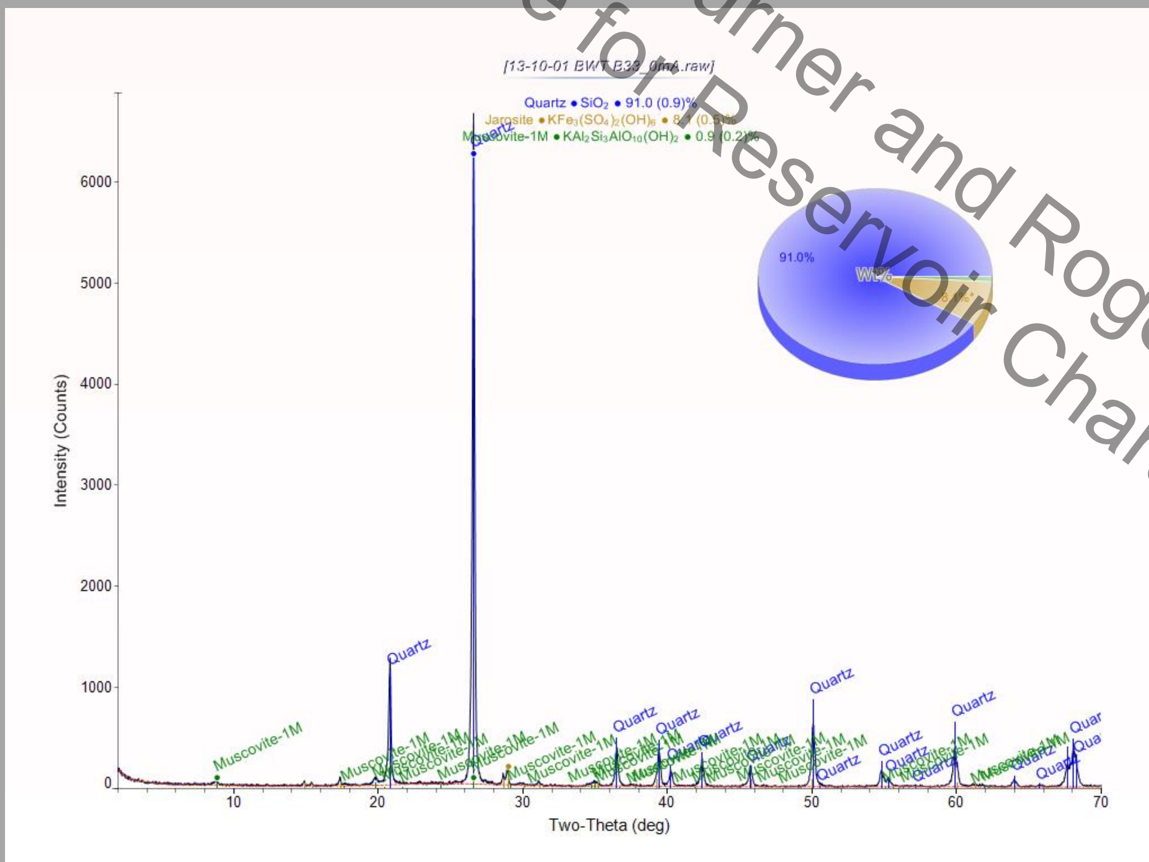
Site D

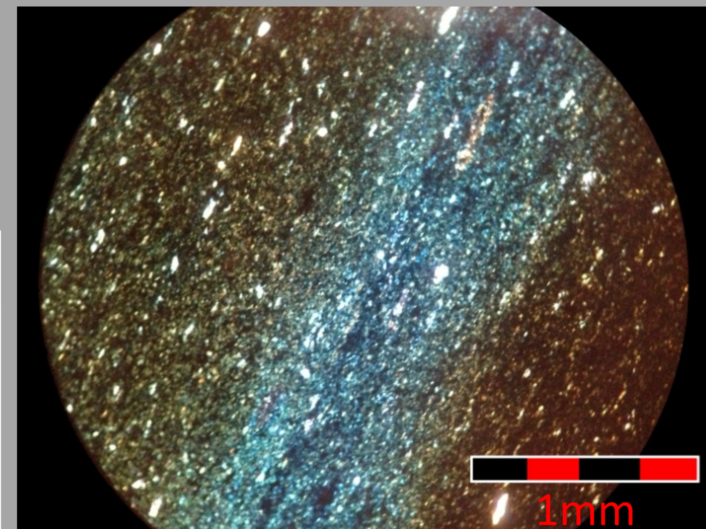
GR and XRF Profiles Site B



Thin “White Beds”

