Reservoir Characteristics for the B Interval of the Niobrara Formation in the Redtail Area, Weld County, Colorado

Adam Simonsen
Apsimonsen@mymail.mines.edu
M.S. Geology Candidate / Fall 2021

MUDTOC Consortium Meeting Fall 2020

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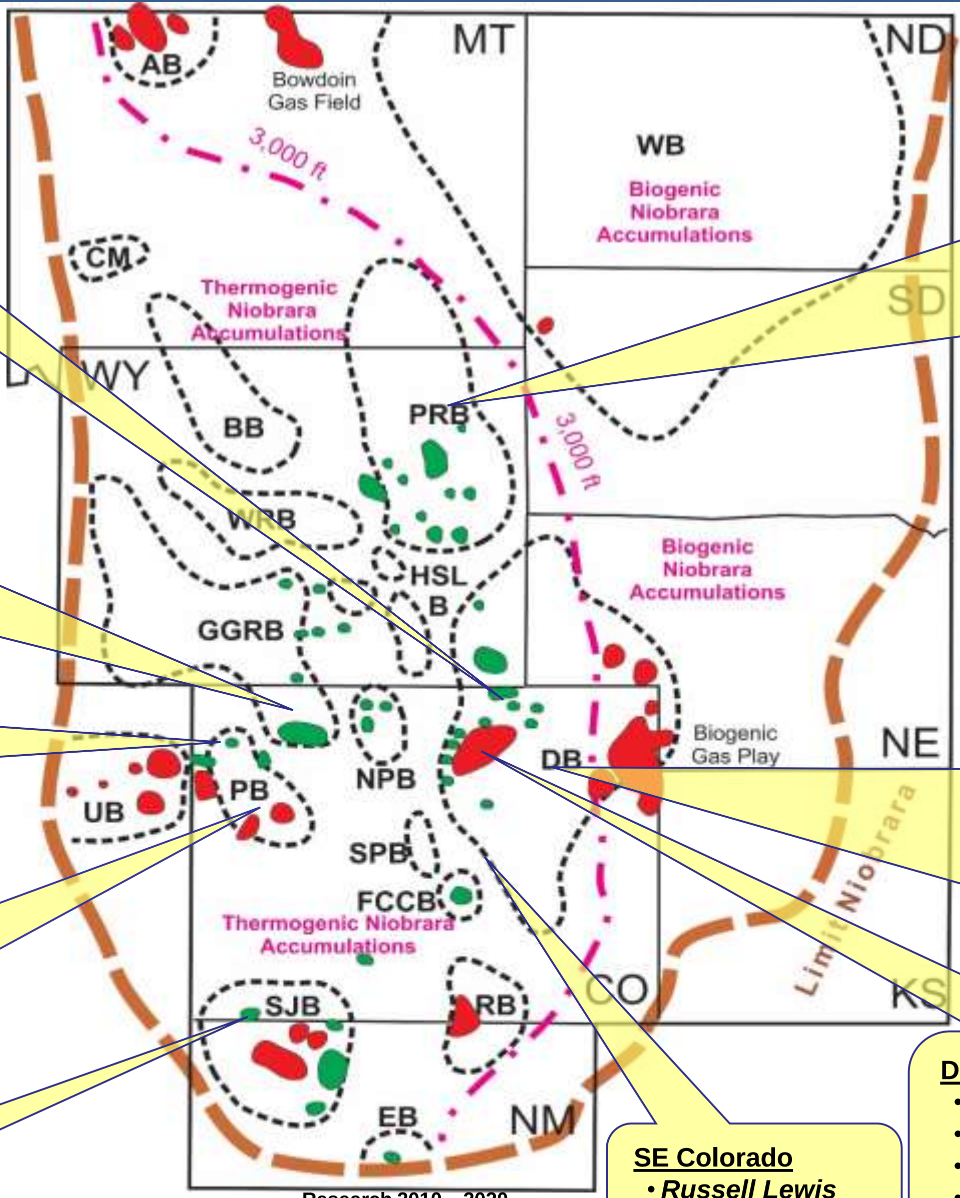

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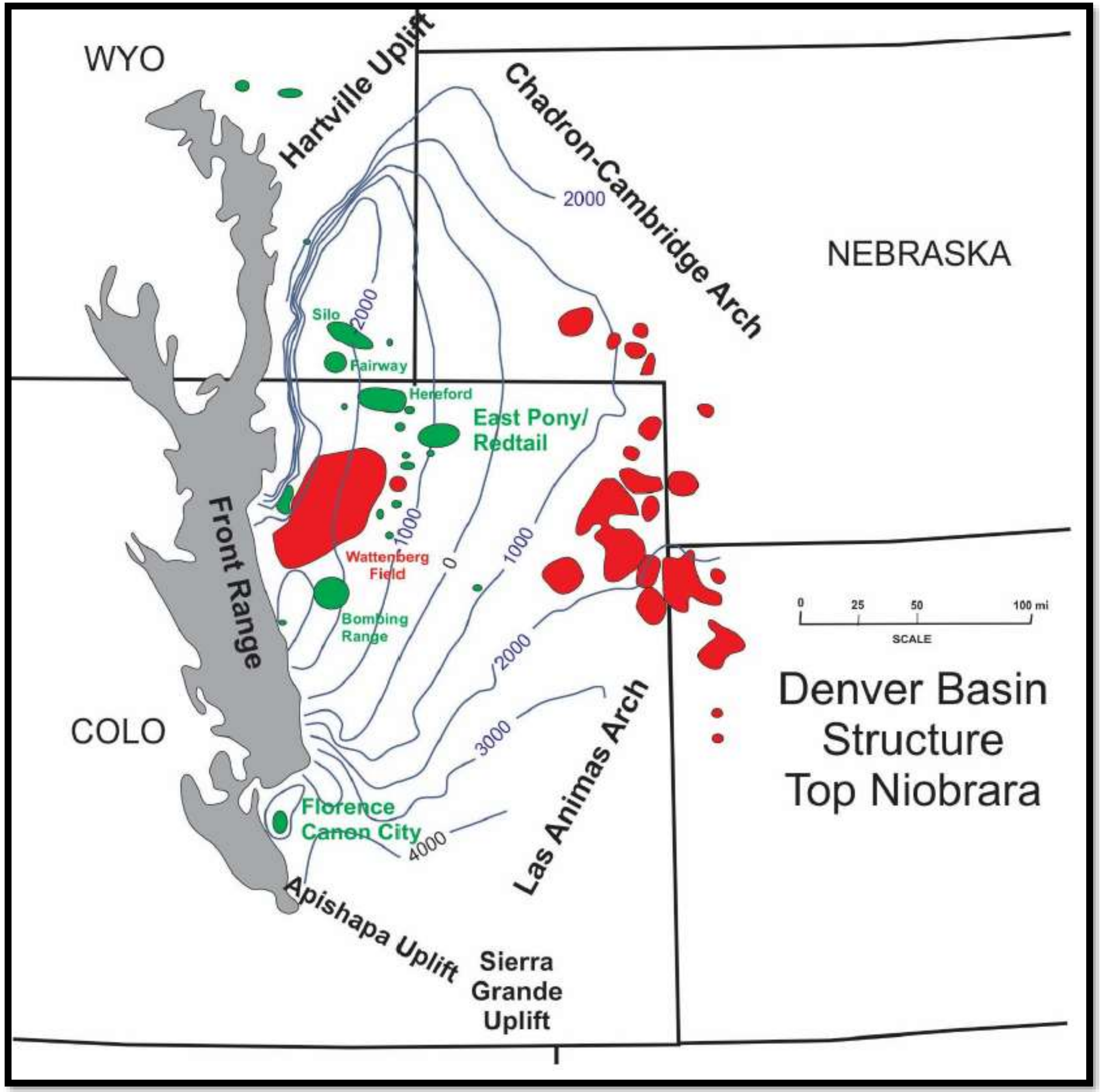
Outline

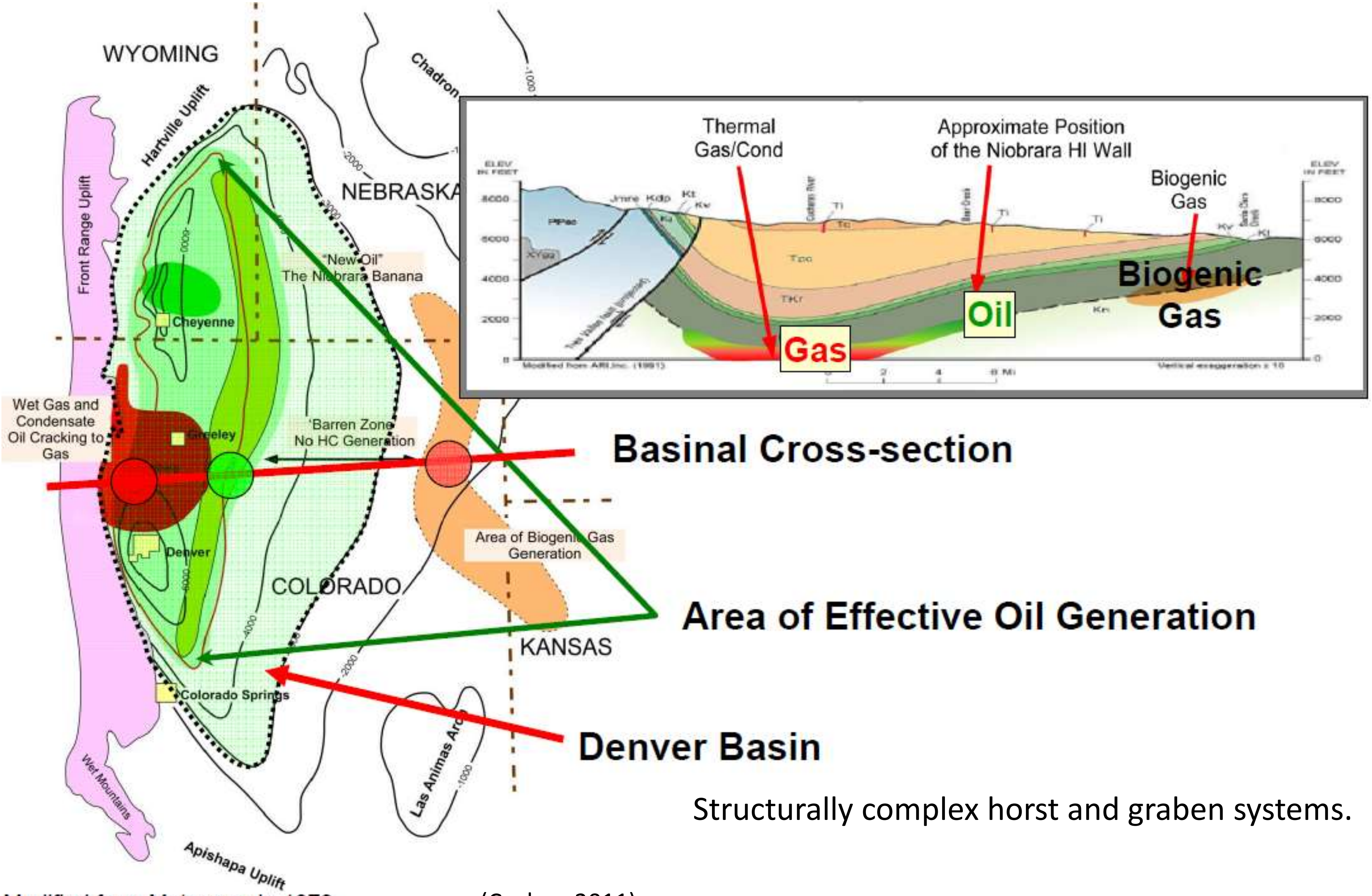
- Introduction
- Geologic Maps and Study Area
- Type Well
- Well Core Photos
- X-ray Fluorescence (XRF) Analysis
- Future Work

Niobrara Structure Map and Redtail Location



(Sonnenberg, 2017)

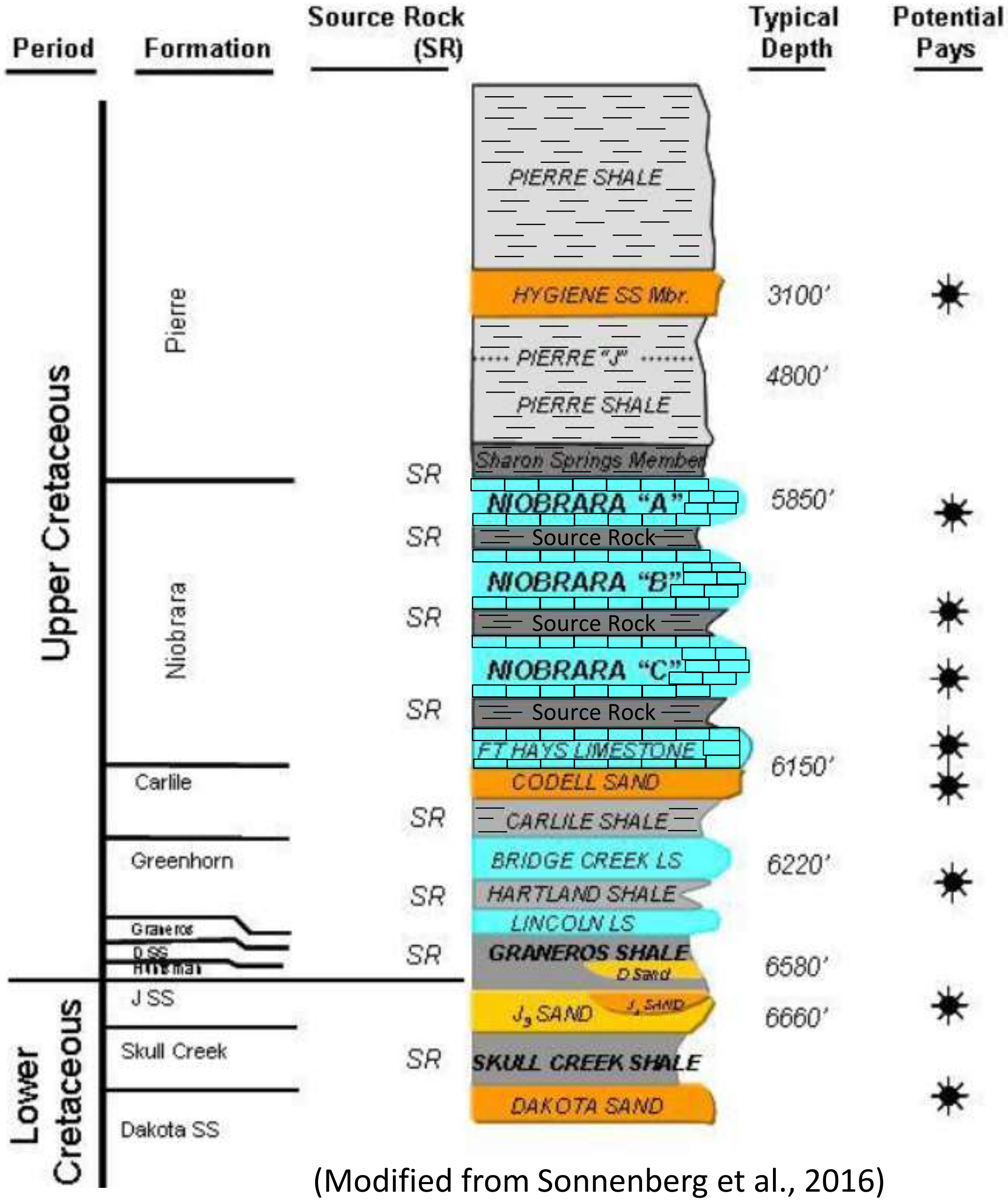
DJ Basin Cross Section



Structurally complex horst and graben systems.

