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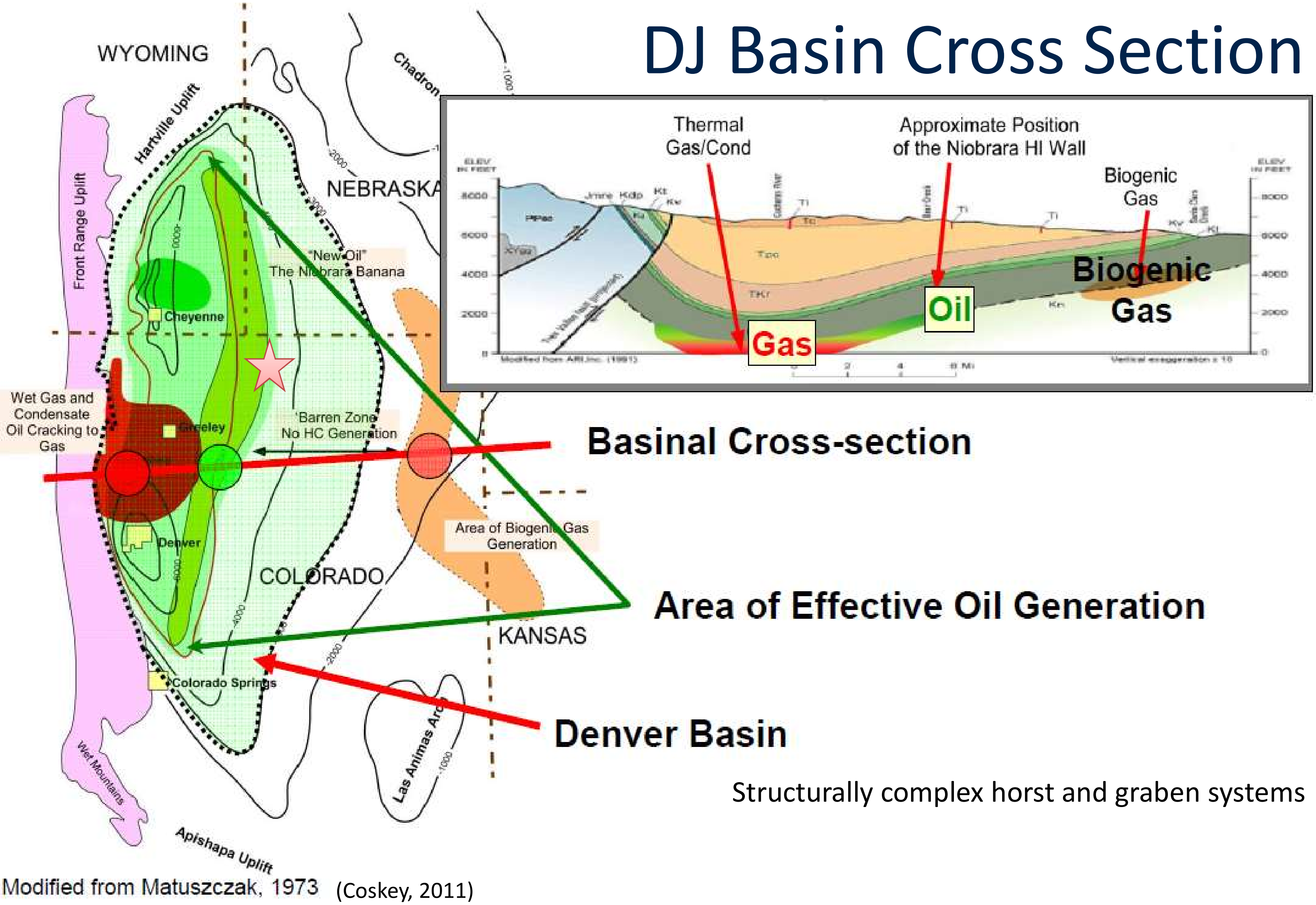
RESERVOIR CHARACTERIZATION OF THE NIOBRARA B INTERVAL AT REDTAIL FIELD: WELD COUNTY, DENVER JULESBURG BASIN, NORTHEAST COLORADO

Outline

COLORADO SCHOOL OF MINES MUDTOC

- Introduction
- Type Well
- Geologic Maps
- Core Descriptions
- Pyrolysis Data
- X-ray Fluorescence (XRF) Analysis
- Future Work

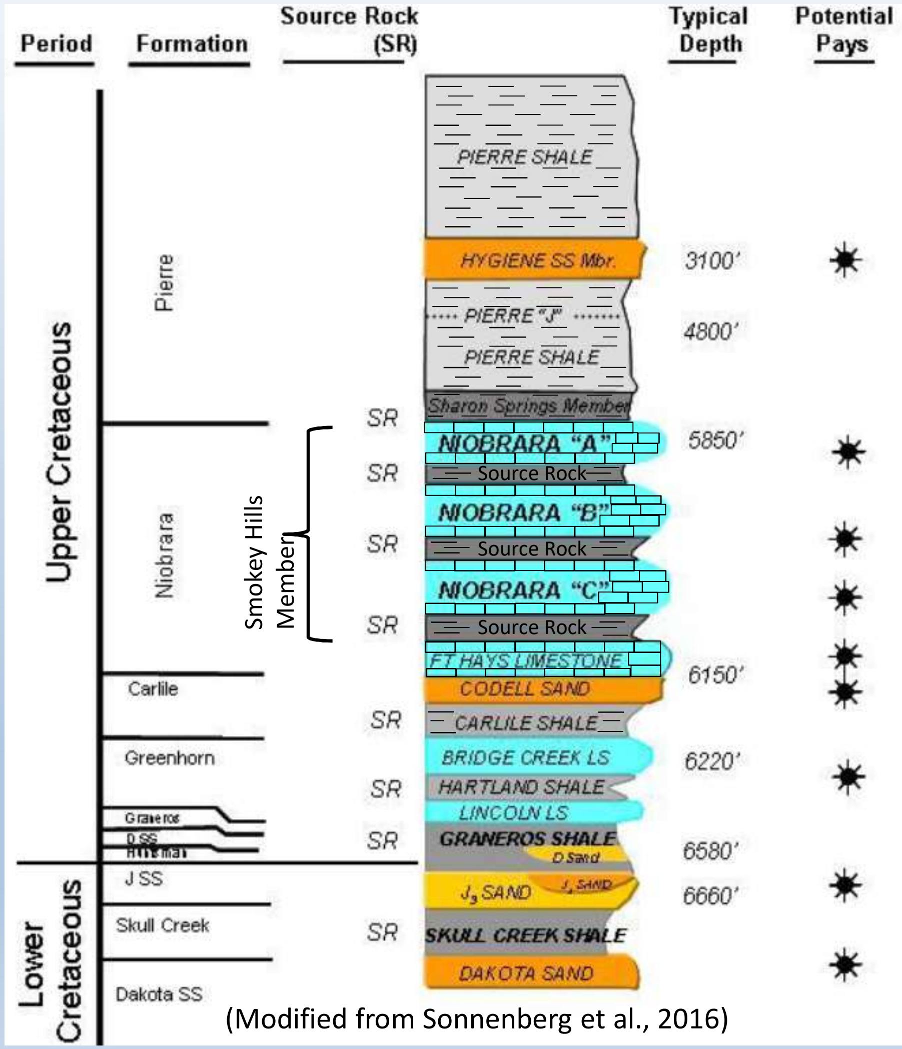
DJ Basin Cross Section



(Coskey, 2011)

Structurally complex horst and graben systems

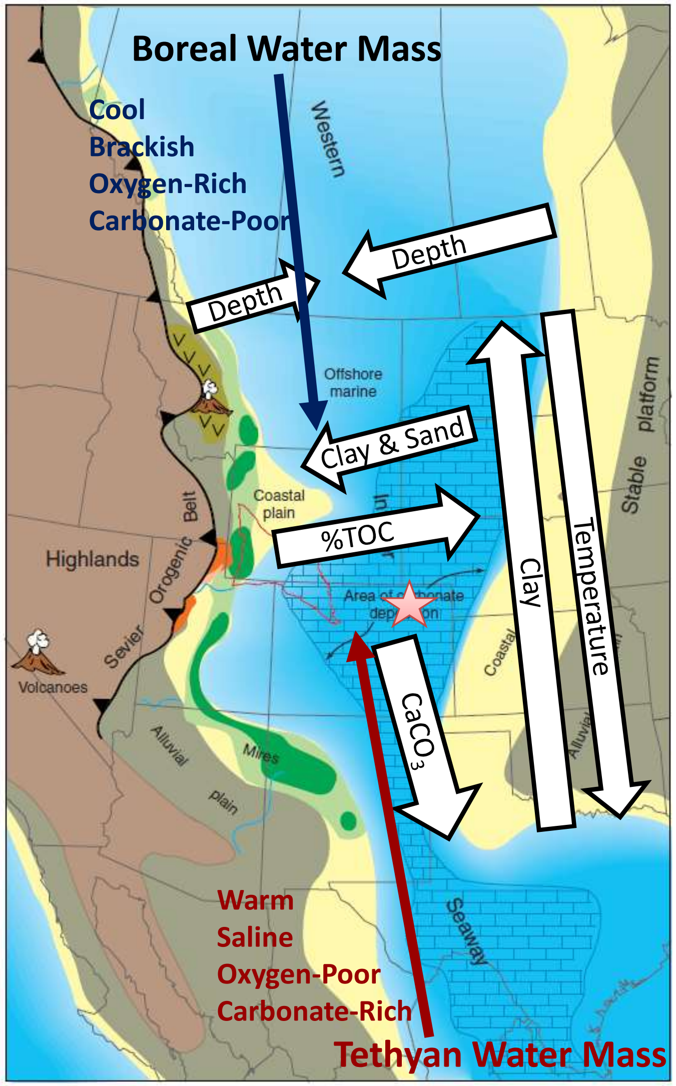
DJ Basin Stratigraphic Column



(Modified from Sonnenberg et al., 2016)

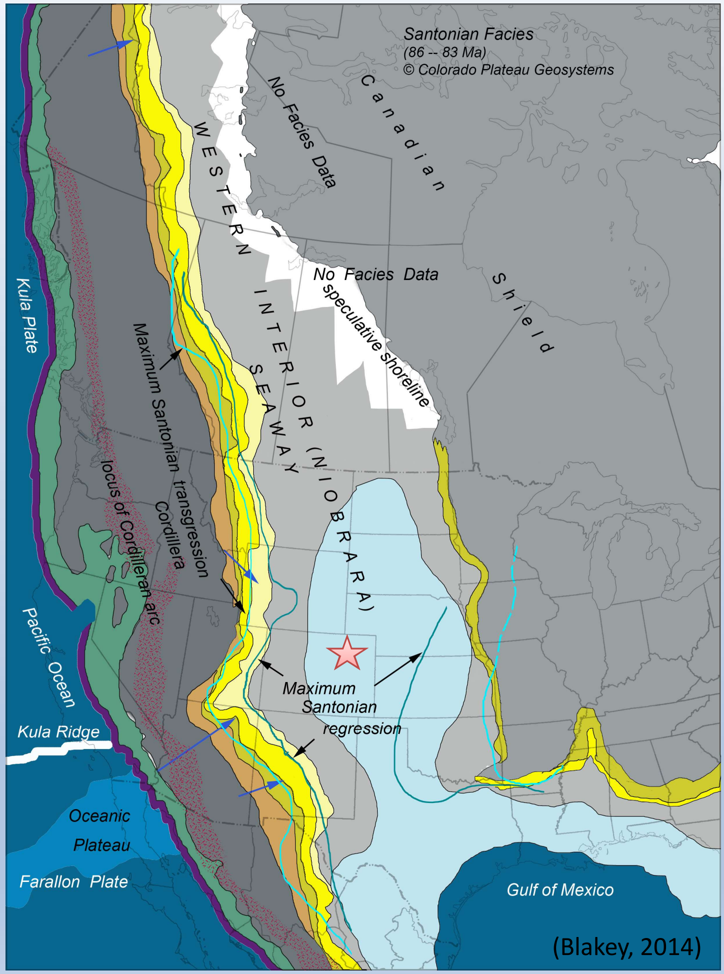
The age of the Niobrara Formation is Coniacian to Campanian of the Late Cretaceous (Around 82-89 mya)

Western Interior Seaway



Paleogeographic reconstruction of the Western Interior Seaway during the Coniacian-Santonian time of the Late Cretaceous. Arrows showing depositional patterns studied by Longman et al. in 1998.