XRD: 91% Quartz (recrystallized radiolarians)
9% Diagenetic Minerals

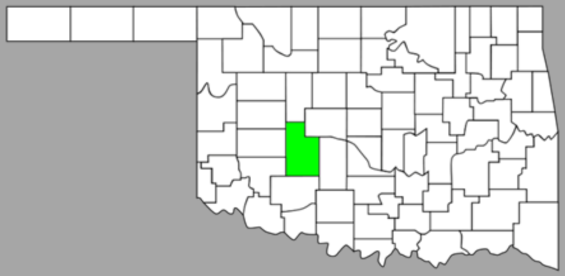


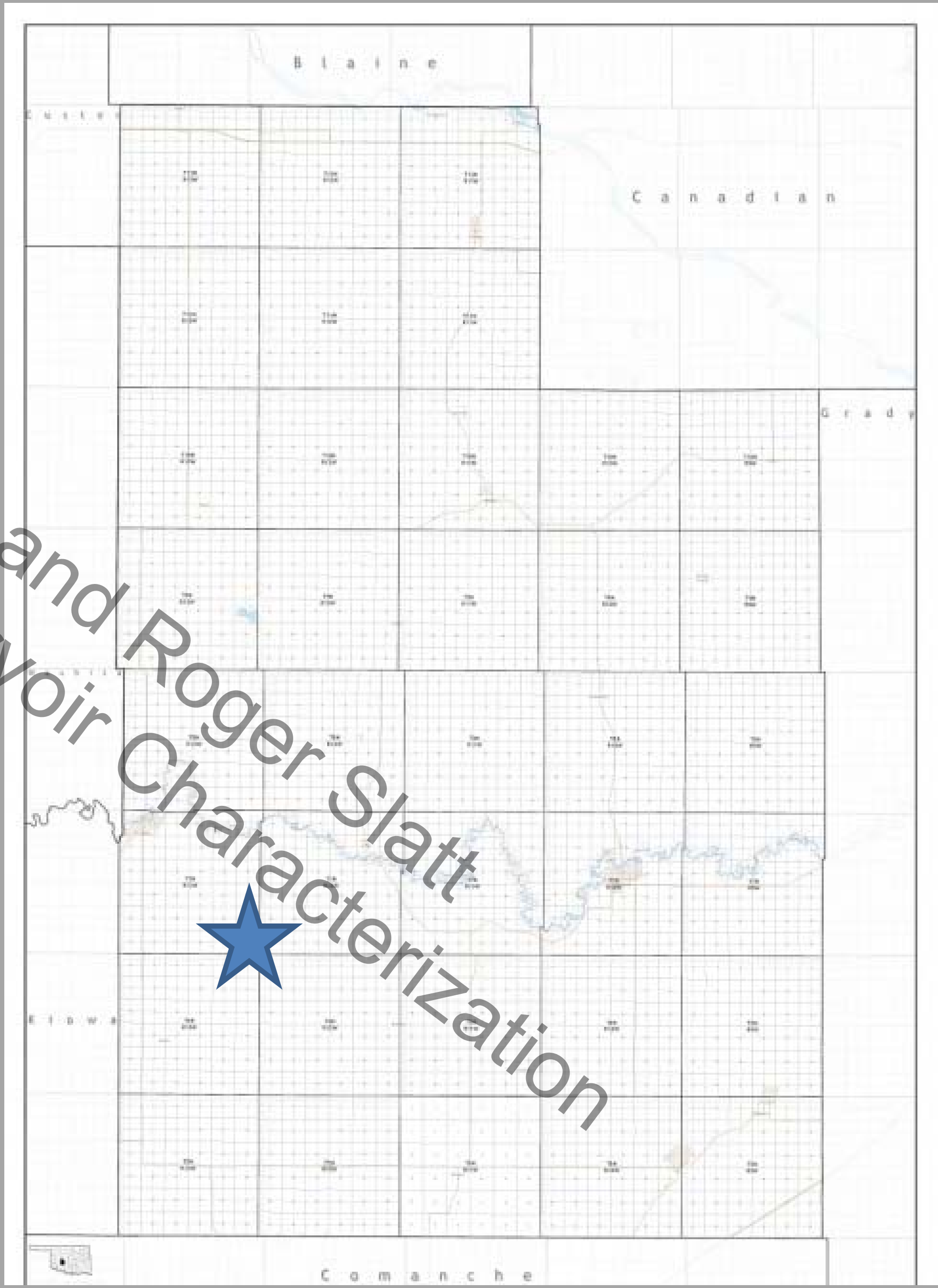


Grid is $1cm^2$ for scale.