(Coskey, 2011)

DJ Basin Stratigraphic Column

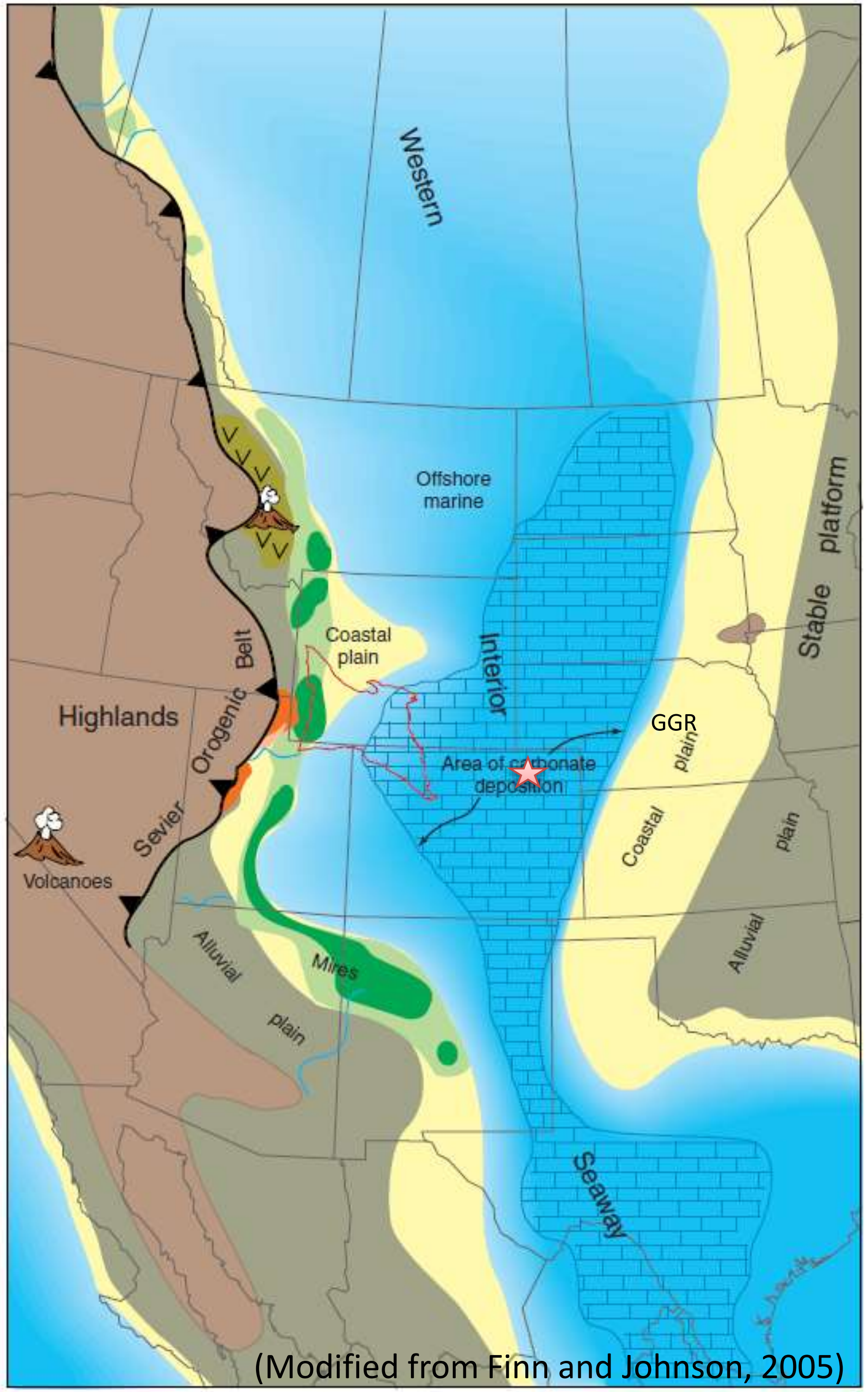


(Modified from Sonnenberg et al., 2016)

The age of the Niobrara Formation is Coniacian, Santonian, and Campanian of the Late Cretaceous (81-89 mya)

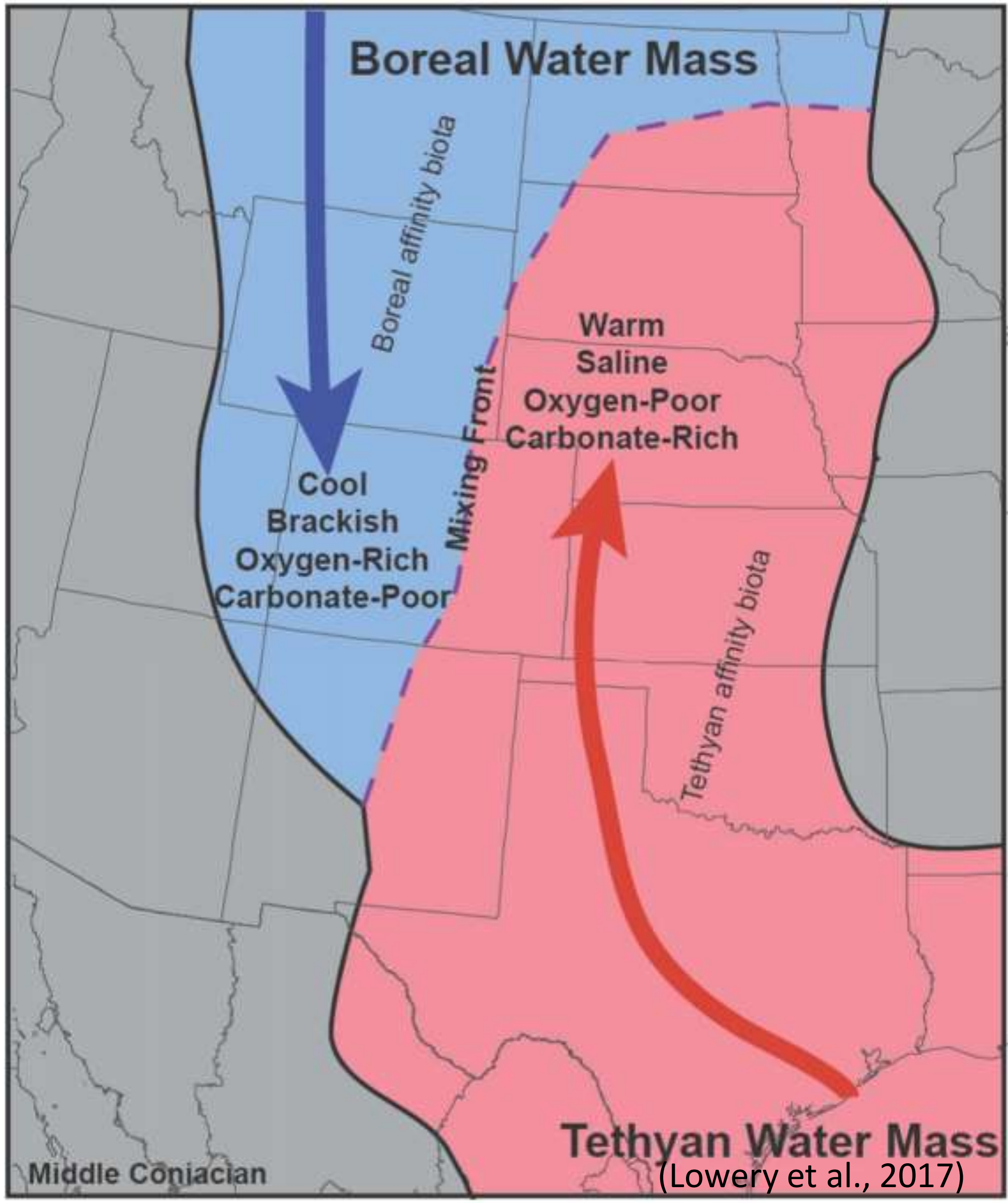
Redtail Field the Niobrara Formation is around a depth of 5,500ft-6,200ft

Western Interior Seaway



(Modified from Finn and Johnson, 2005)

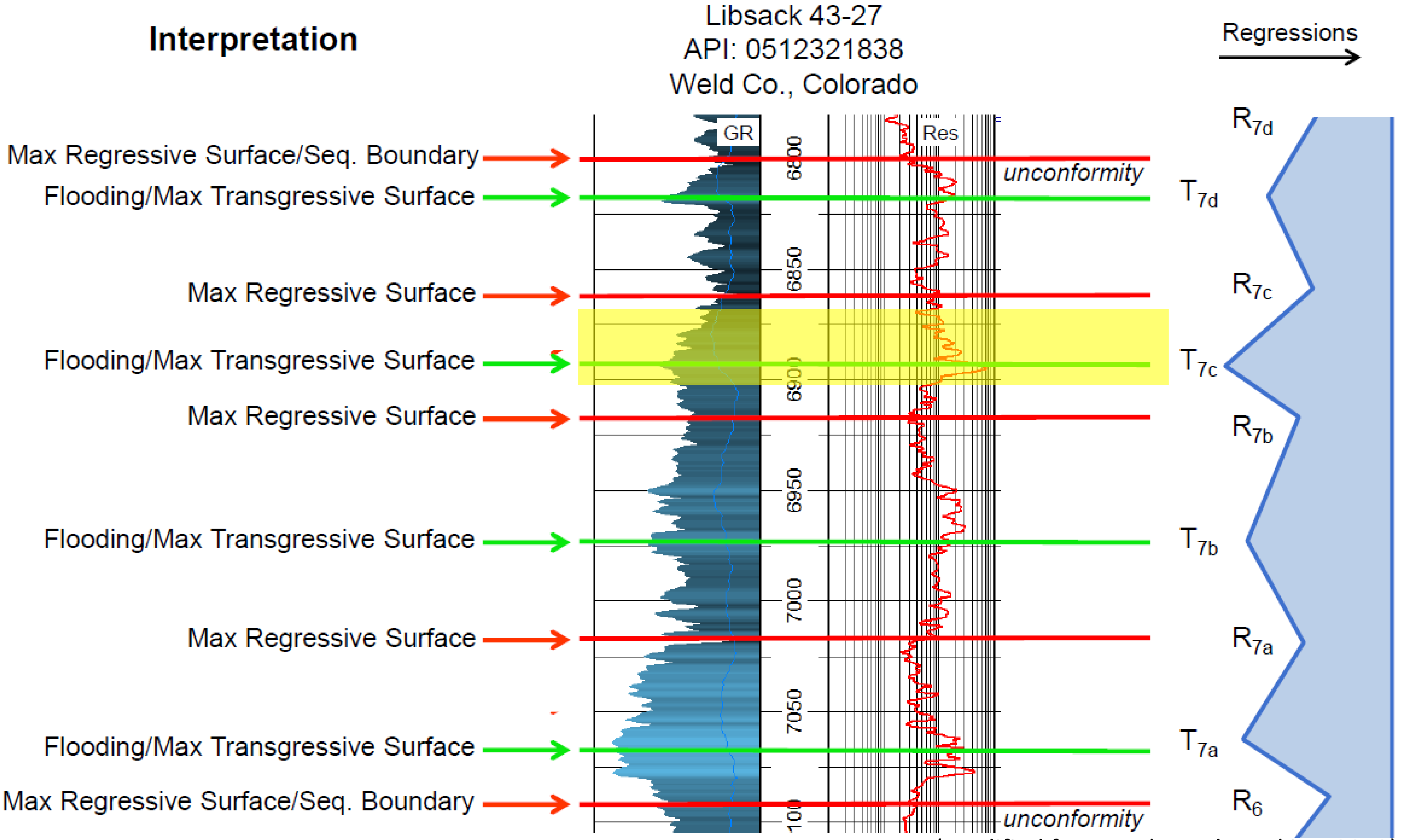
Western Interior Seaway during the Coniacian-Santonian time of the Late Cretaceous



(Lowery et al., 2017)