Paleogeographic distribution of geographic limits during the Santonian (Upper Niobrara Interval) showing the maximum transgression and regression.

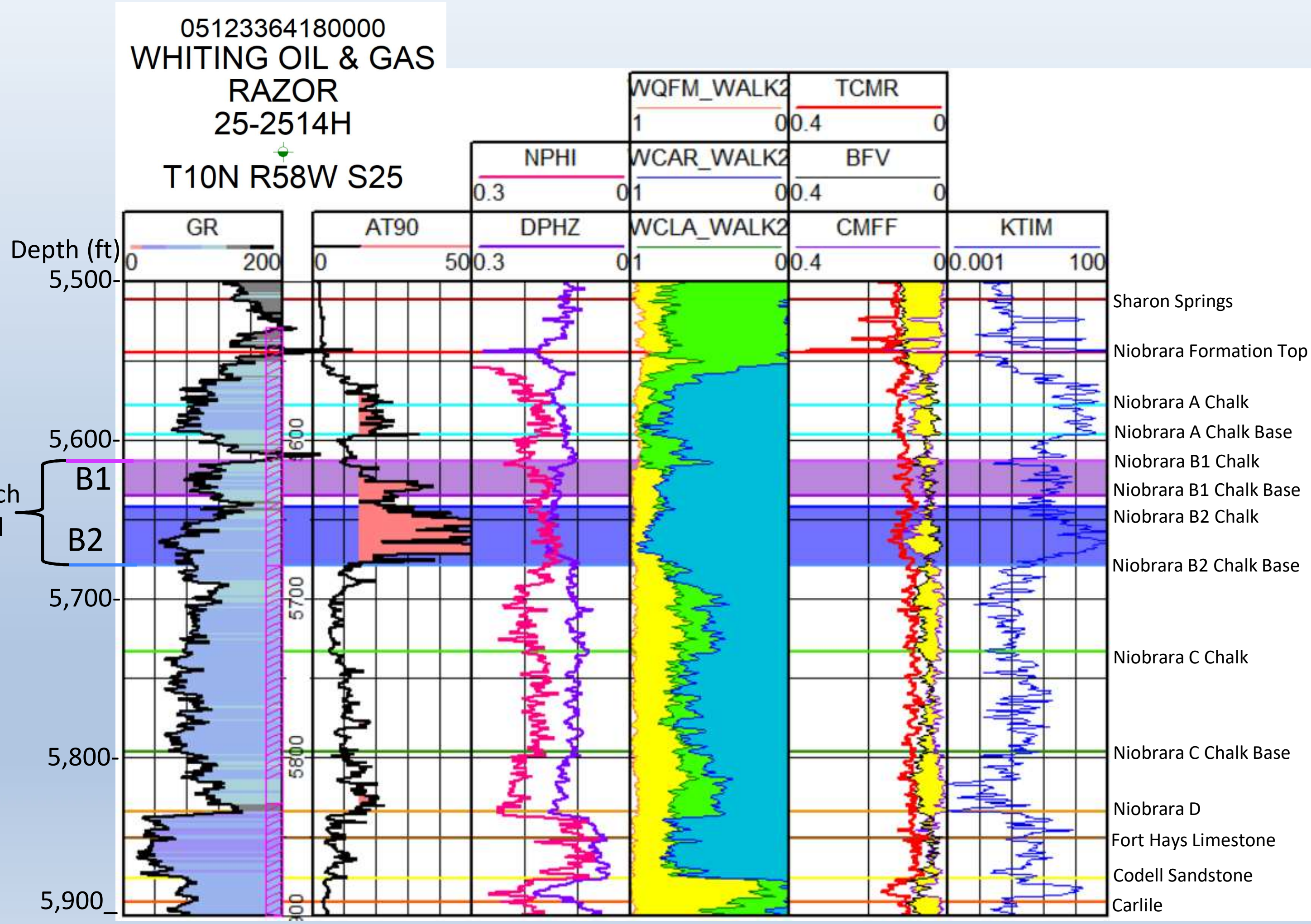


Modified from Roberts and Kirshbaum (1995) and Finn and Johnson, (2005)
Depositional patterns from Longman et al. (1998)

Type Well Razor 25-2514H

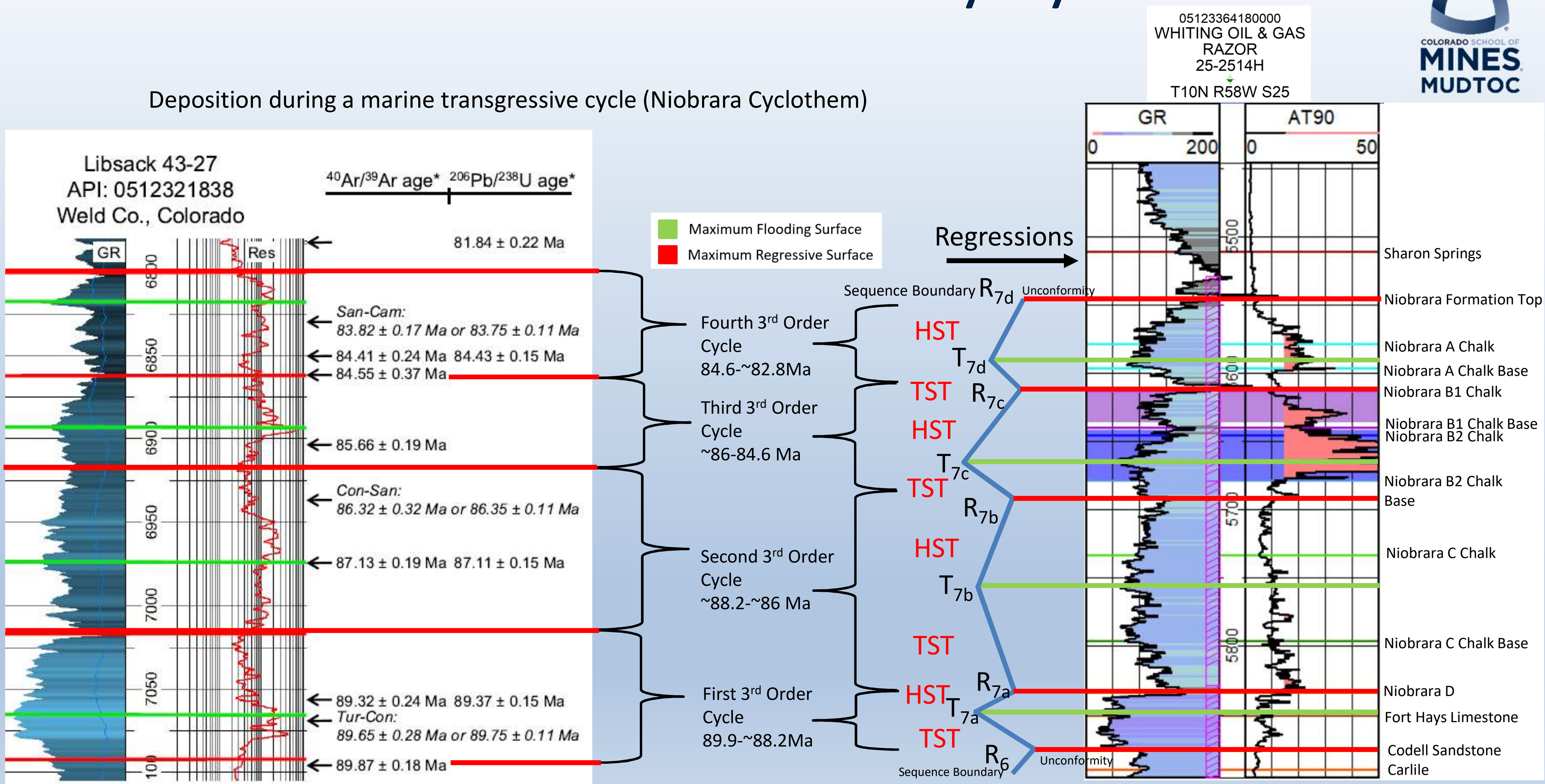
B1 Chalk: 5,613-5,639 ft TVD

B2 Chalk: 5,645-5,678 ft TVD



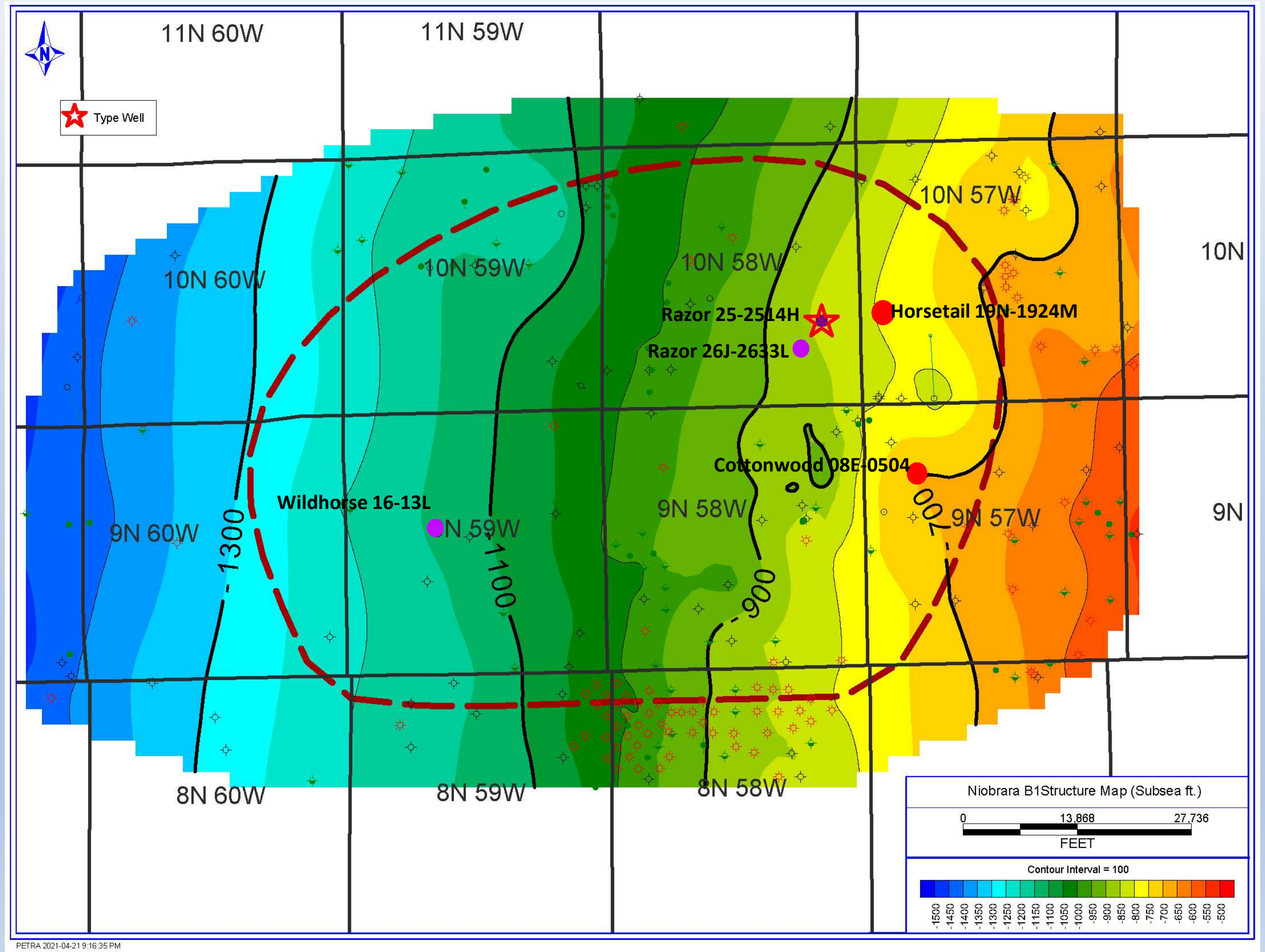
Western Interior Seaway Cycles

Deposition during a marine transgressive cycle (Niobrara Cyclothem)



Modified from Drake and Hawkins (2012) who modified from Longman et al. (1998)

Nio B1 Structure Map



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In Redtail Field the Niobrara Formation is at a depth of -700-1,250ft subsea.