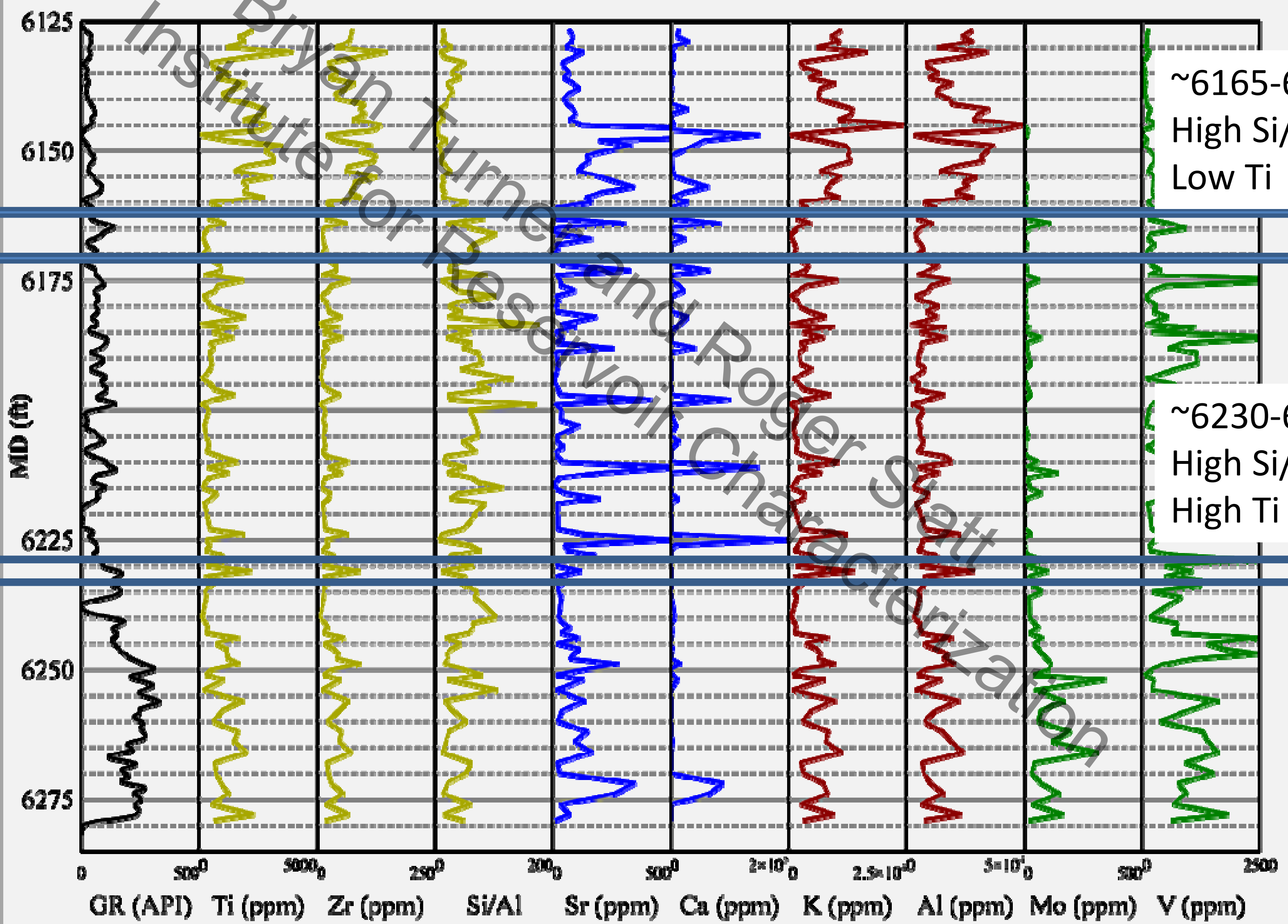
Hall 2B

- Jones and Pellow Operator
- Highly faulted well
- Northern Anadarko Basin (Caddo County)
- Heavily sampled





Hall 2B GR and Chemostratigraphy