During this time nutrient rich cold-water from the north and warm-water from the south mixed together and created a pristine environment for algae to grow

Western Interior Seaway Cycles

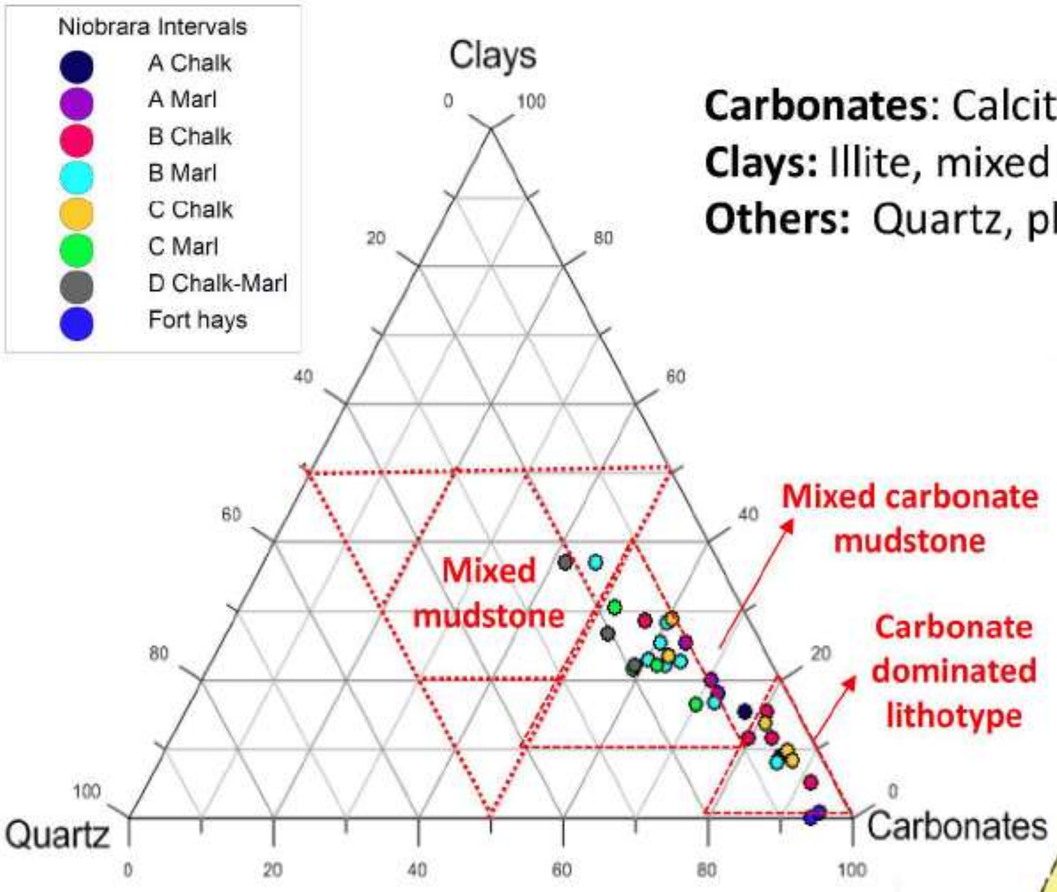


(Modified from Drake and Hawkins, 2012)

Deposition during a marine transgressive cycle (Niobrara Cyclothem)

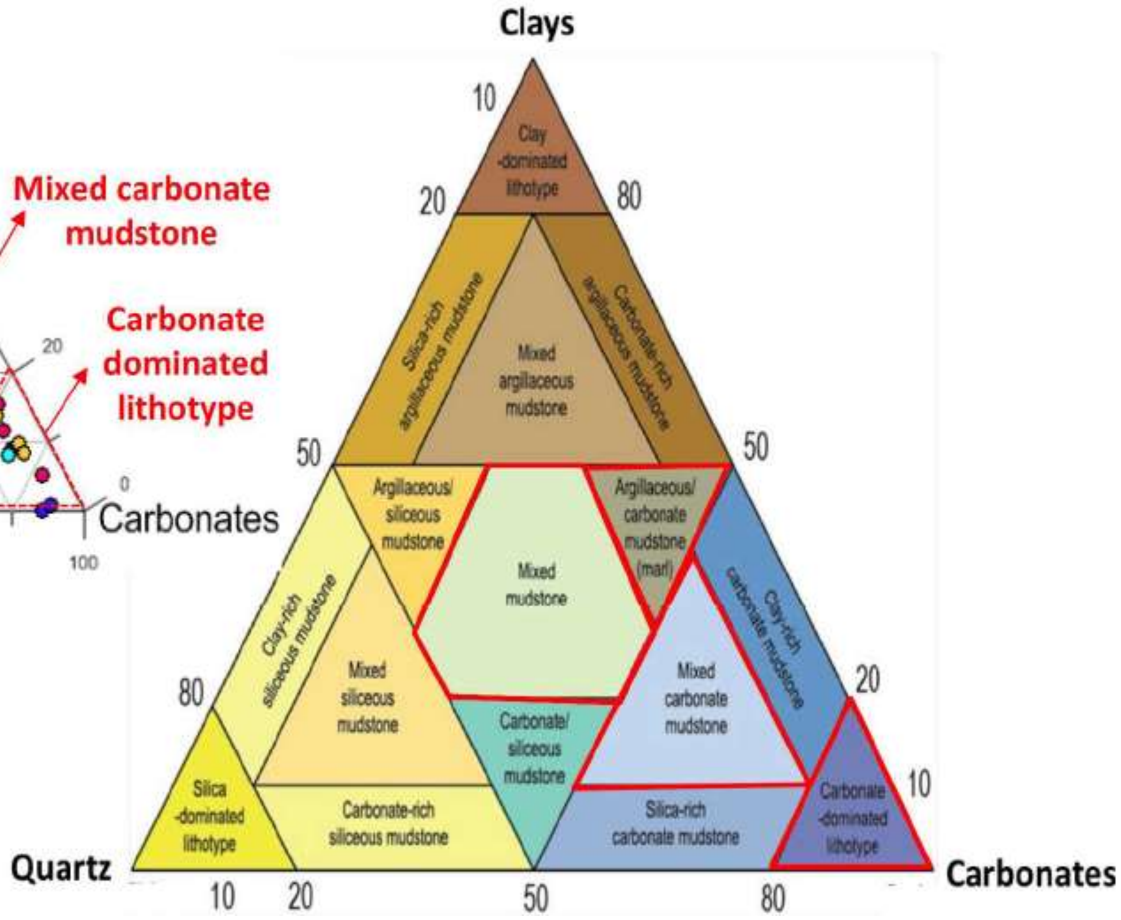
Boxed in yellow is the Niobrara B interval and was deposited during a marine transgressive cycle

Niobrara Mineralogy



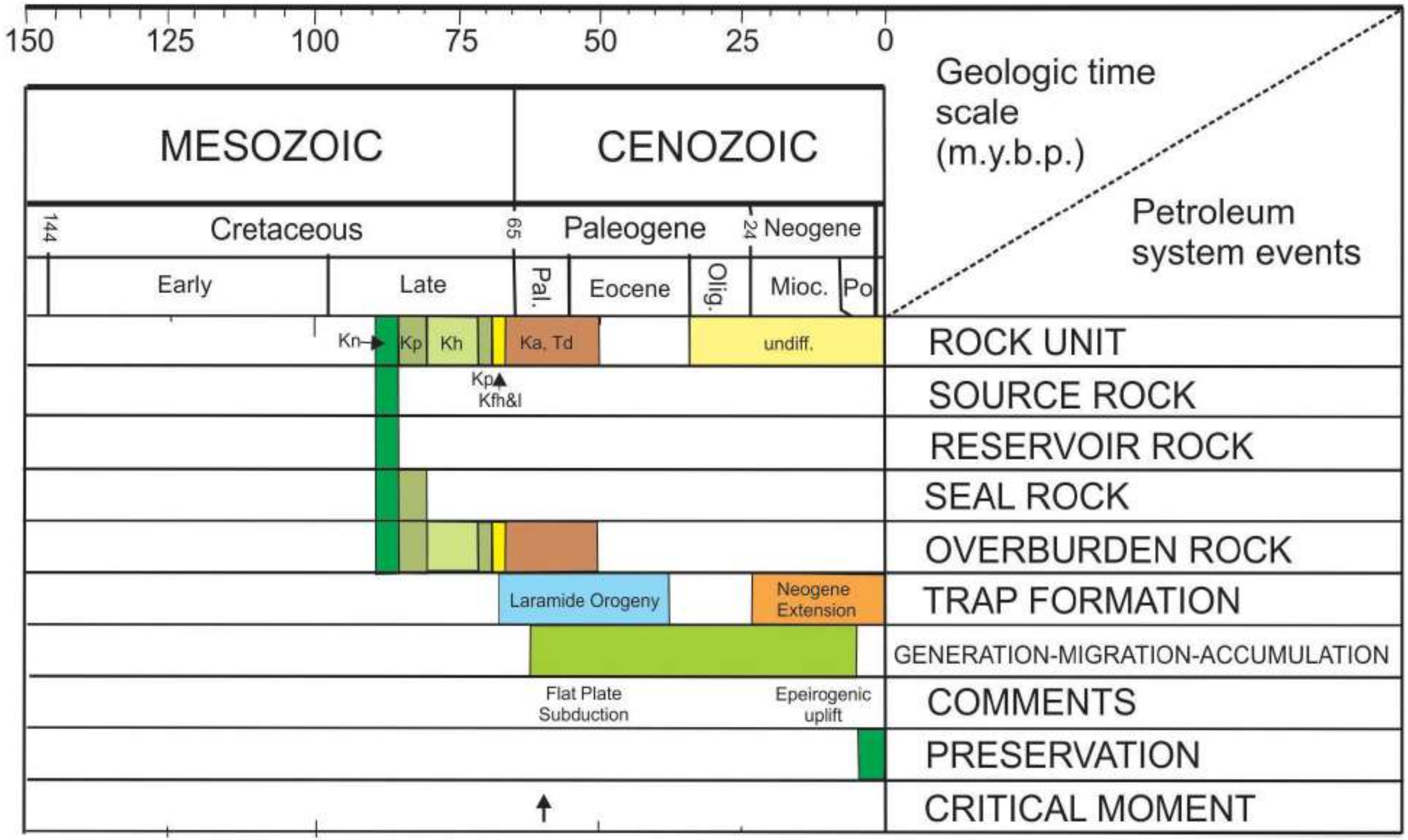
Niobrara Formation

Carbonates: Calcite, Dolomite
Clays: Illite, mixed layer illite-smectite (20-30% smectite)
Others: Quartz, plagioclase and pyrite



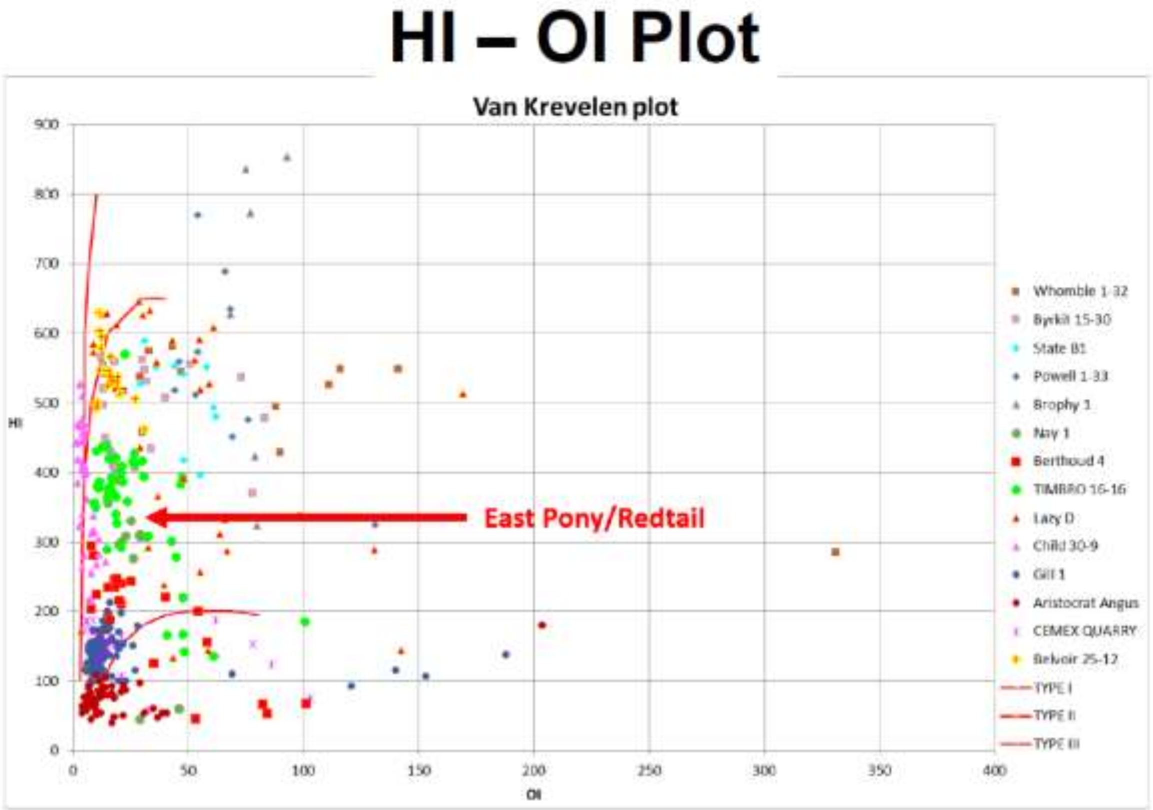
(ElGhonimy and Sonnenberg, 2015: Modified from Gamero et al., 2012)