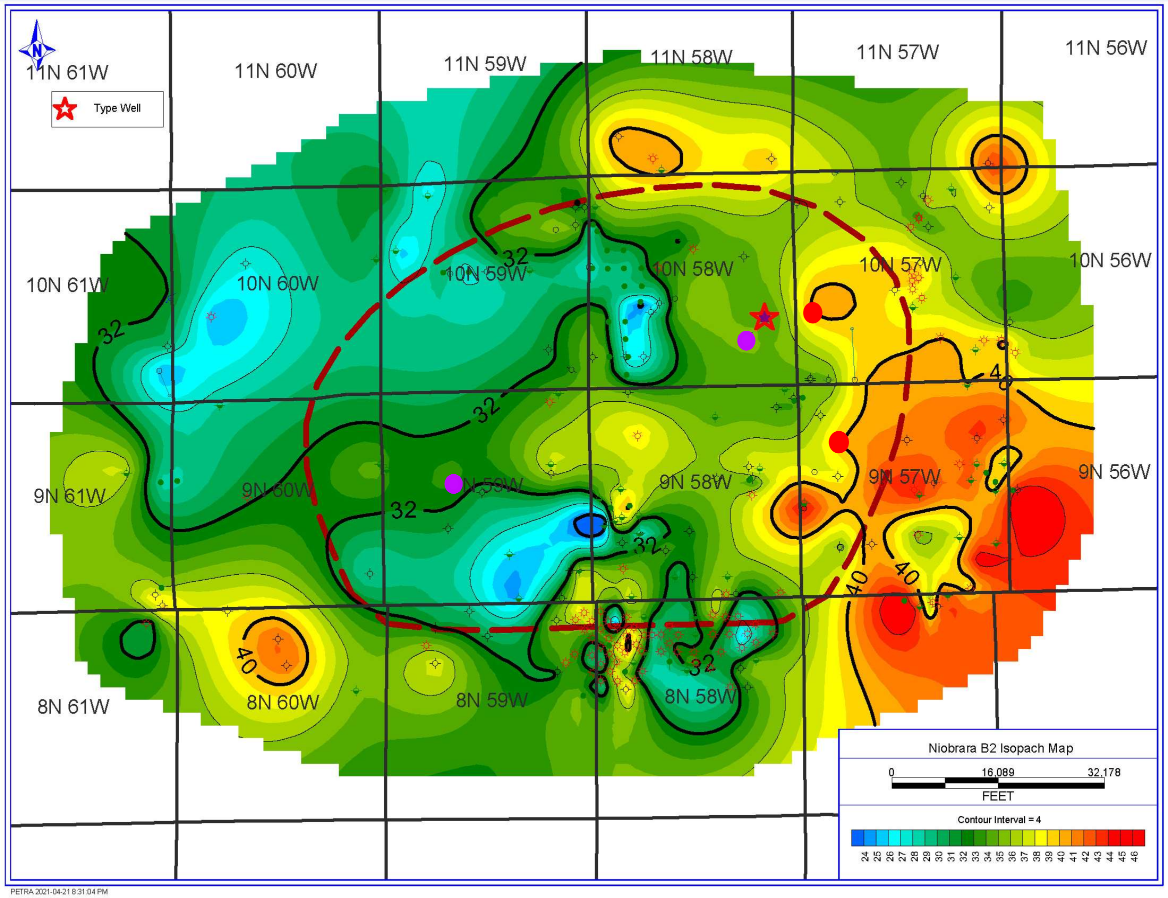
266 wells used

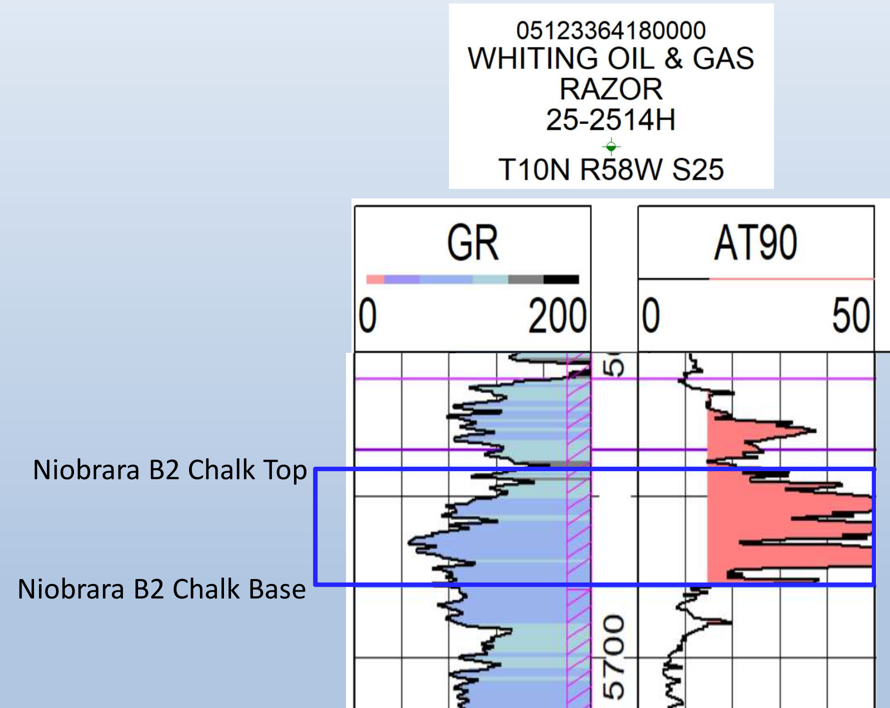
Three wells shown in red have core that fully includes the B1 and B2 intervals and are: Razor 25-2514H, Horsetail 19N-1924M, and Cottonwood 08E-0504.

Two wells shown in purple have core that partially includes the study interval and they are: Razor 26J-2633L and Wildhorse 16-13L.

These well cores were provided by Whiting Oil and Gas Corporation.

Nio B2 Chalk Isopach Map

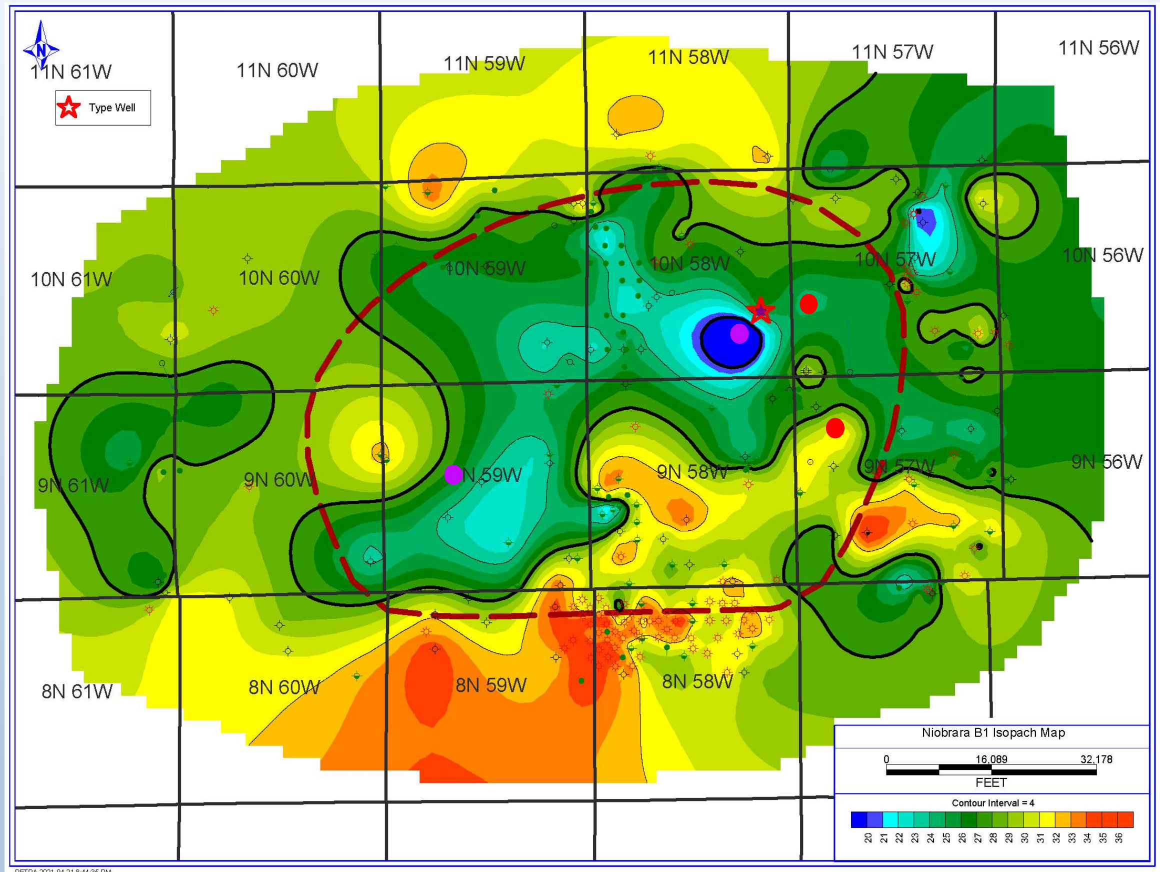


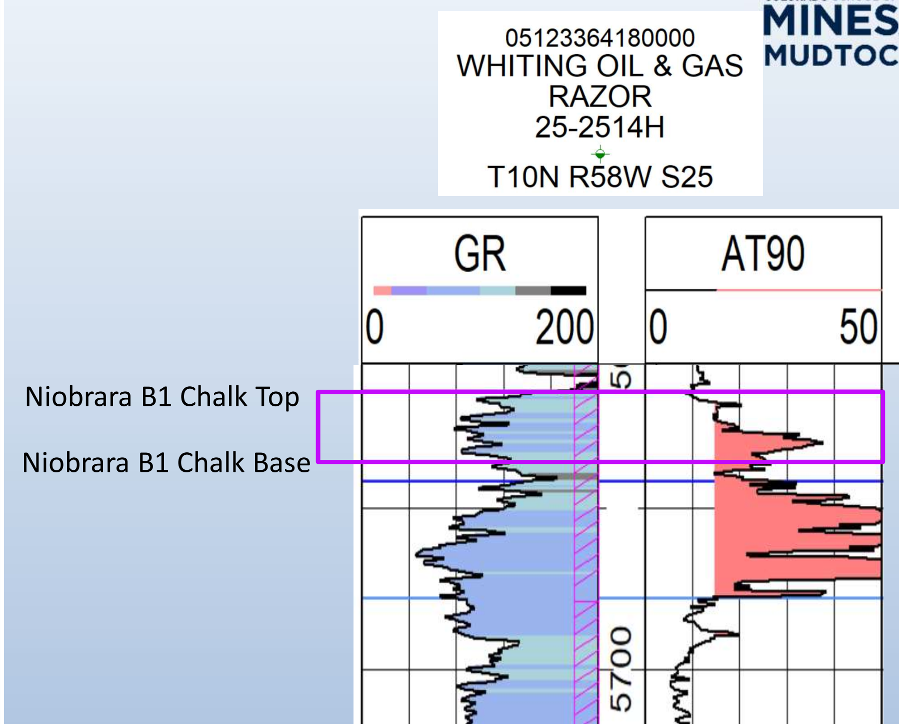


Niobrara B2 has a variable thickness in the field ranging from 24-43 ft.

B1 thin is compensated by thicker B2.

Nio B1 Chalk Isopach Map





B1 Chalk has a variable thickness in the field ranging from 20-35 ft.

The dark blue spot is the location of the Razor 26J-2633L well. The thickness of the other interval seem appropriate and my current theory is that there is a fault that thinned the Nio B1.