~6165-6170’:
High Si/Al
Low Ti

~6230-6232’:
High Si/Al
High Ti

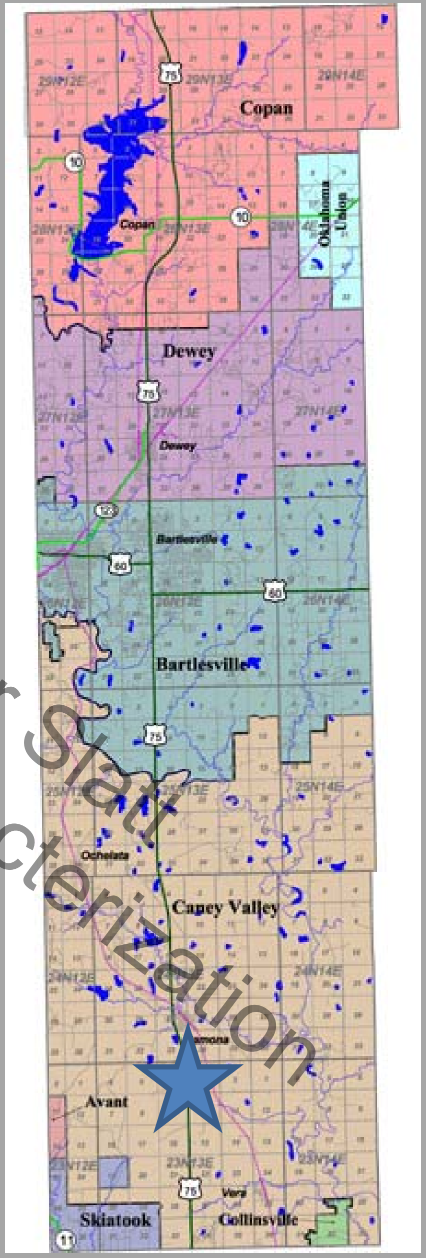
Core - Jones and Pellow Hall 2B

Biogenic Quartz Horizons ~6165 -6170’