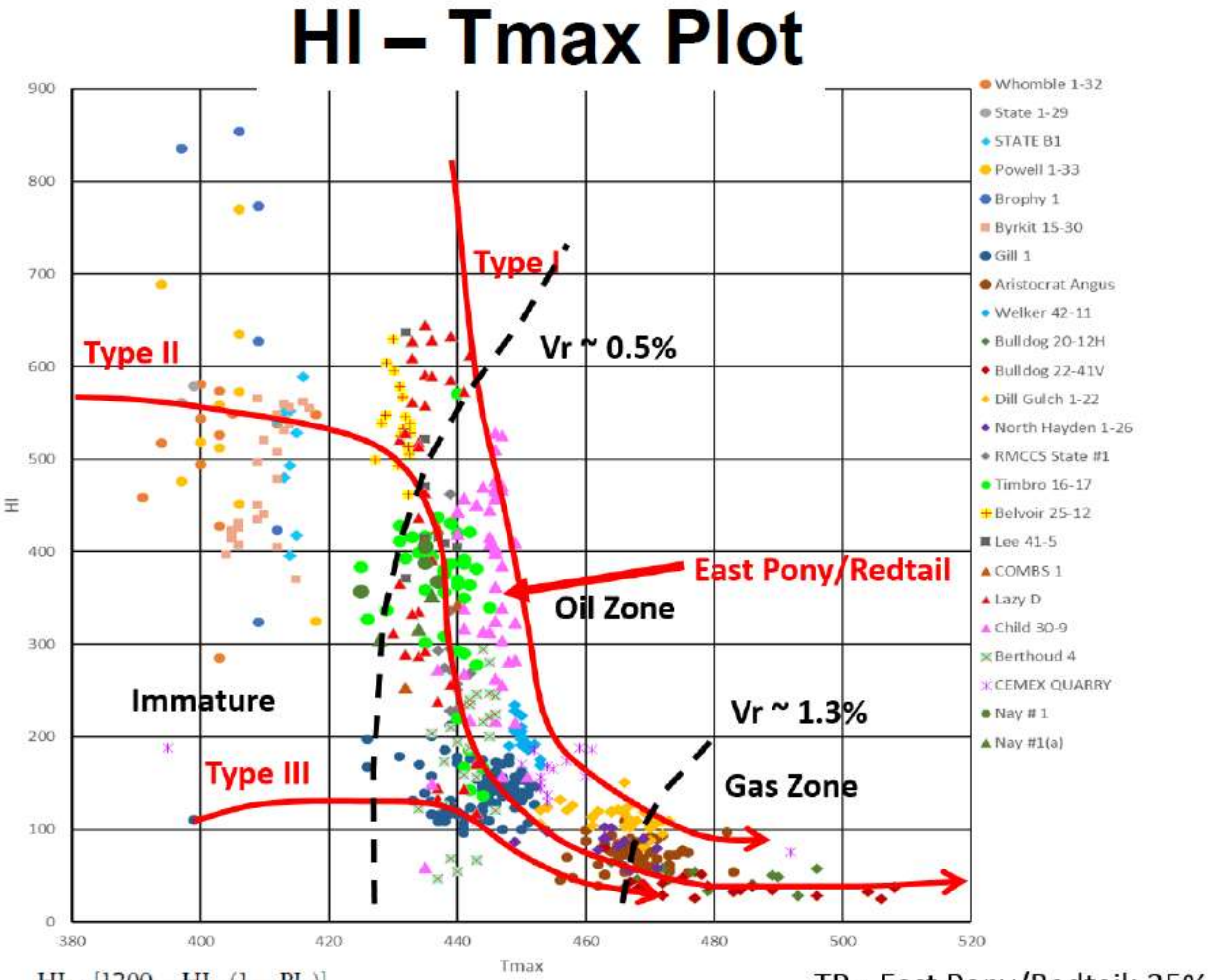
Niobrara Petroleum System Events Chart



(Sonnenberg, 2011)

Source Rock Analysis





$$TR_{HI} = 1 - \frac{HI_{pd}\,[1200 - HI_{o}\,(1 - PI_{o})]}{HI_{o}\,[1200 - HI_{pd}\,(1 - PI_{pd})]}$$

TR_{HI} East Pony/Redtail: 35%

TR_{HI} Wattenberg: 87%

(Sonnenberg, 2017)

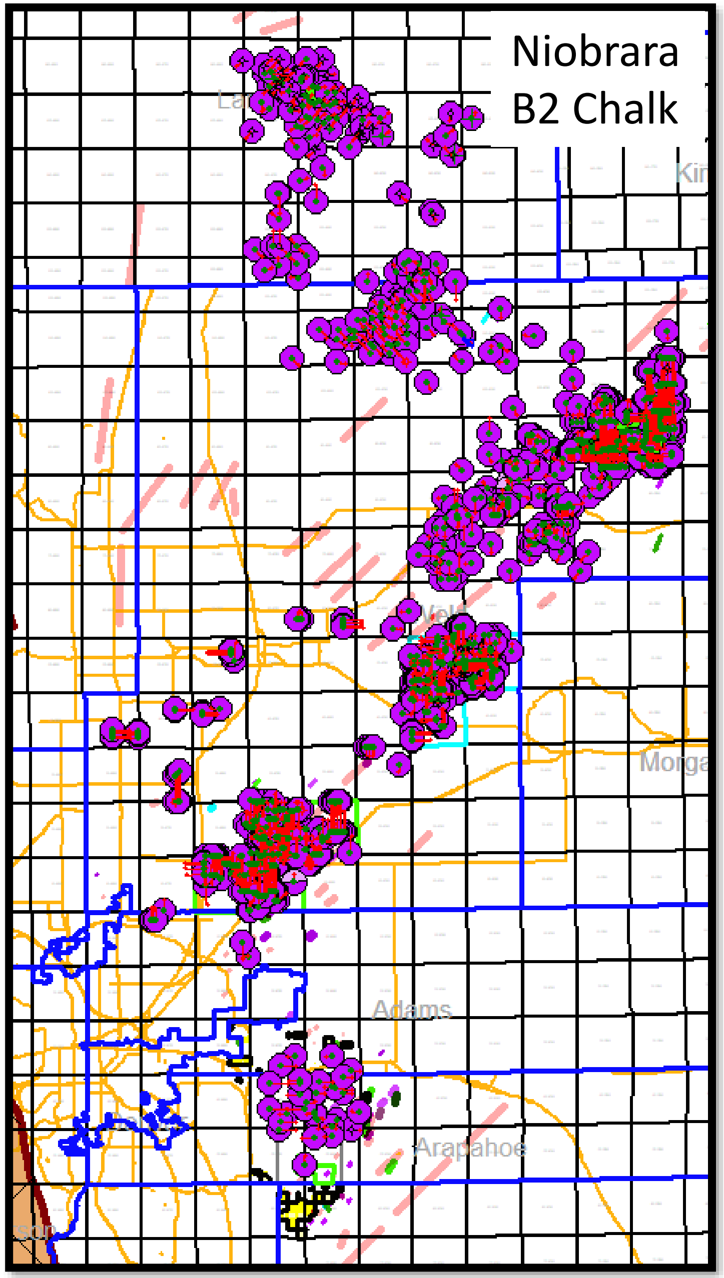
Niobrara Production

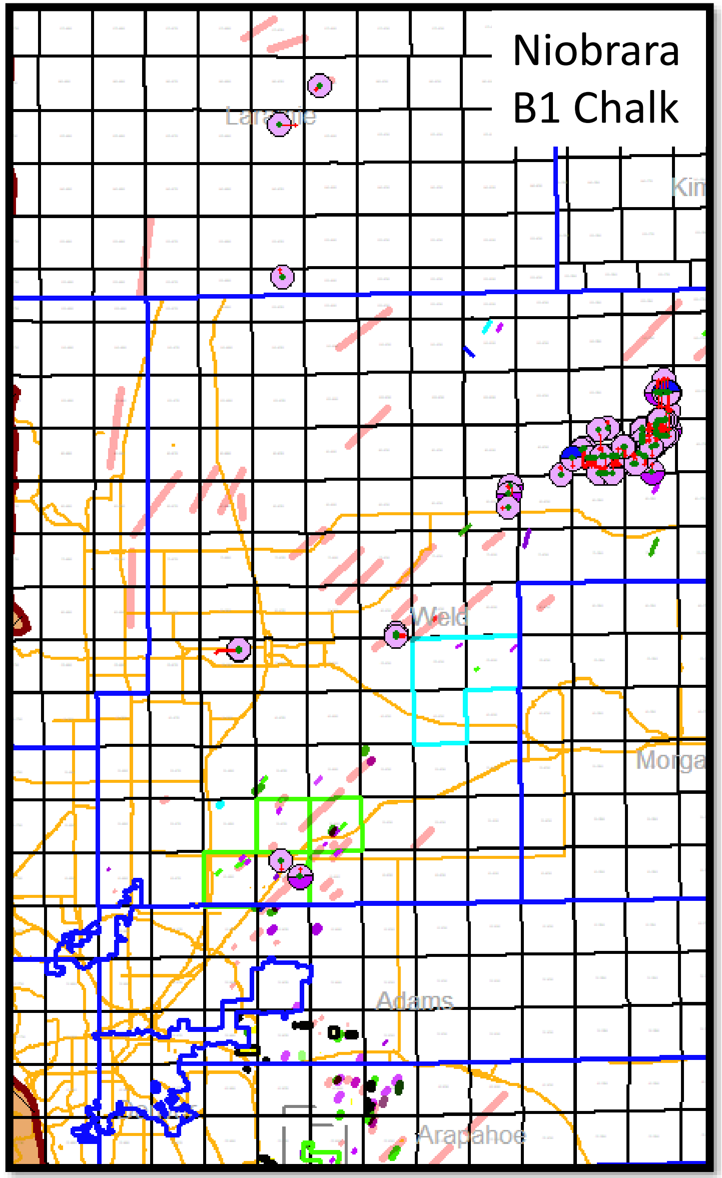
2,617 total production zones pick for horizontal wells including: Niobrara A, B1, B2, C, D intervals, the Fort Hays Limestone and the Codell Sandstone.

Out of all these horizontal wells, 44.4% are producing out of the Niobrara B2 chalk and 3.6% out of the Niobrara B1 chalk.

These zones were picked and maps were made while interning at GMT Exploration.

- Wells with Niobrara B1 Chalk as Production Zone
- Wells with Niobrara B2 Chalk as Production Zone