CORE DESCRIPTIONS

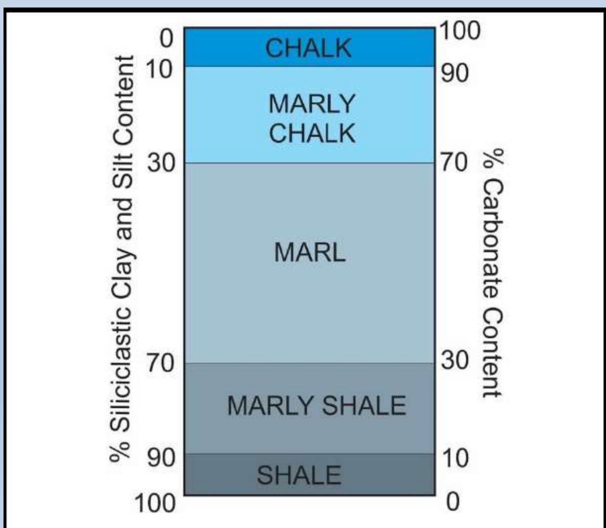
COLORADO SCHOOL OF MINES MUDTOC

Core

Razor 25-2514H Core provided by Whiting Oil and Gas Corporation and cored by Core Lab Petroleum Services

Core descriptions from 5,679-5,610 ft MD

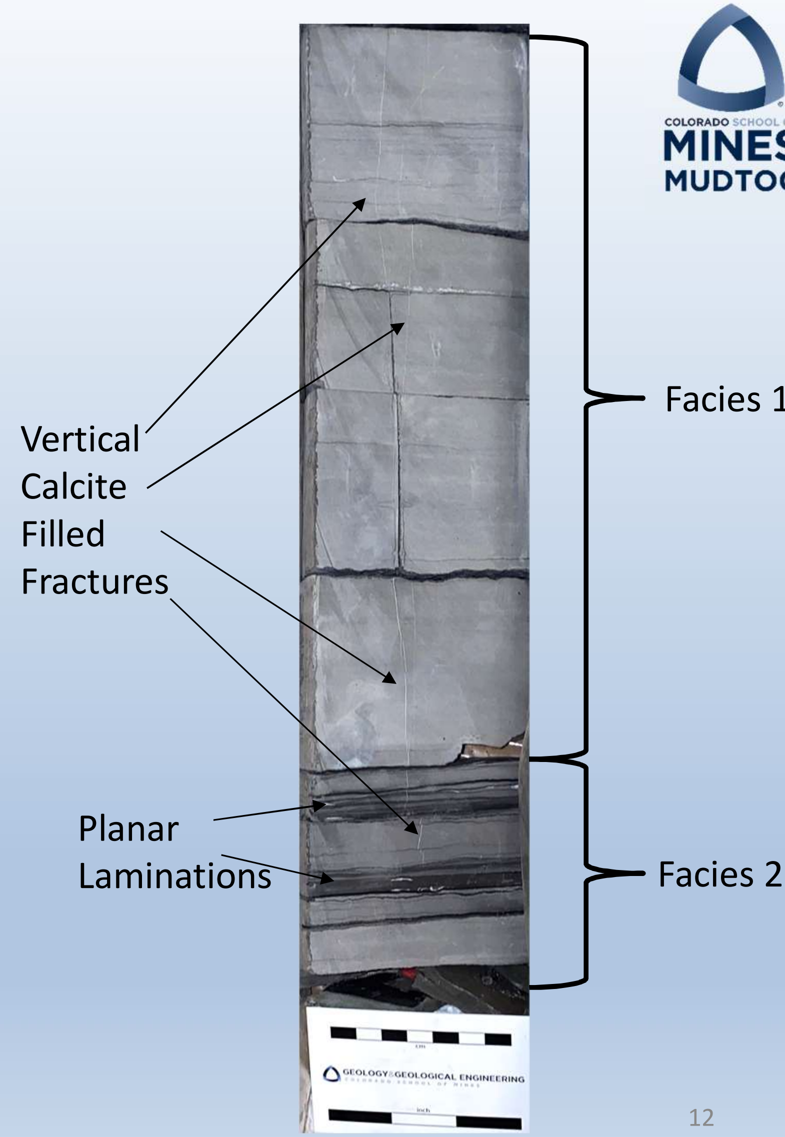
Depth correction is
log = core – 5 ft



CSM Niobrara Consortium – 'Unlock the Chalk'

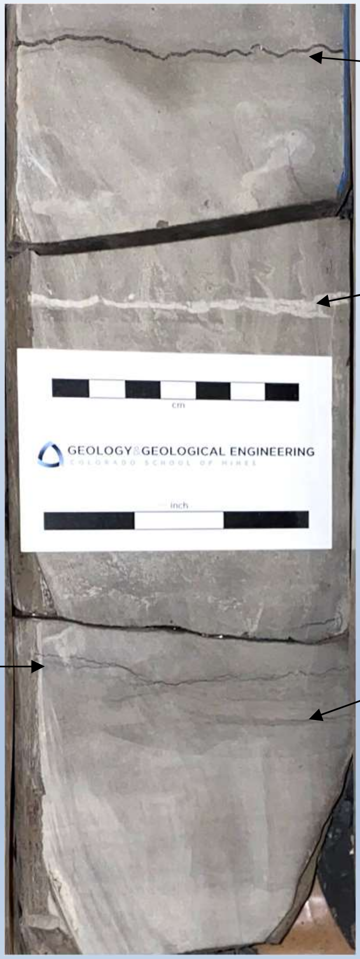
Used the chalk and marl classification system as defined by the Colorado School of Mines Niobrara Consortium to identify four facies in the Niobrara B interval in the Razor 25-2514H well.

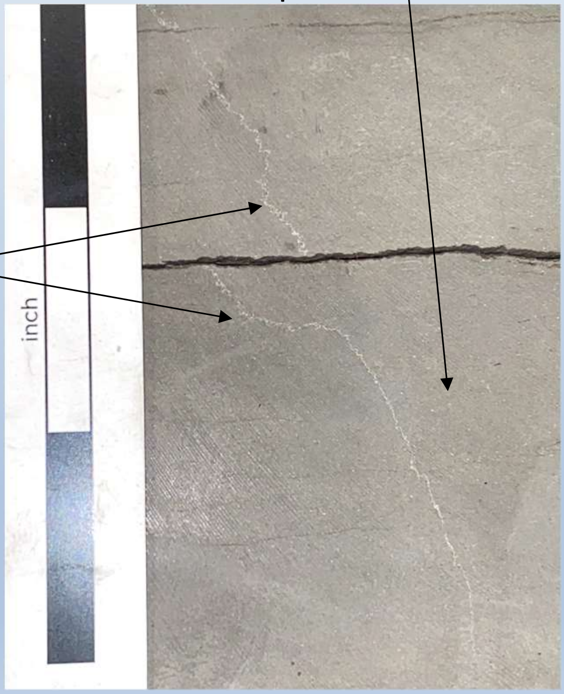
After Sonnenberg (2012)



Facies 1

- Homogenous chalk with few minor clay drapes
- Contains white speckles in core that are foraminifera with calcite rinds
- There are few layers of oyster shell hash and inoceramids
- The majority of the styolites in the B interval are located within this facies





Facies 2

- Planar laminated chalks and marls that are interbedded with some clay drapes
- Rare wavy beds but, overall the beds are planar
- Contains white speckles in core that are foraminifera and copepod pellets
- Oysters shells and oyster shell hash present
- Most common facies through the B1 and B2 intervals

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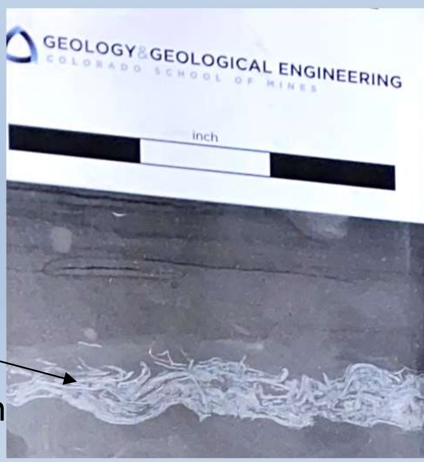

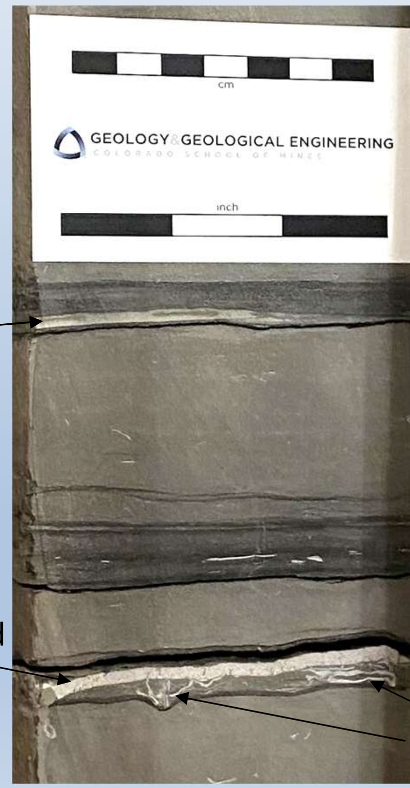

Facies 3

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- Dark grey argillaceous chalk
- Most prevalent at the top and bottom of the B1 and B2 chalk intervals in the transition zones
- Contains more clay content with planar laminations and some interbedded chalk
- Contains thin pyrite beds and nodules
- Some bentonite layers

Pyrite Layer

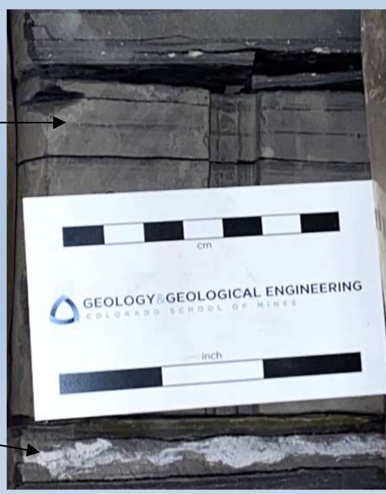
Planar Laminations

Planar Bedding

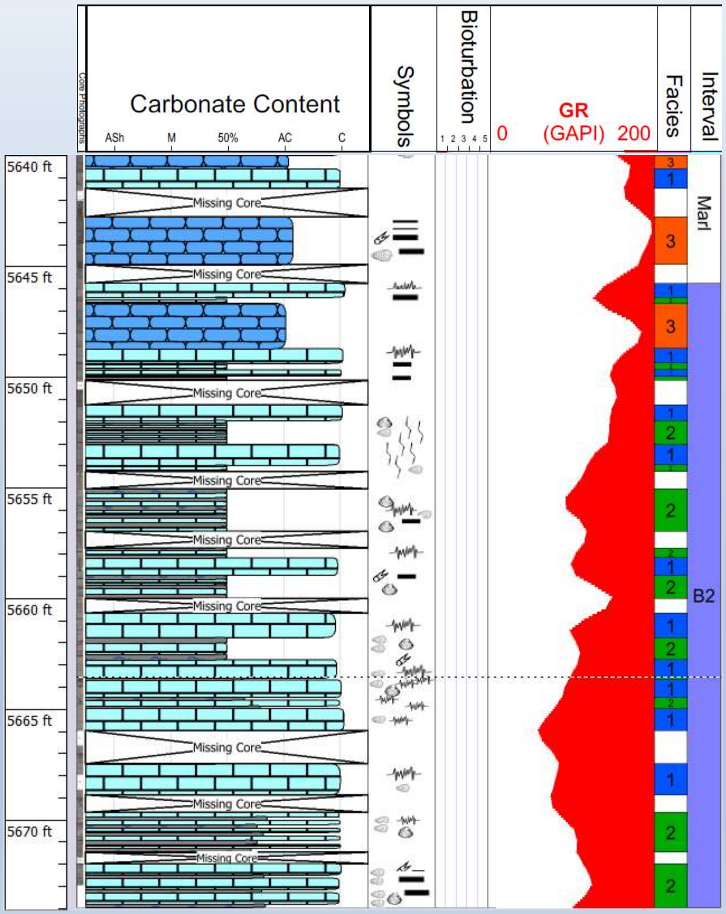
Bentonite Bed

Facies 4

- Overall is a mainly structureless marl with some planar laminations
- Is a darker grey than the argillaceous chalk to almost black in color
- Is very fractured in core and appears in the marl benches
- Contains thin pyrite beds and nodules
- Has some bioturbation