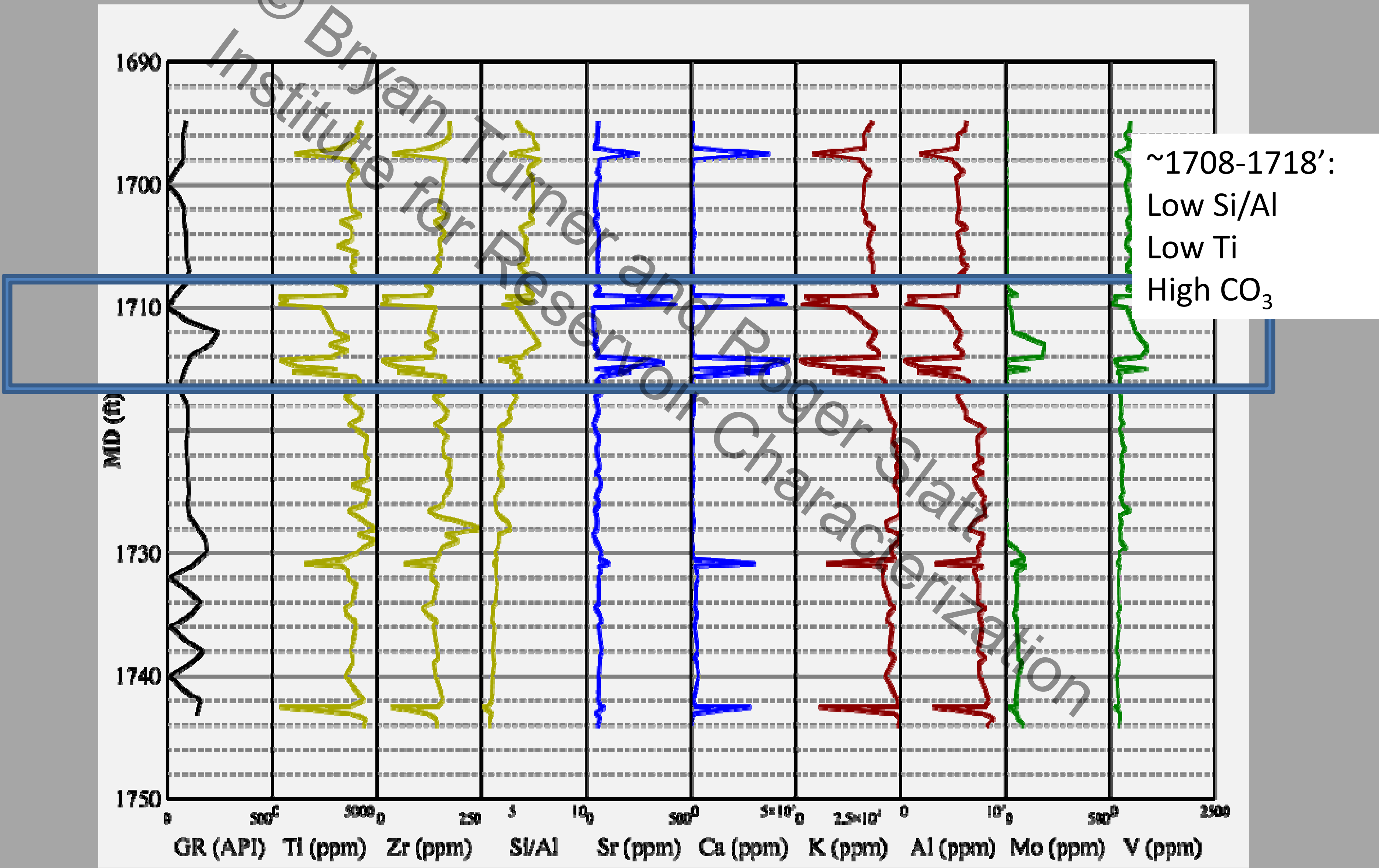
Clastic Quartz Horizons ~6130 - 6132

Anthis 2

- Constellation Energy Operator
- Proximal Well
- Northern Cherokee Platform (Washington County)