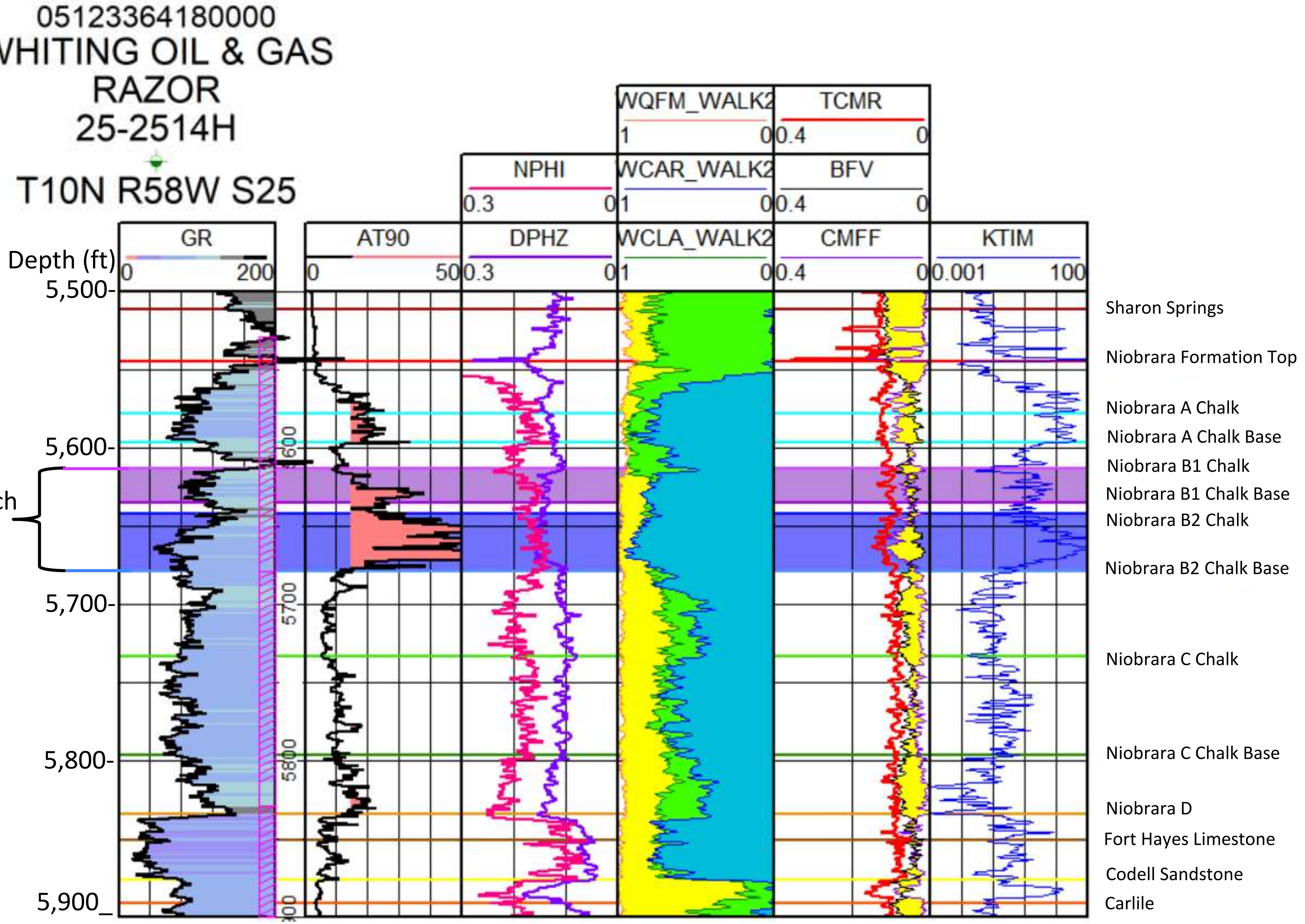


Niobrara Type Log

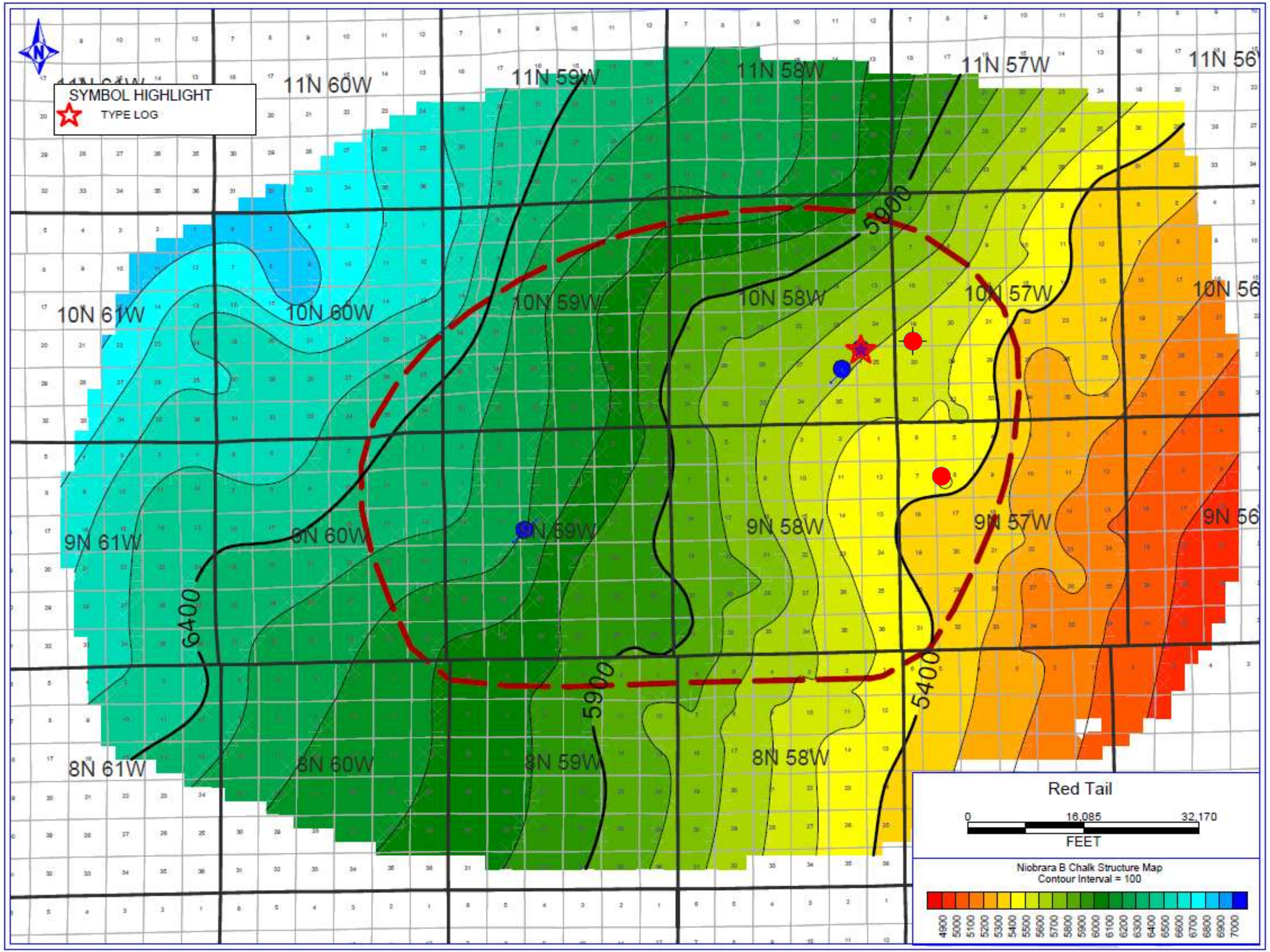
B1 Chalk: 5,613-5,639 ft TVD

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

Research Interval



Niobrara B1 Structure Map

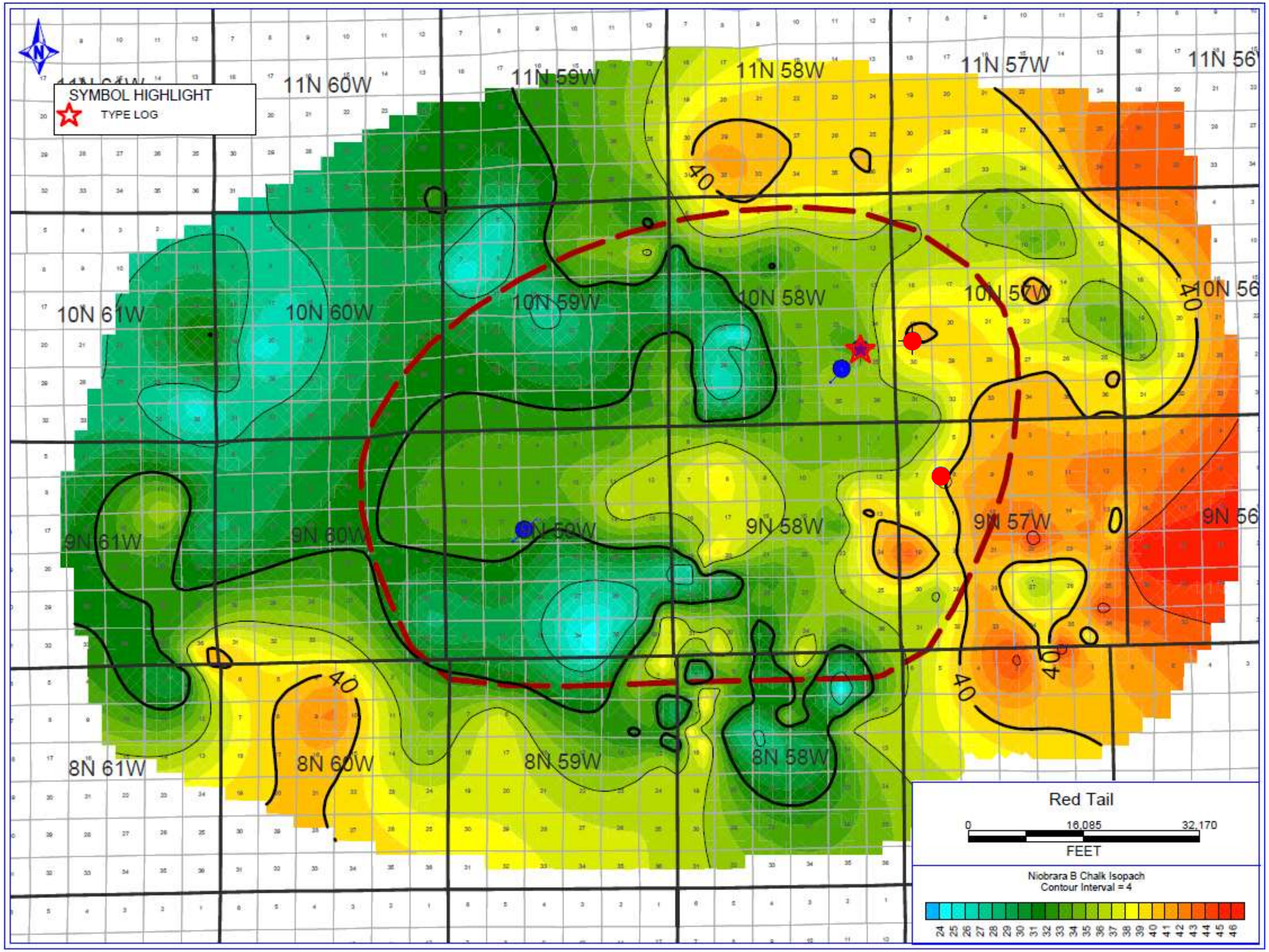


Three well cores shown in red that fully include the B1 and B2 intervals are: Razor 25-2514H,Horsetail 19N-1924M, and Cottonwood 08E-0504.

Two wells cores shown in blue that partially include the study interval the are: Razor 26J-2633L and Wildhorse 16-13L.

These well cores were provided by Whiting Petroleum.