Core Description/ Stratigraphic Column



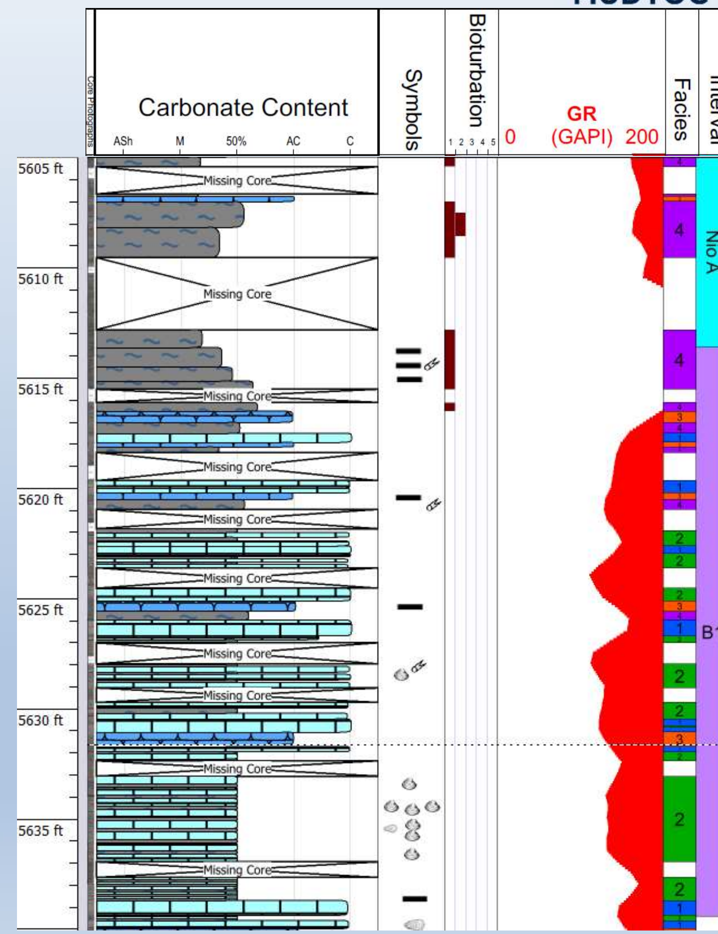
Operator Whiting Oil and Gas Corporation	Easy Core The EasyCopy Company
Top 5605 ft	Bottom 5674 ft
Log Scale 1 : 60	Country United States
Well Name & No. Razor 25-2514H	Location Red Tail Field
Logged by	Date Wed Oct 11 2017
Basin Denver Julesburg Basin	UWI No. 05-123-36418
Field Red Tail Field	KB 0 ft

Lithologies

- Argillaceous Chalk
- Chalk
- Marl>55%
- Cemented Fractures
- Stylolites
- Inoceramid
- Oyster
- Pyrite Nodule
- Pyrite Lamination

Facies

- 1 Massive Clean Chalk
- 2 Laminated Chalks and Marls
- 3 Argilleous Chalk
- 4 Marl
- Missing



If any one wants a more detailed zoomed in version, ask me and I will send it to you

PYROLYSIS DATA
RAZOR 25-2514H

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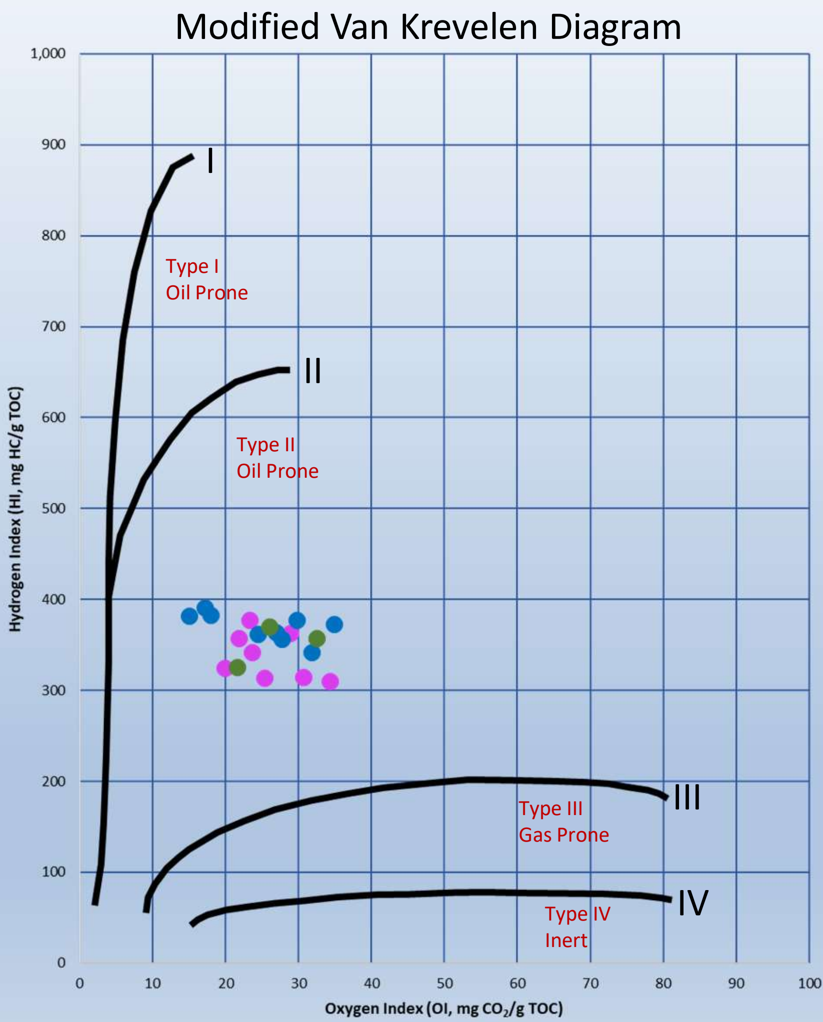
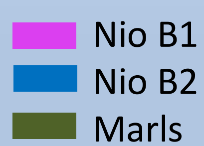
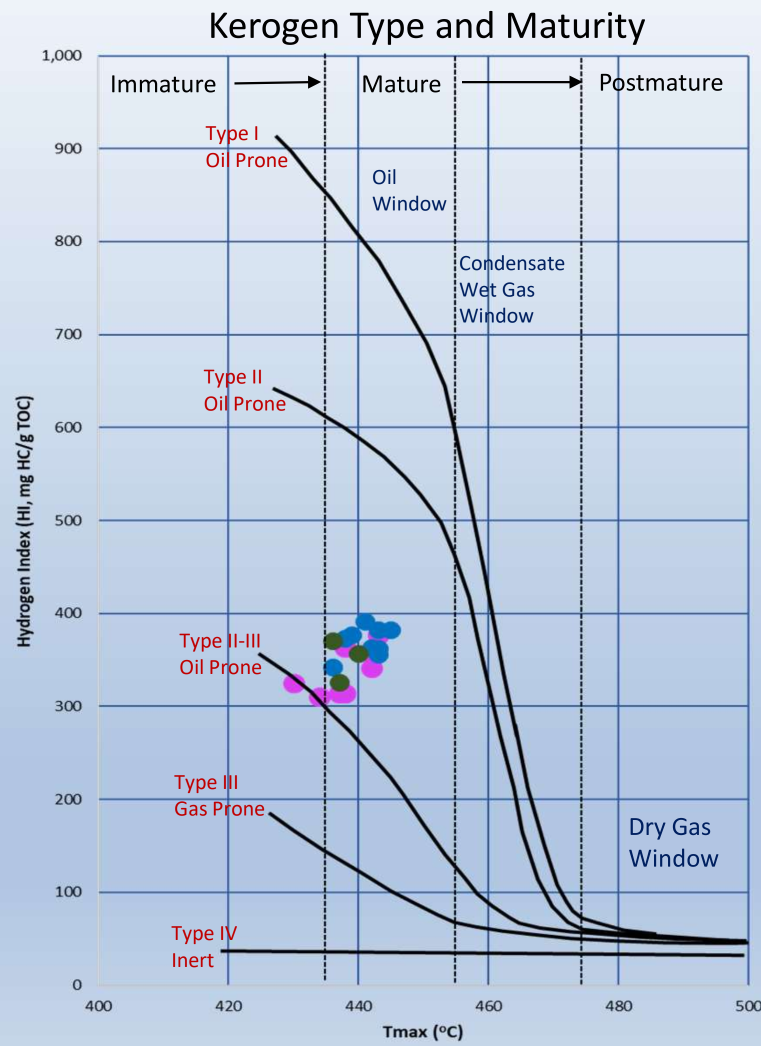
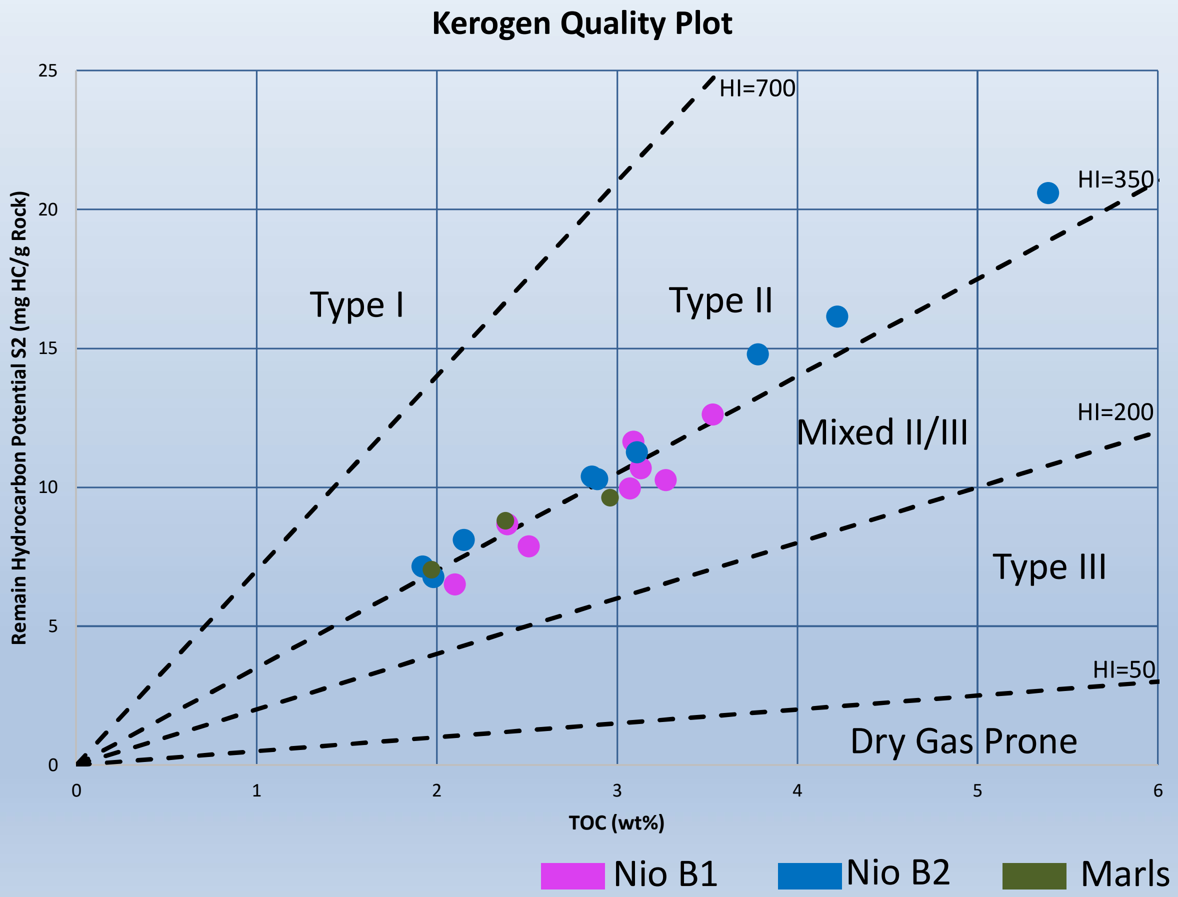
Pyrolysis Data