Anthis 2 GR and Chemostratigraphy

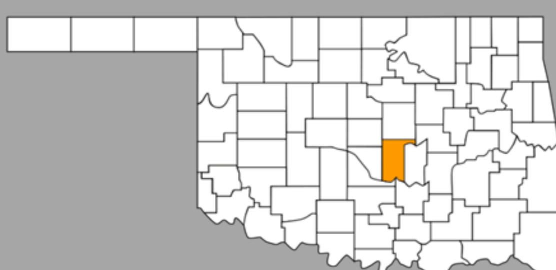


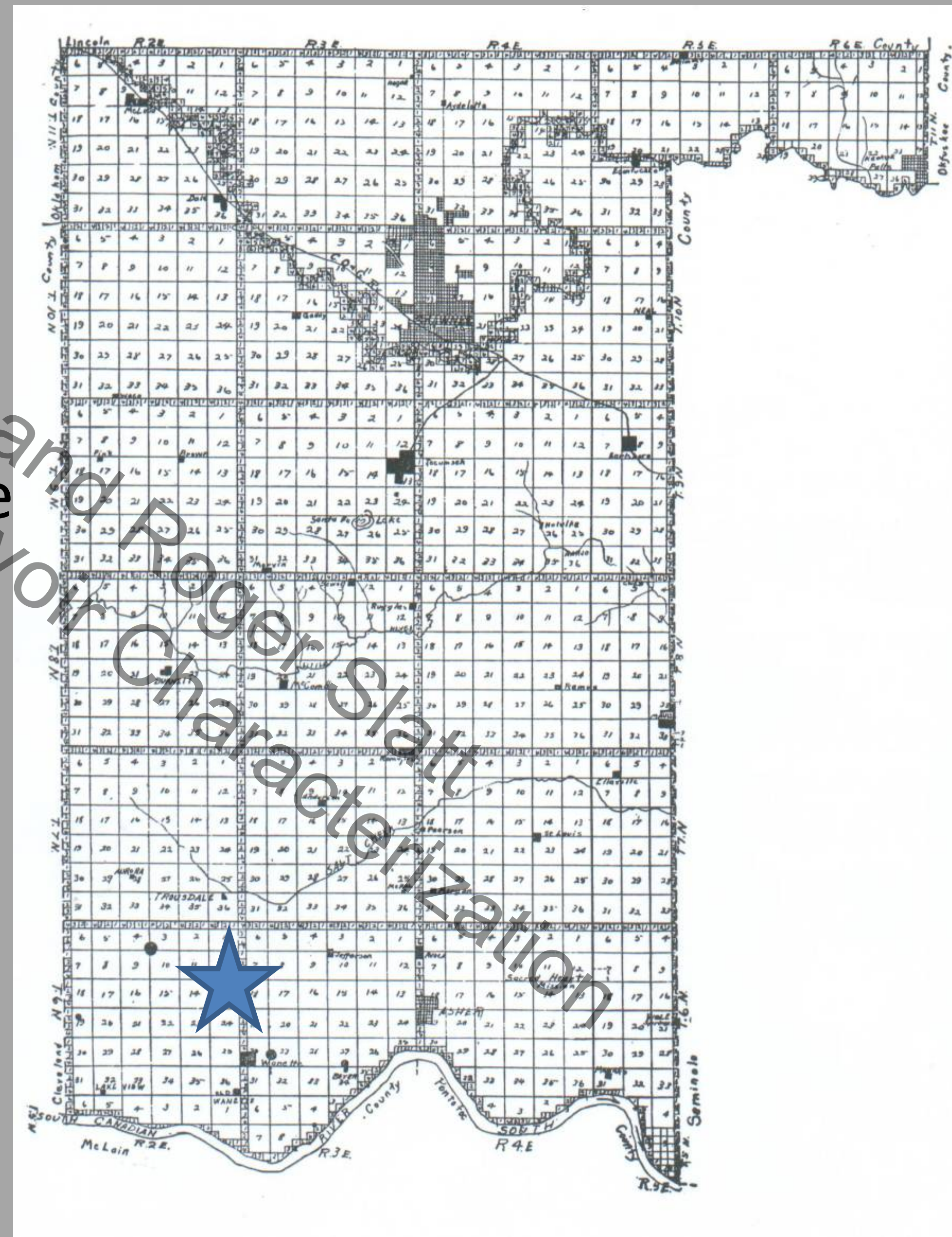
Core – Constellation Energy Anthis 2