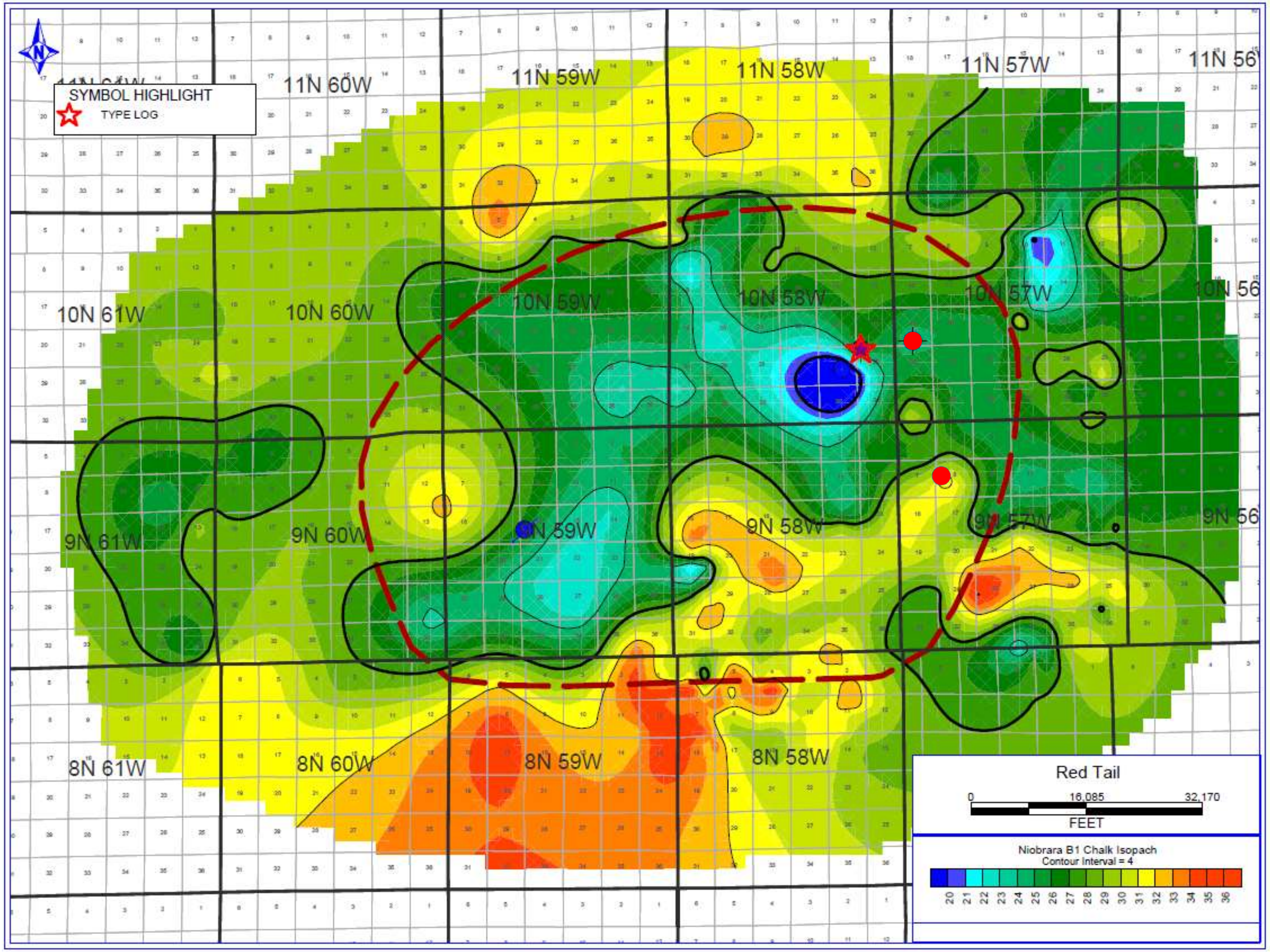
Niobrara B2 Isopach Map



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

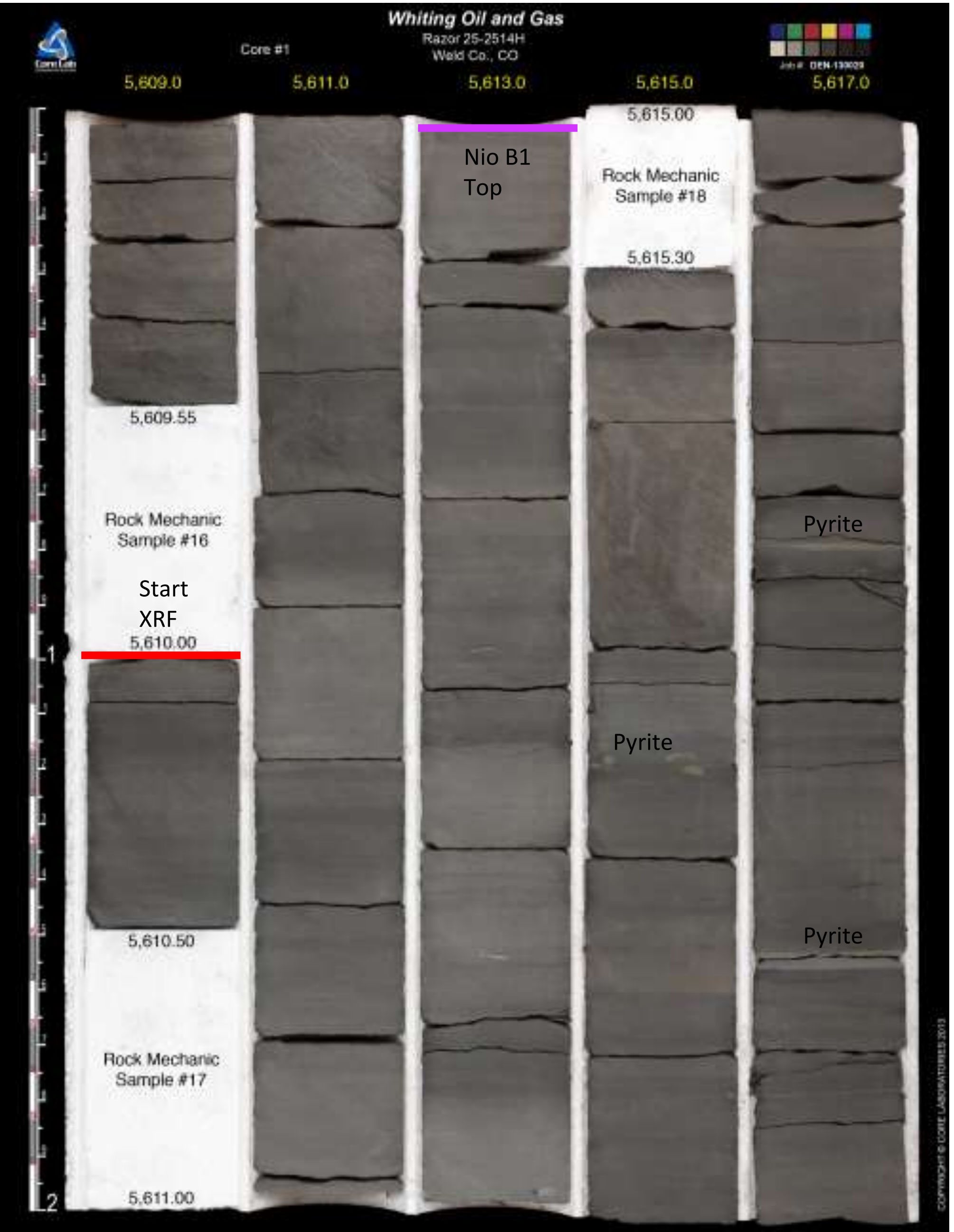
B1 thin is compensated by thicker B2.

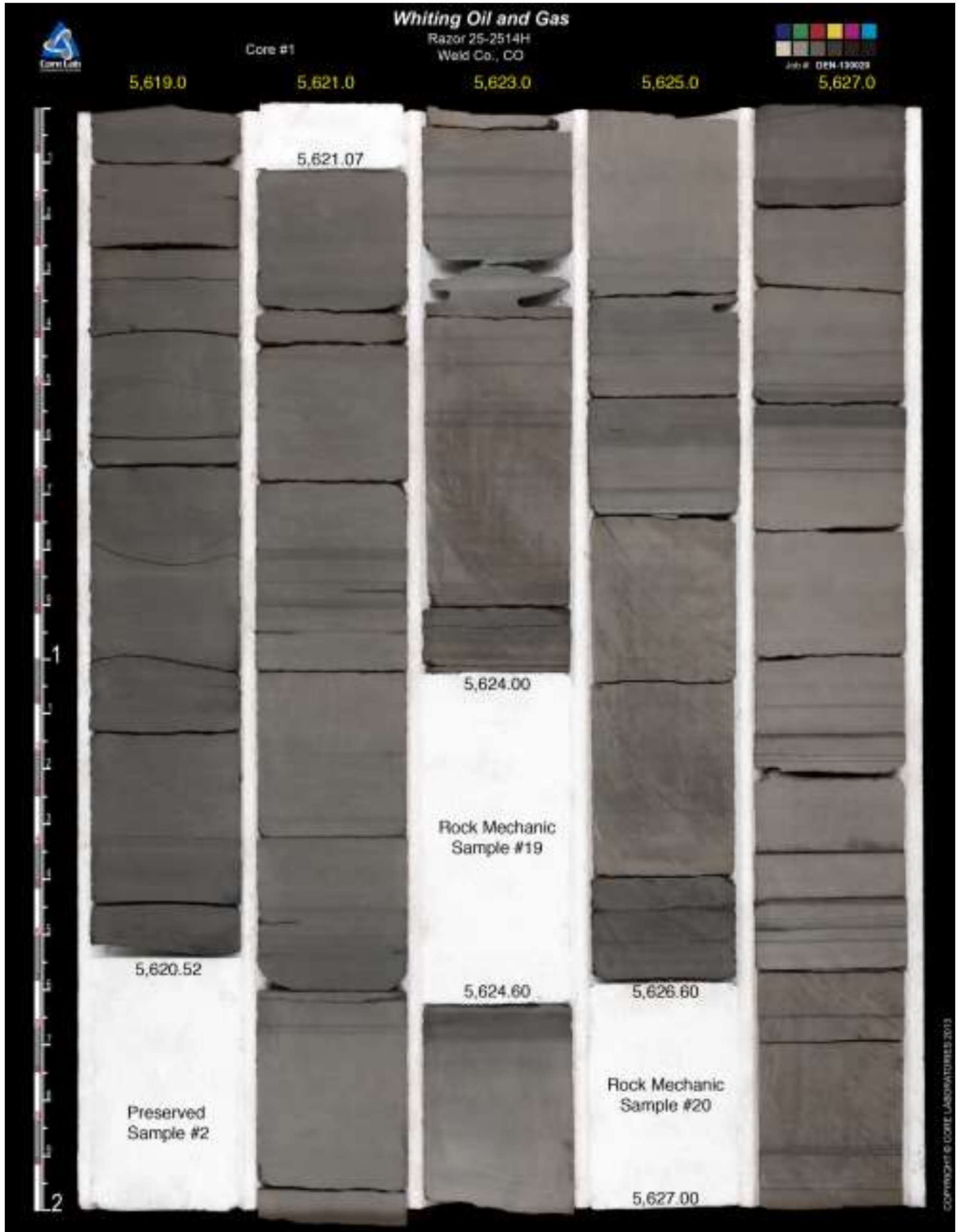
Niobrara B1 Isopach Map



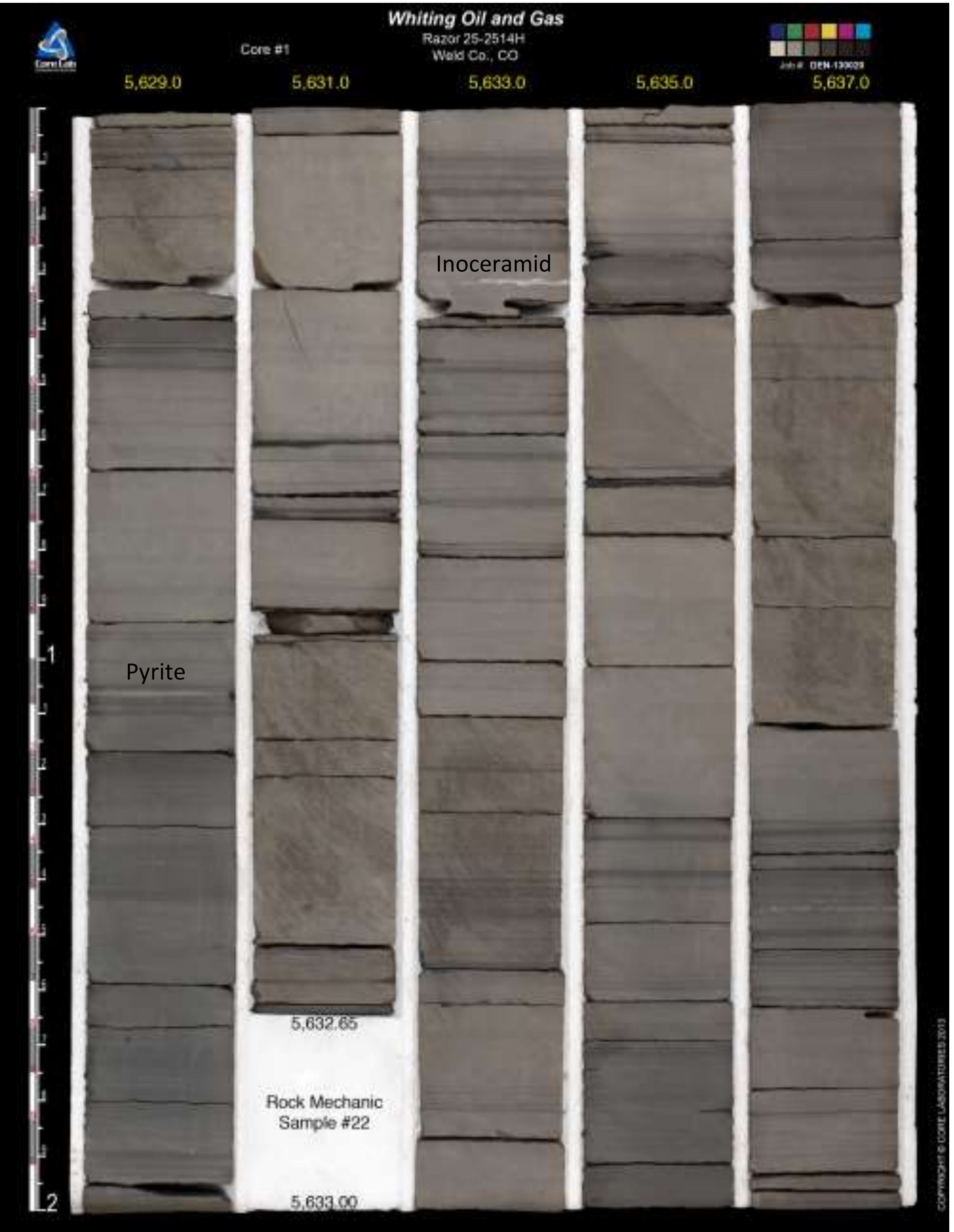
B1 Chalk has a variable thickness in the field ranging from 20-35 ft. The dark blue spot is the location of the Razor 26J-2633L well. The thickness of the other interval seem appropriate and my current theory is that there is a fault that thinned the Nio B1.