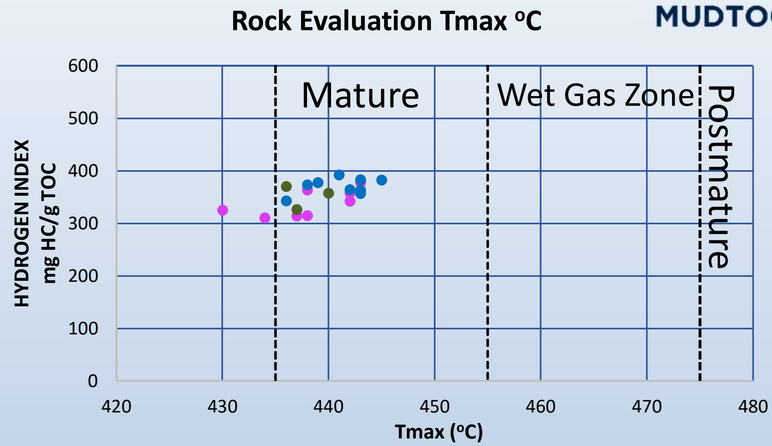


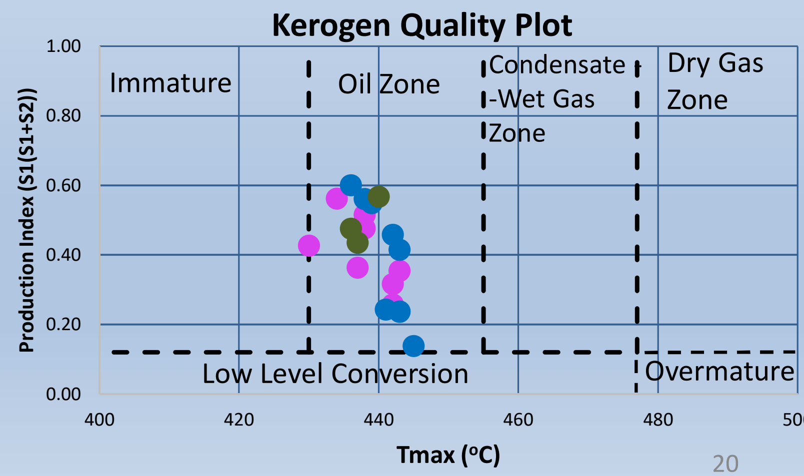




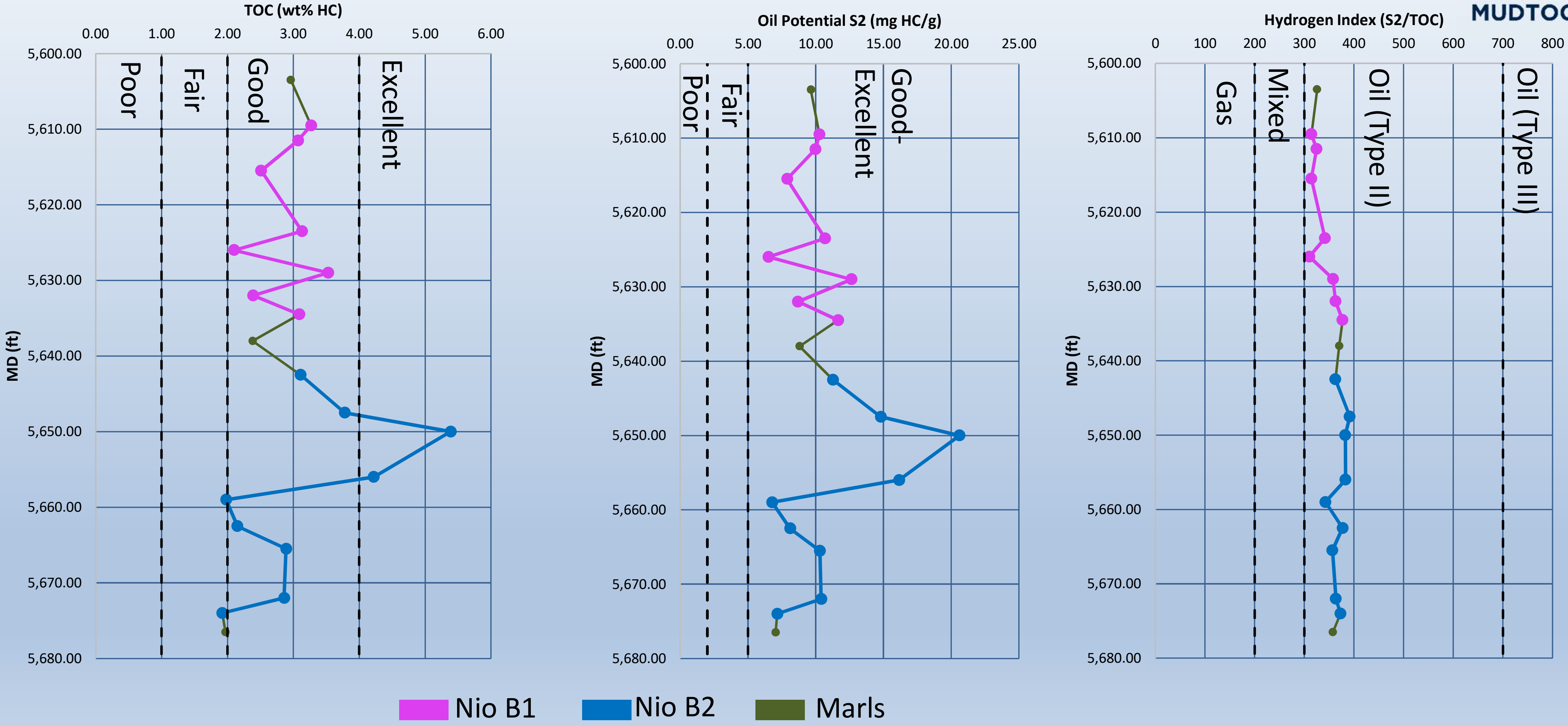
Kerogen Conversion and Maturity Plot



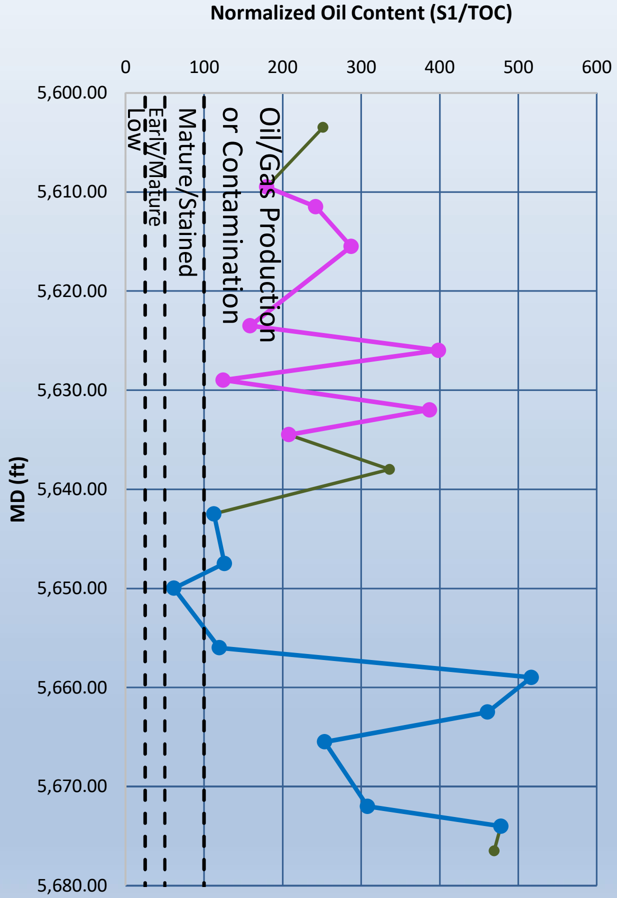


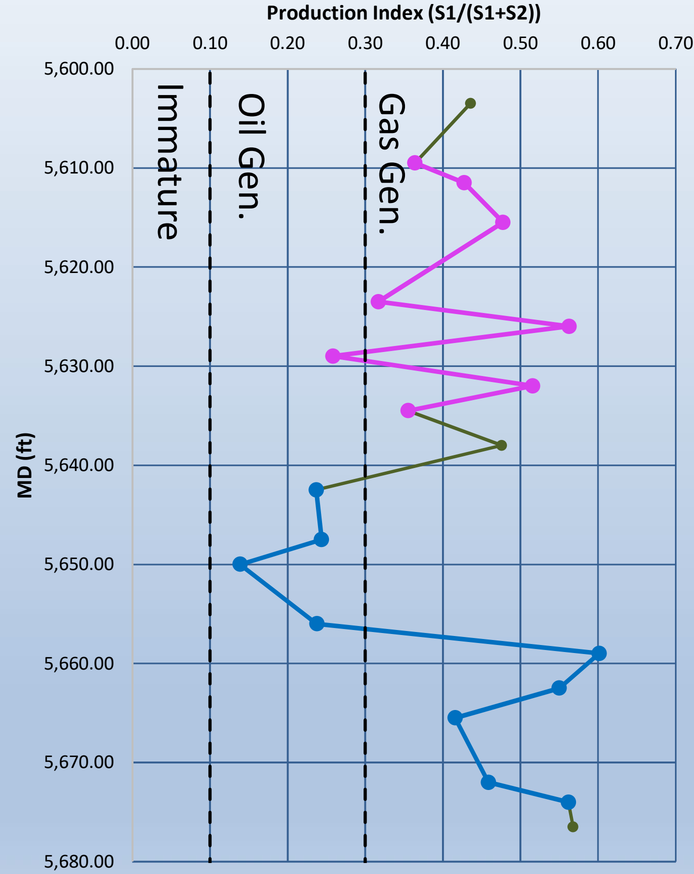


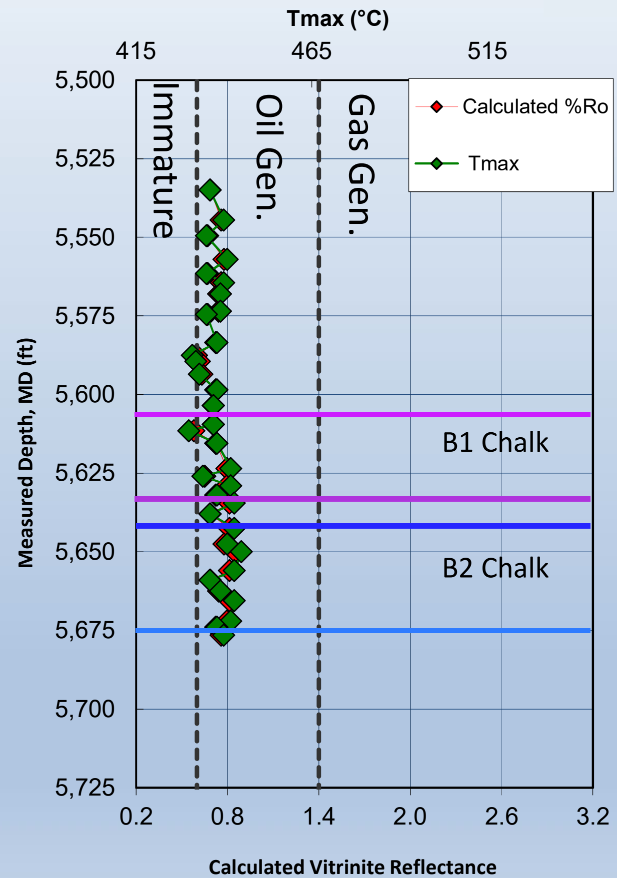
Source Potential Logs



HC Indicator and Maturity Logs







Nio B1 Nio B2 Marls

XRF DATA RAZOR 25-2514H

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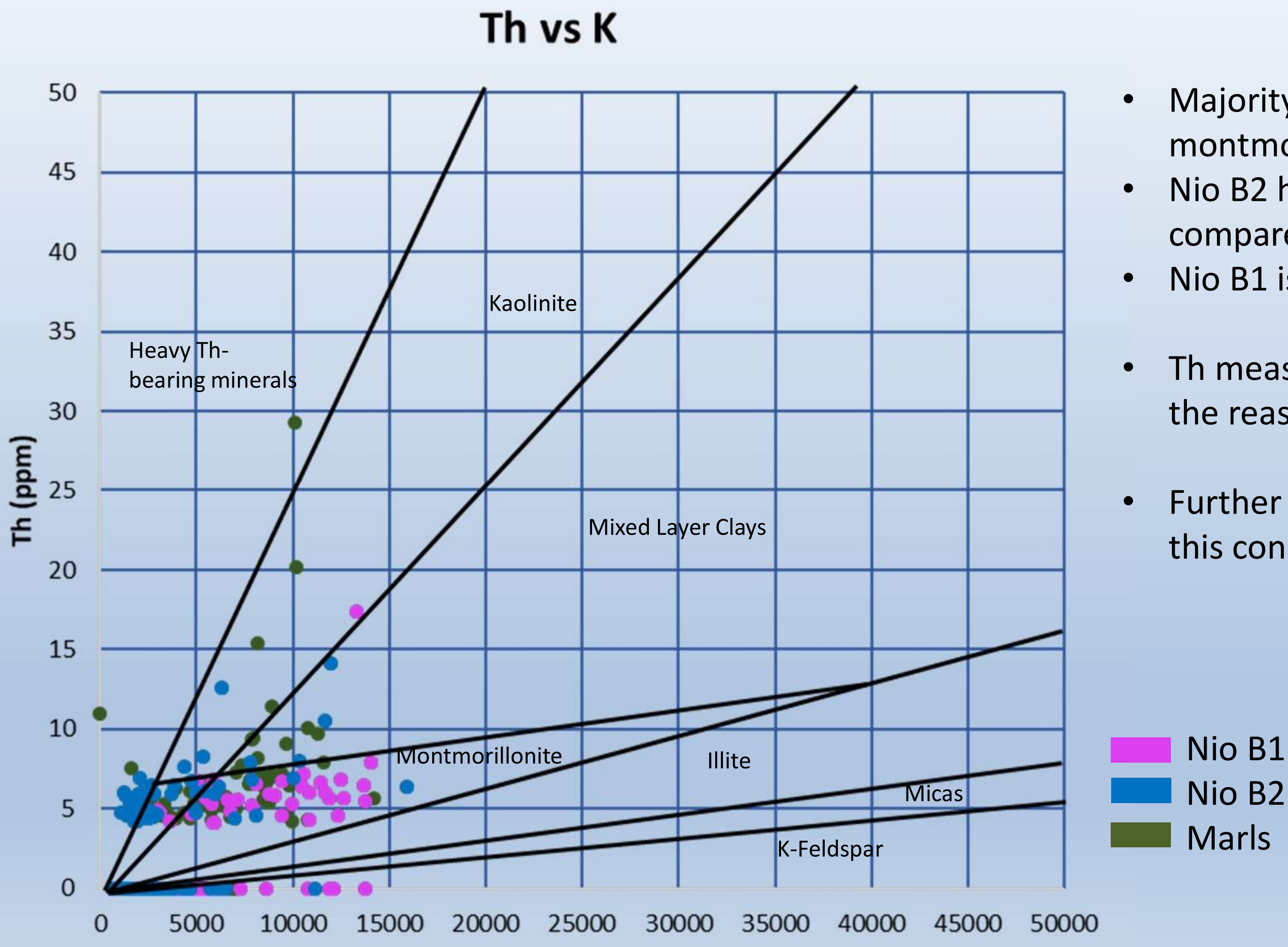