Ray 1-13

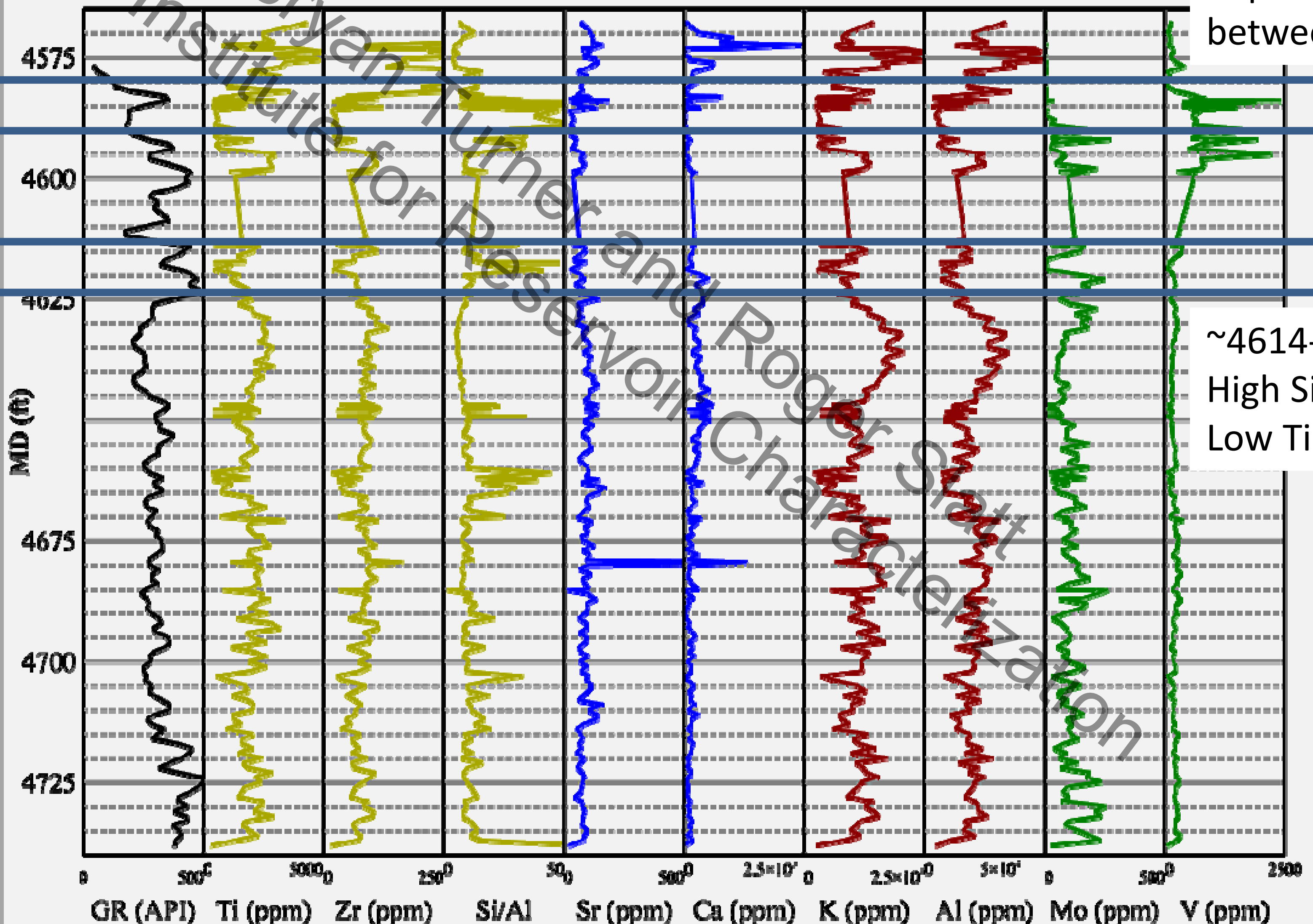
- West Star Operator

- Southern Cherokee Platform (Pottawatomie County)