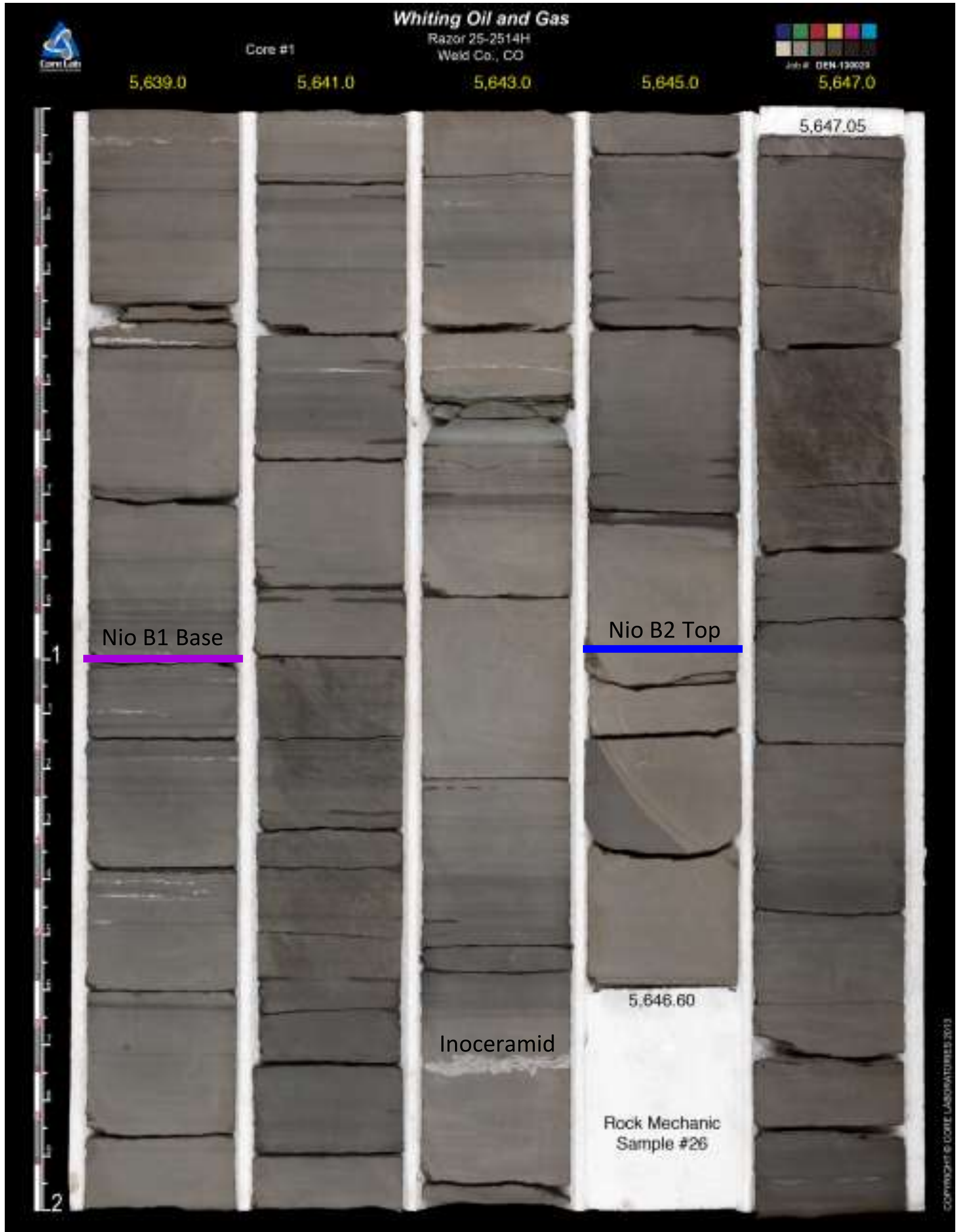
Razor 25-2514H Core Photos



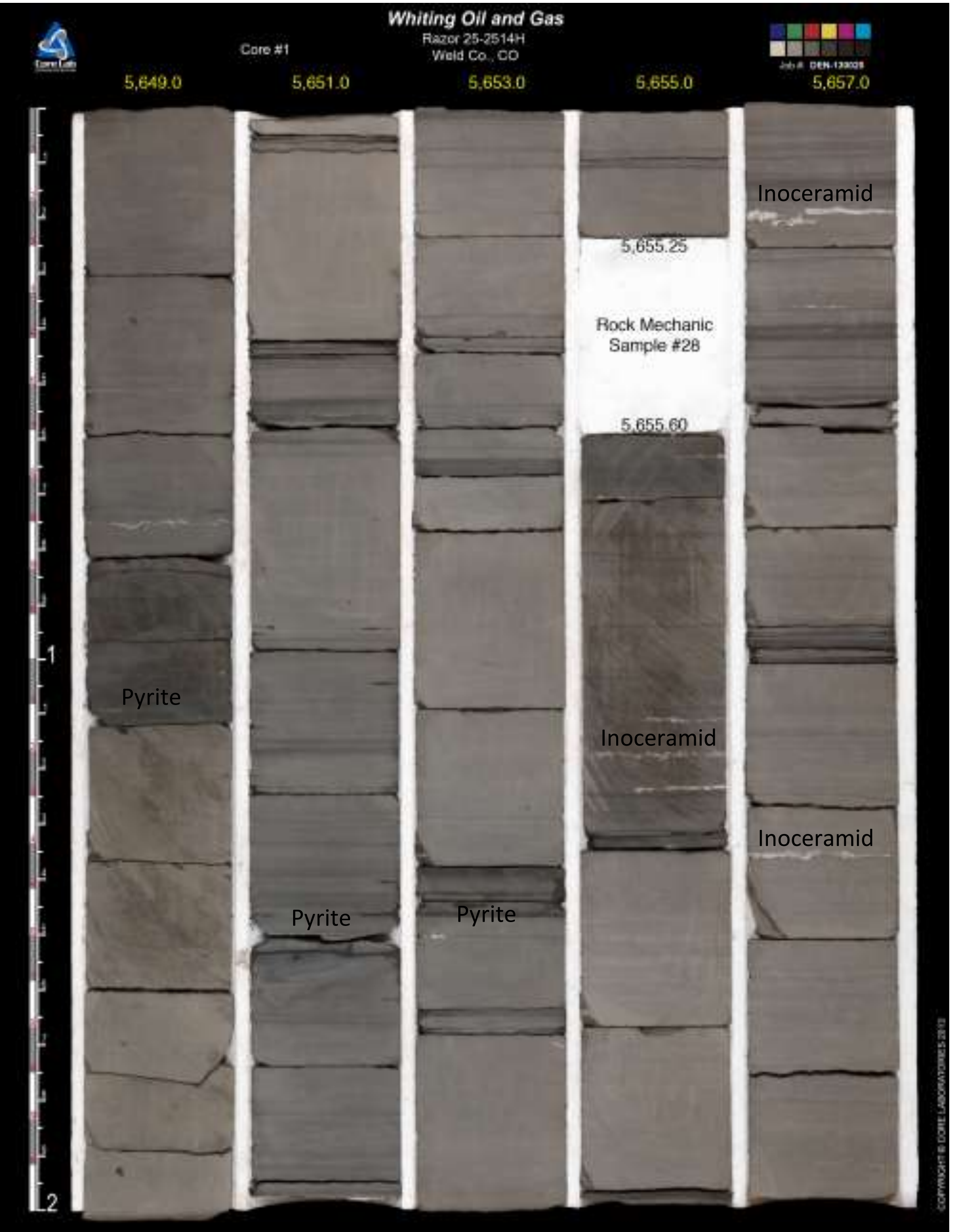


Razor 25-2514H Core Photos



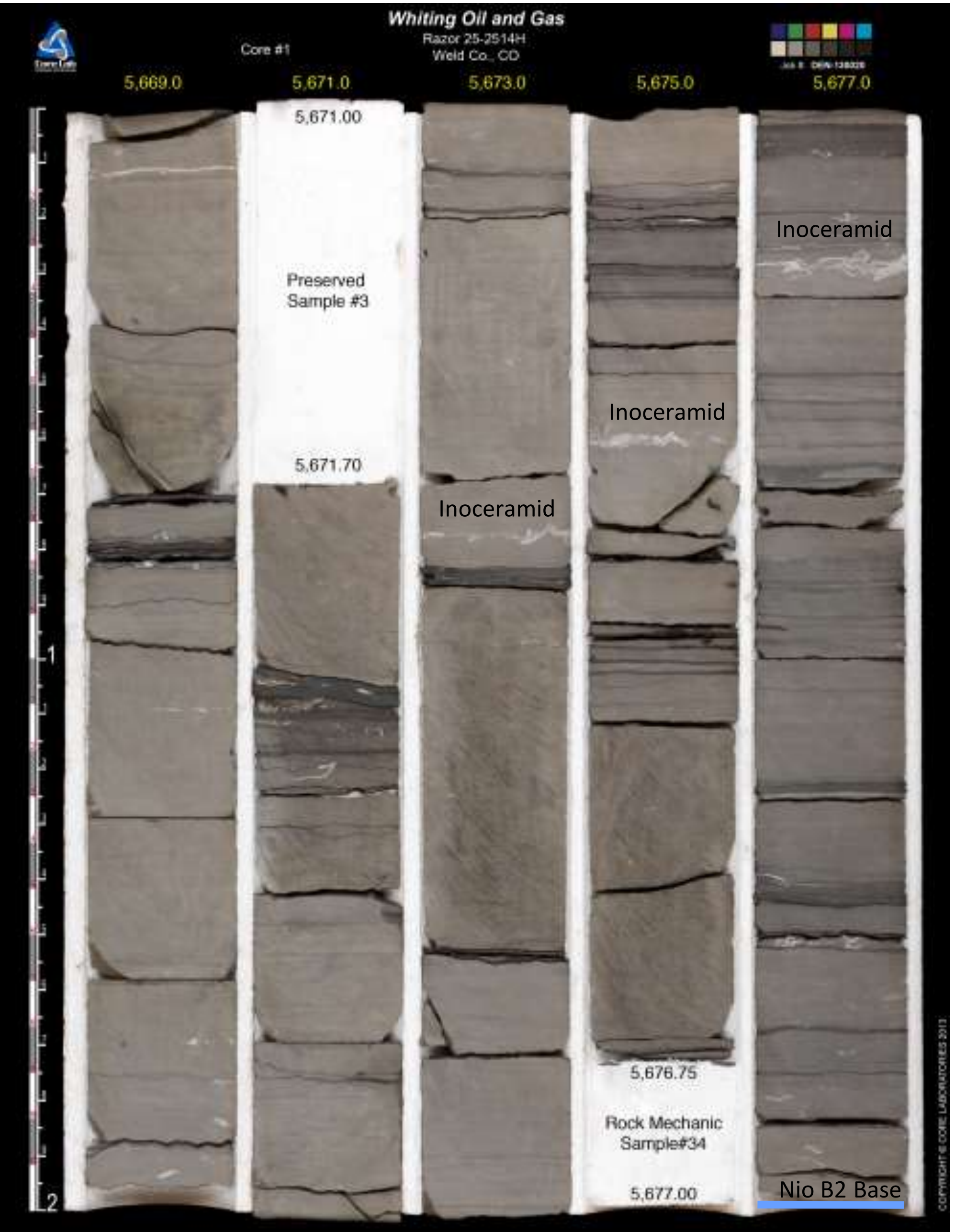


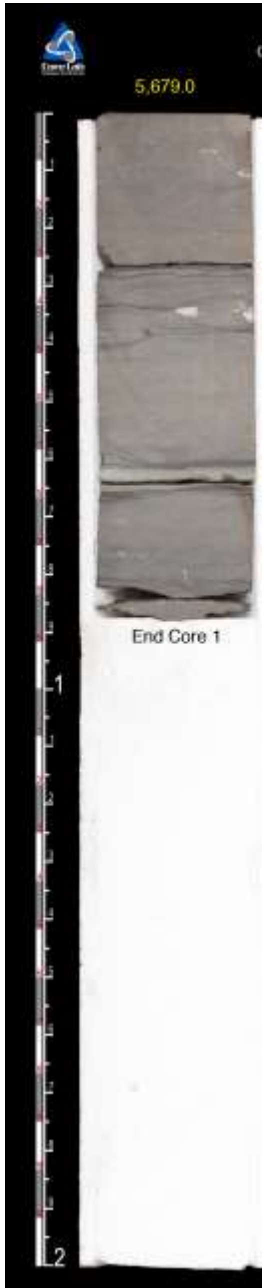
Razor 25-2514H Core Photos



A lot of heterogenitiy in core. Compare core to elemental data.

Razor 25-2514H Core Photos



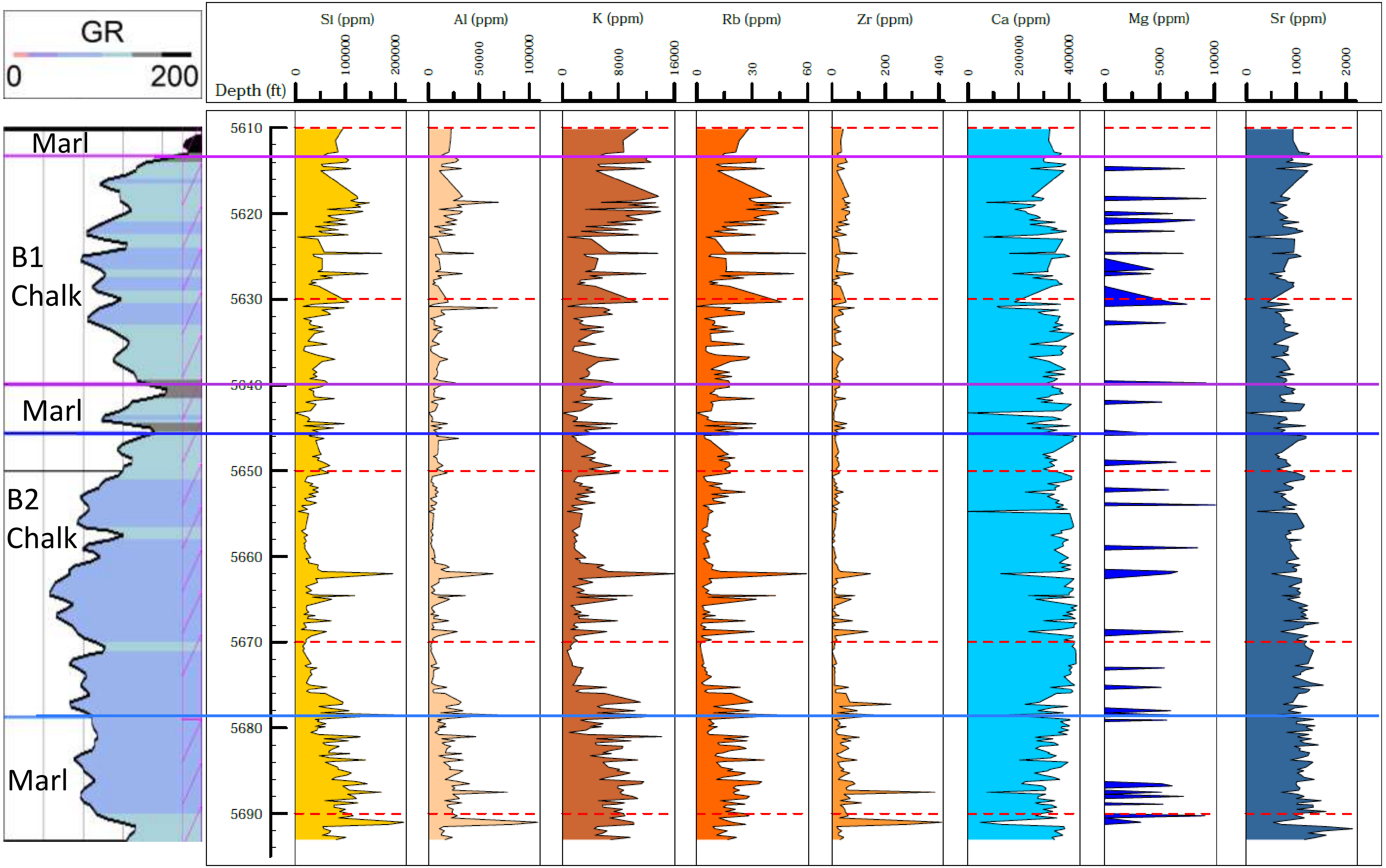


Inoceramids are found in nearshore sandstones to deep sea shales. Most dominant to exclusive macro fossil found in facies associated with oxygen deficient benthic conditions.
Since they had a large gill area, they could survive in oxygen deficient waters.

Have been used to suggest nonanalog bathyal conditions during the Late Cretaceous greenhouse climate.
Explanation for the occurrence of multiple inoceramid colonies during the Late Cretaceous was there were short lived oxygenation events that superimposed on a dysoxic benthic background.