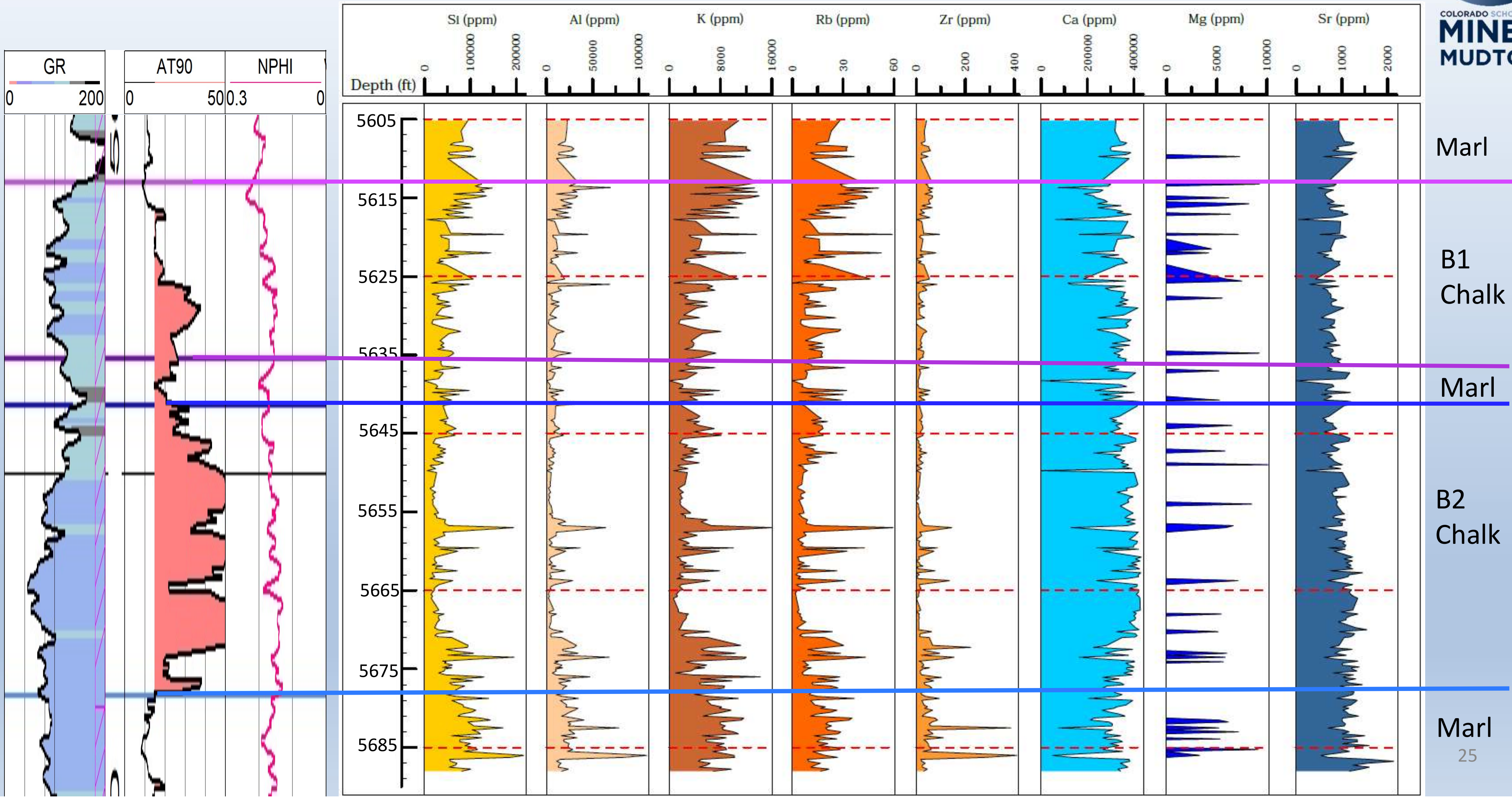
Razor 25-2514H Potassium-Thorium Cross Plot



(Template from Schlumberger, 1985)

- Majority of the measurements indicate a montmorillonite (bentonite) with some kaolinite
- Nio B2 has more heavy Th-bearing minerals compared to Nio B1 and the marls
- Nio B1 is clays mainly consist of montmorillonite
- Th measured using XRF is fairly inaccurate and is the reason for a lot of (0) readings
- Further analysis using XRD will aid in supporting this conclusion