Ray 1-13 GR and Chemostratigraphy



~4583-4588': Rapid shifts between

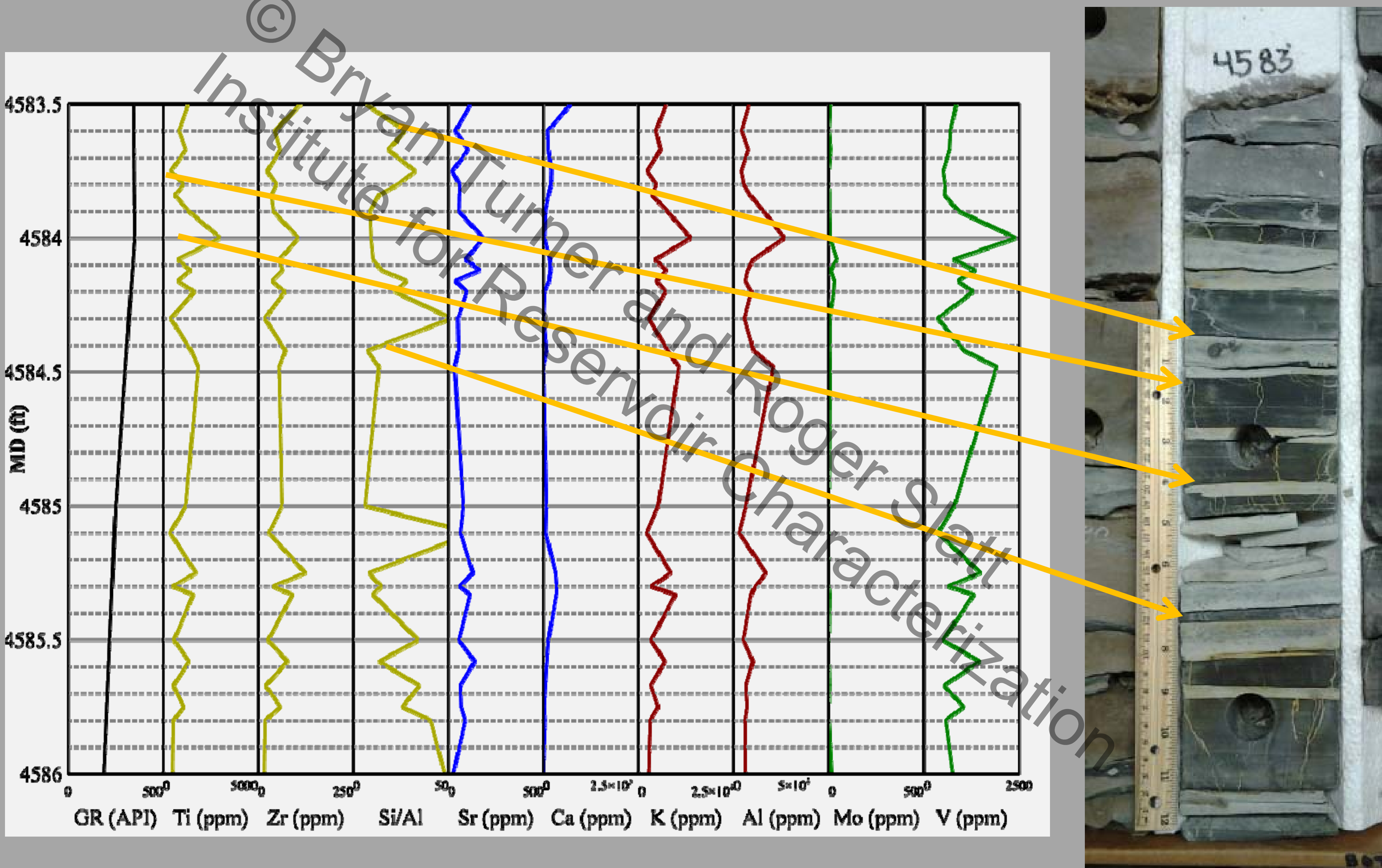
~4614-4624': High Si/Al Low Ti

Core – West Star Ray 1-13

Biogenic Quartz
Horizons
(4619-4624')

Rapid Facies
Shifts:
(~4583-4586')

Utility of High Resolution Chemostratigraphy



Conclusions and Future Work

- Chemostratigraphic data is becoming increasingly cost-effective to collect
- High resolution chemostratigraphy can provide detailed understanding of target lithology

  -Landing Zones -Drilling Hazards

  -Fracture Behavior -Completion Design

- Tie these elemental proxies to sedimentation rates to develop a sequence stratigraphic framework.

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References

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