(Berrocoso, et al., 2008)

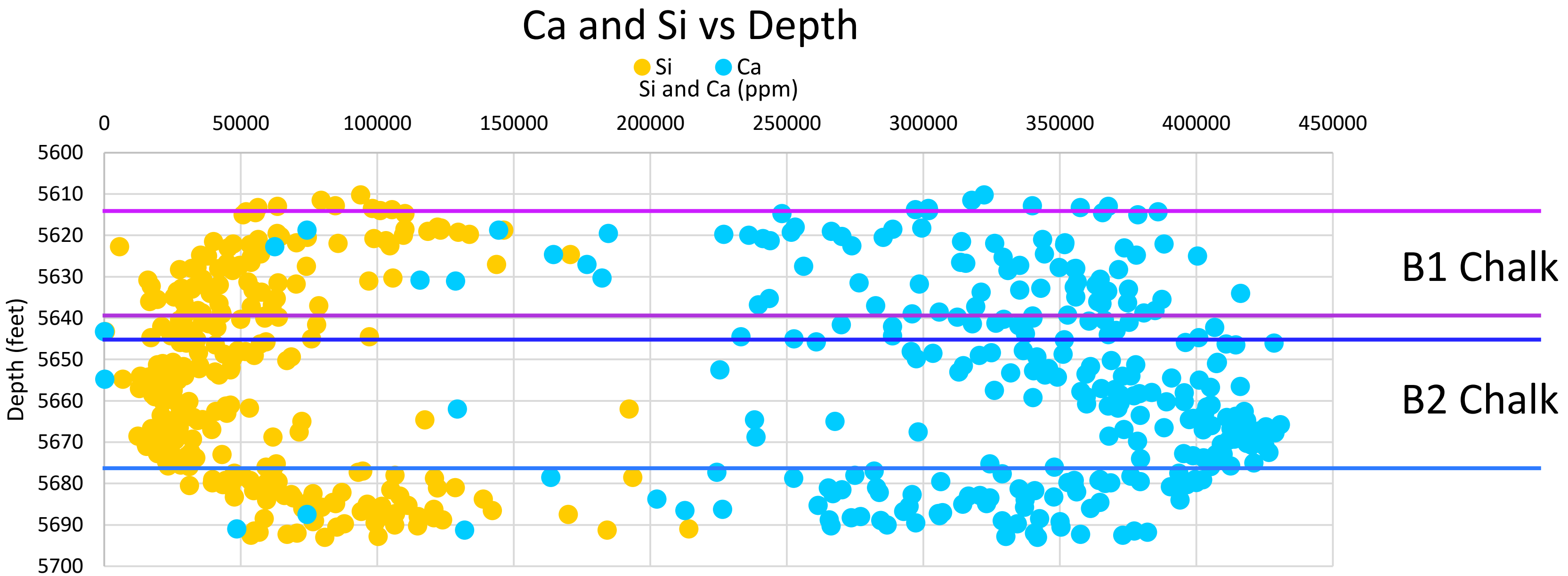
Razor 25-25 Detrital and Carbonate Indicators

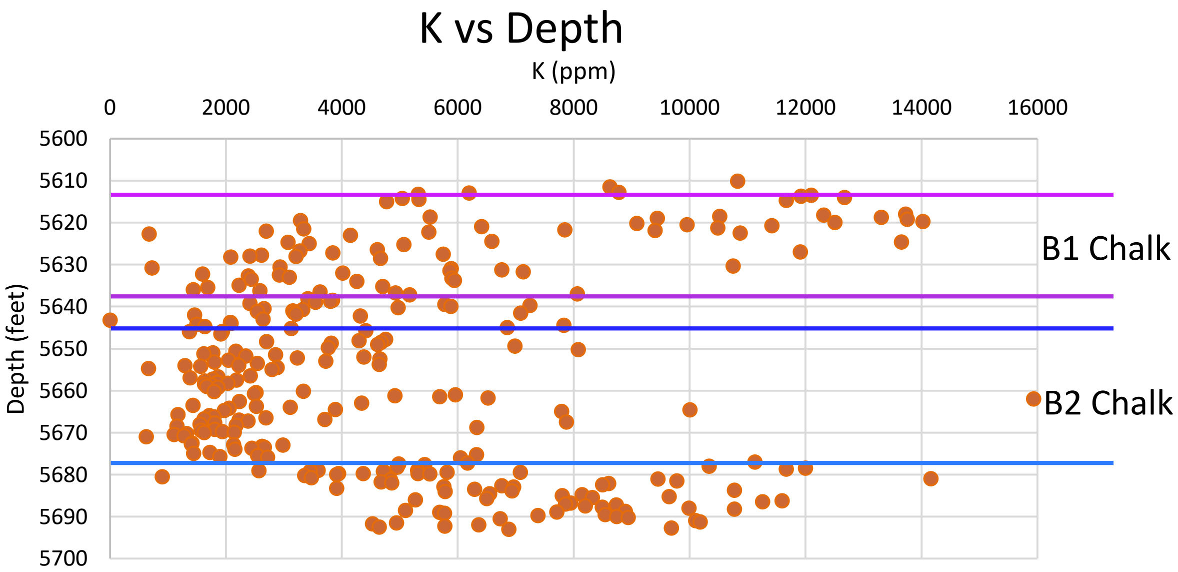


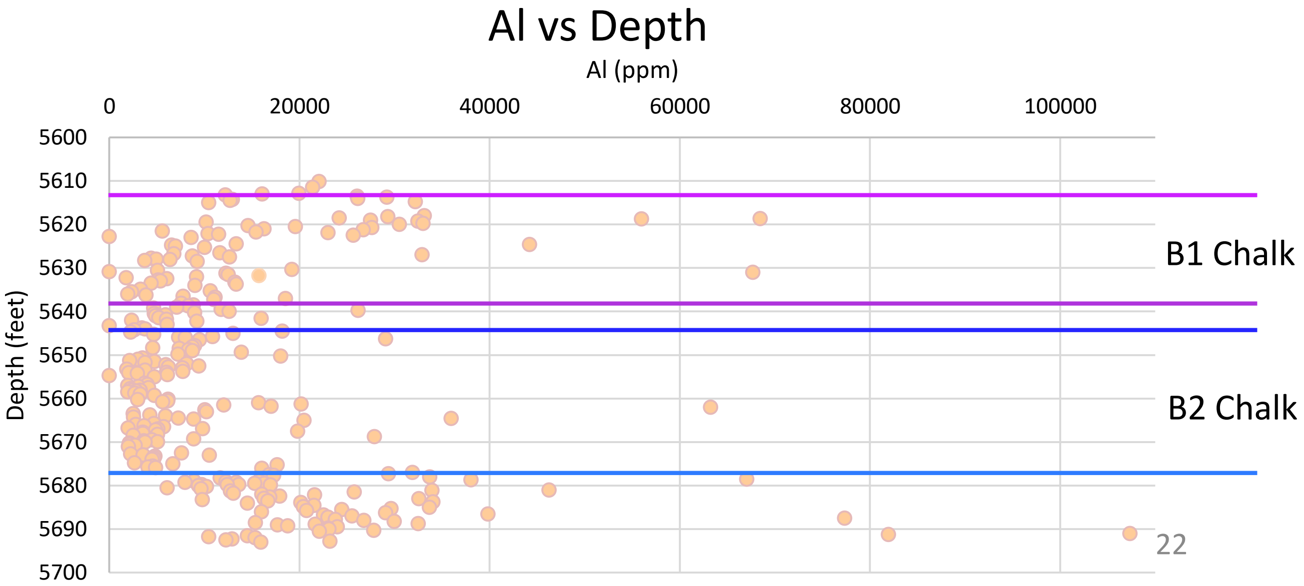
Elements vs Depth

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

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

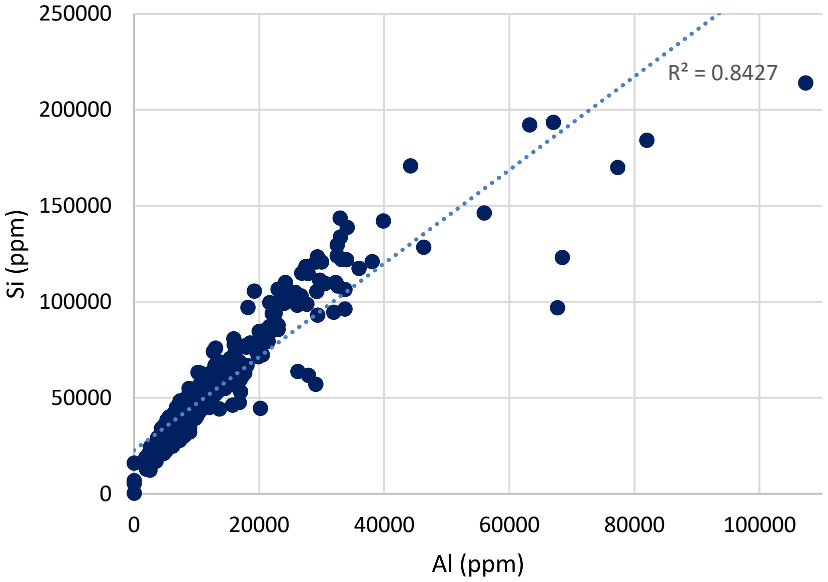






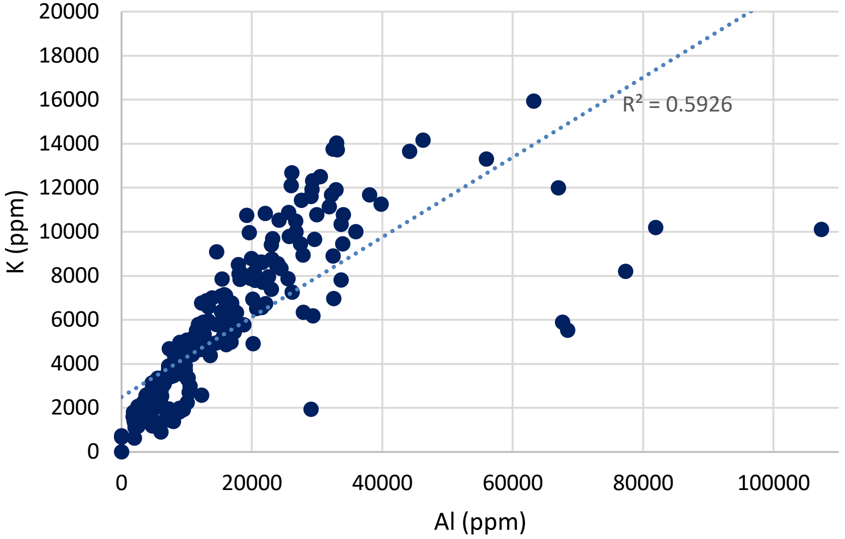
Razor 25-25 Elemental Cross Plots

Si vs Al



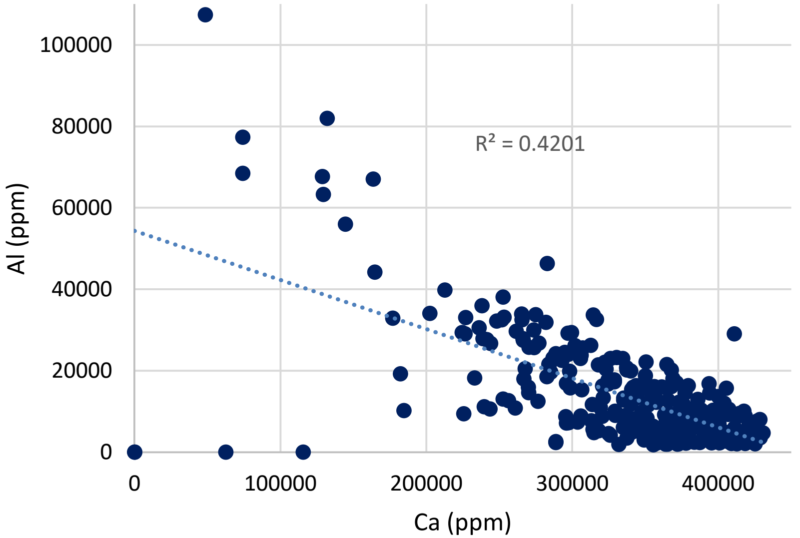
Si vs Al cross plot shows a great correlation and indicates that the silicon content is detrital sourced

K vs Al



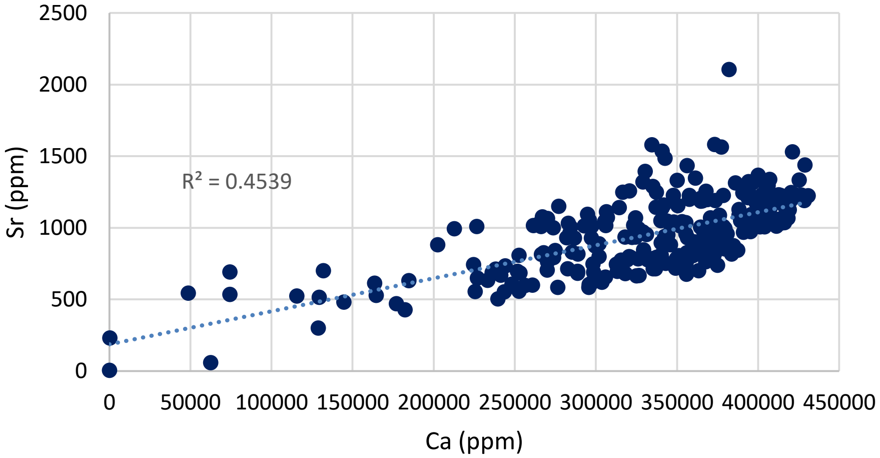
K vs Al cross plot shows a good correlation and is due to the large amount of both elements in clay (mixed I/S and illite)

Al vs Ca



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

Sr vs Ca



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

Future Work

- Split up the Niobrara B1 and Niobrara B2 in Razor 25-25 XRF data. Really need to have this, need to know the elemental data, don't want to drill the top b1 zone, want to drill were is more carbonate.
- Create and interpret more cross plots from Razor 25-25 XRF data to identify redox elements
- XRF on other cores
- Core descriptions, facies distribution, mineralogy, X-ray Diffraction (XRD), Field Emission Scanning Electron Microscope (FE-SEM), source rock analysis, petrophysical analysis, and geochemical analysis

Maybe just focus on one core, just the Razor25-25. Maybe

Sources

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