Razor 25-2514H Detrital and Carbonate Indicators

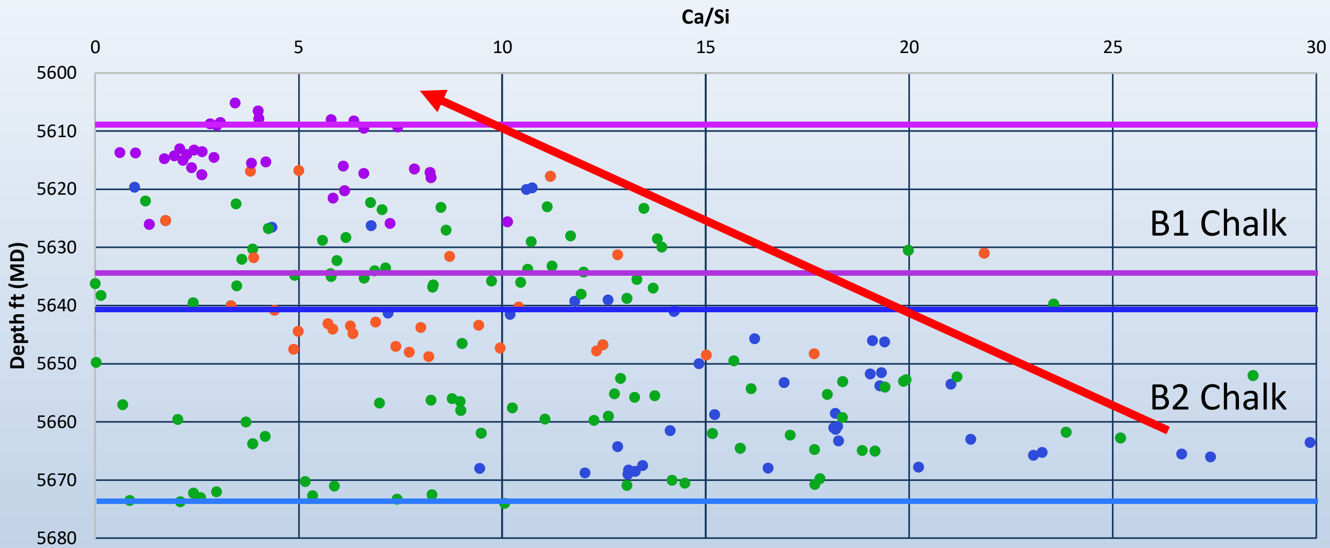


COLORADO SCHOOL OF MINES MUDTOC

Element vs Depth

Razor 25-2514H
B1 Chalk: 5,608-5,635 ft MD

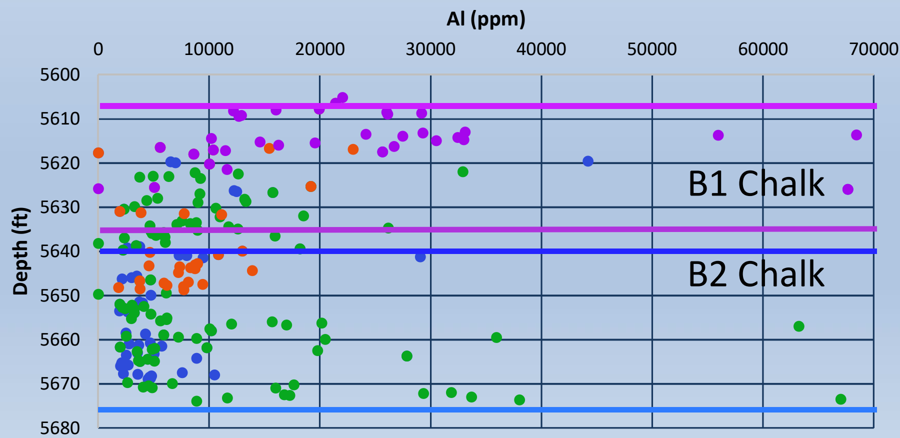
B2 Chalk: 5,641-5,674 ft MD

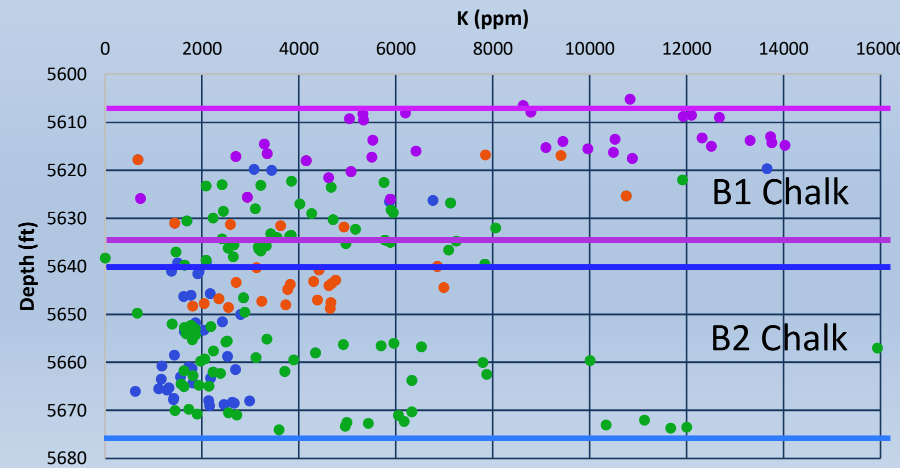


Decrease in Depth

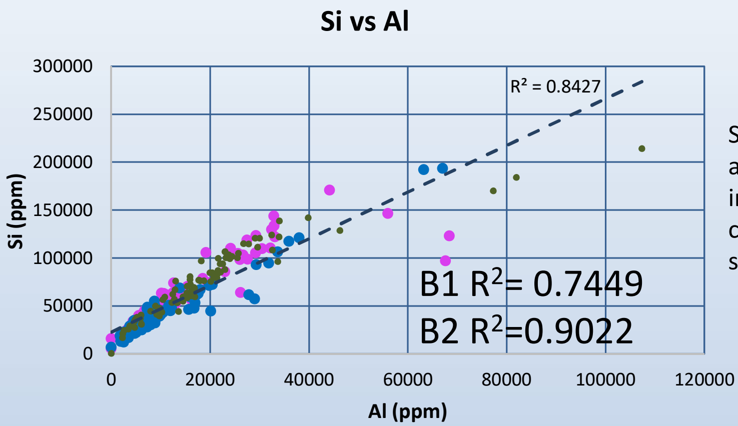
- Increase in Si
- Decrease in Ca

Facies 1
Facies 2
Facies 3
Facies 4

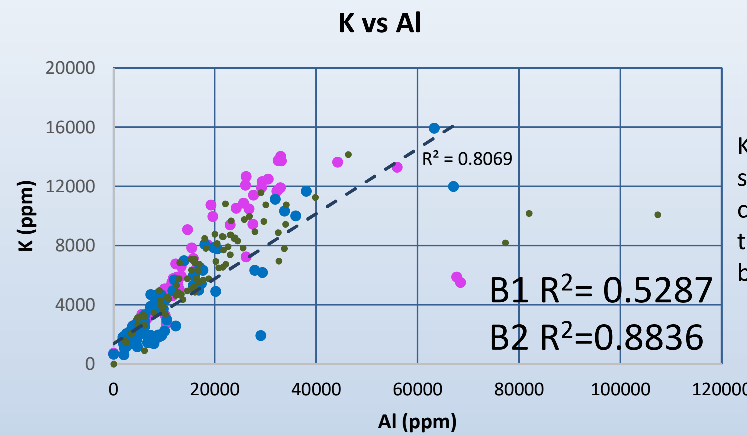




Razor 25-2514H Elemental Cross Plots

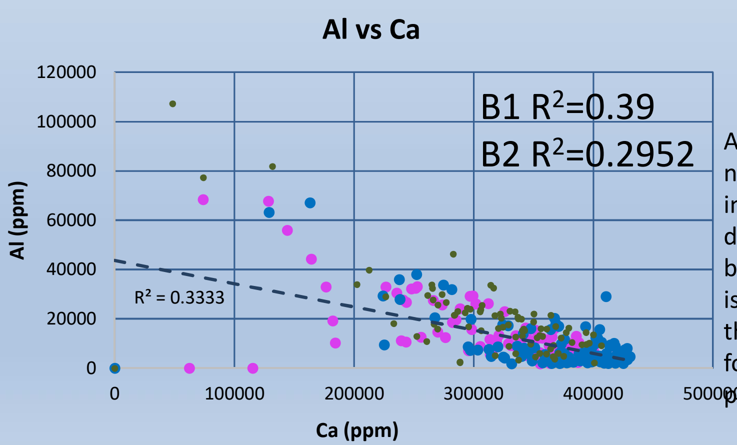


Si vs. Al cross plot shows a great correlation and indicates that the silicon content is detrital sourced.

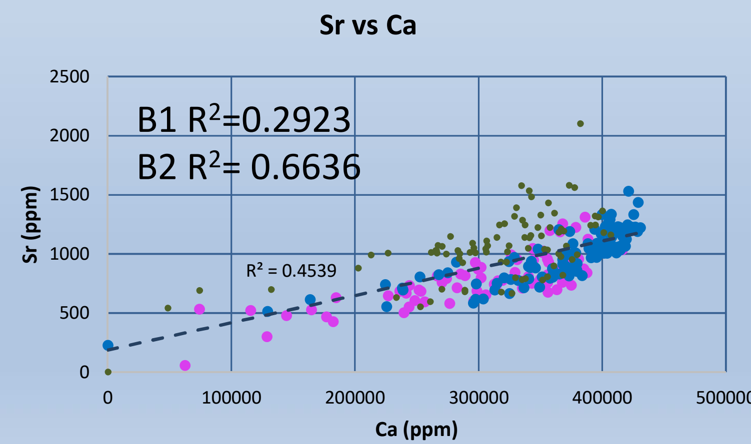


K vs. Al cross plot shows a good correlation and is due to the large amount of both elements in clay.

Nio B1 Nio B2 Marls



Al vs. Ca cross plot has a negative correlation which indicates that the Al is detrital. Ca is mainly biogenic, but since the trend is a little scattered part, of the calcium could was formed in an authigenic process.



Sr vs. Ca cross plot has a good correlation and indicates that there is no aragonite enrichment present.

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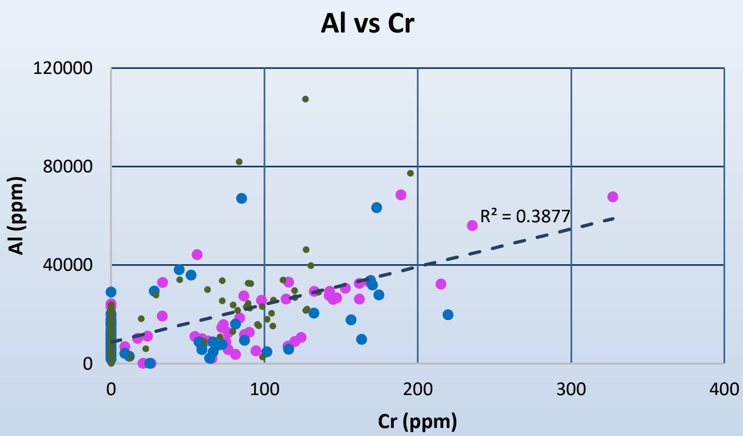
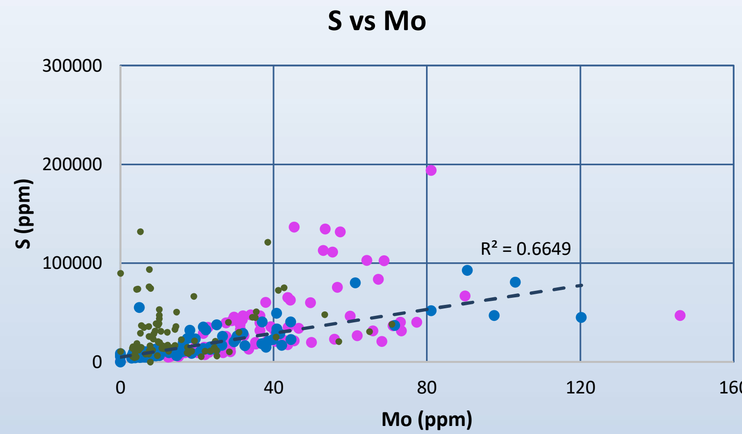
Razor 25-2514H Redox Trace Elements

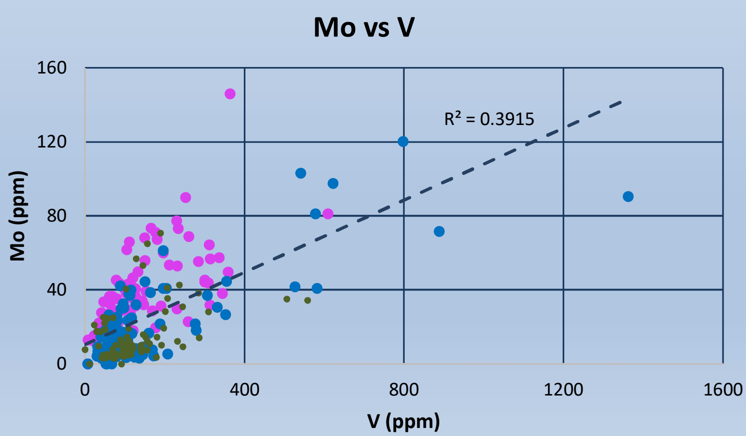


Al vs. Cr show a moderate correlation indicating Cr enrichment that can be attributed to the detrital component in addition to authigenic enrichment through redox processes.



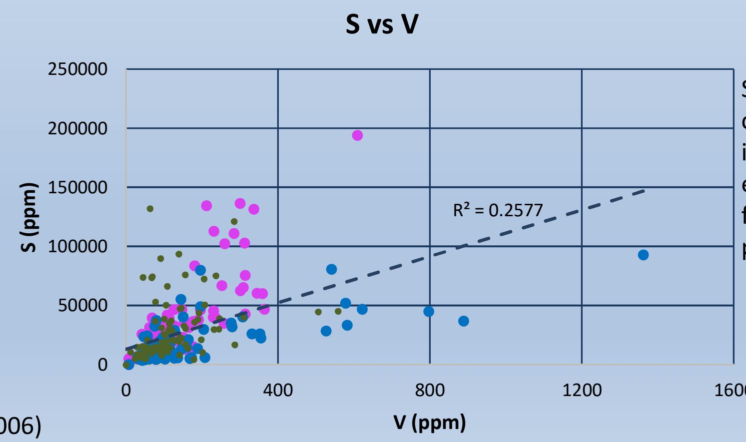
S vs. Mo shows a weak positive covariance which indicates the relationship to pyrite through Mo-Fe-S compounds during authigenic enrichment.

Nio B1 Nio B2 Marls



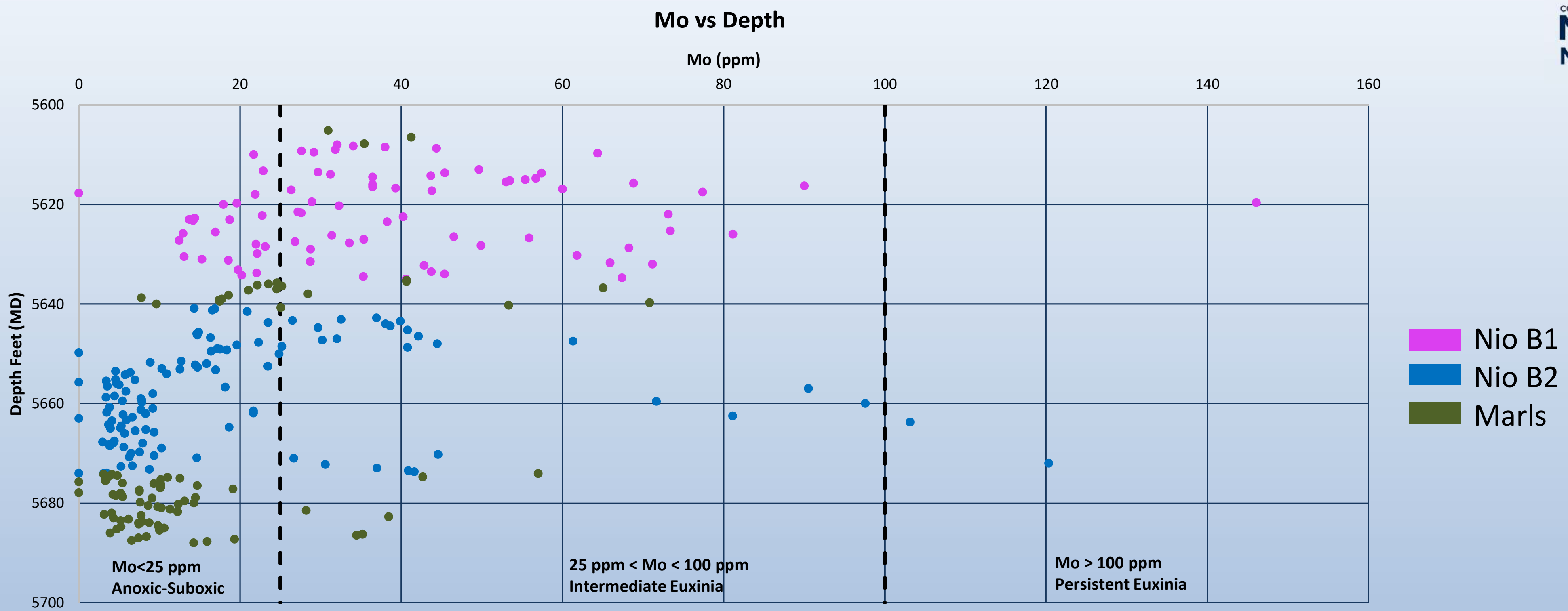
Mo vs. V show a moderate covariance indicating similar authigenic enrichment pathways and further supports deposition in anoxic waters.

(Tribovillard et al., 2006)



S vs. V has a weak correlation which indicates that the V enrichment can possible follow pyrite precipitation.

Razor 25-2514H Redox Elements



- Molybdenum is found concentrated in sediments that are associated with marine anoxic conditions (Bertine, 1972). Mo indicates authigenic enrichment in anoxic waters.
- Increasing amounts of Mo as move up section into Nio B1 indicates that the Nio B1 was deposited in more anoxic conditions than the Nio B2.

Future Work

- Adjust well log formation tops using a model created using XRF data and core descriptions
- Figure out why the Nio B1 have a larger detrital component than Nio B2
- Core descriptions on Horsetail 19N-1924M and Cottonwood 08E-0504
- Create thin sections for Razor 25-2514H and run Field Emission Scanning Electron Microscope (FE-SEM) scans
- XRD on Razor 25-2514H
- Work with NMR logs to decide if recorded permeability in the area for the Niobrara is too high
- Create pay zone maps based of resistivity well logs
- Determine undrilled potential areas and whether the Niobrara B1 or B2 chalk should be the targeted interval

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Fall 2021

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