Beyond the Uteland Butte Part II: Delineating Stacked Pay Sweet Spots for Development Optimization

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Abstract

Over the past 10 years, oil production in Utah's Uinta Basin has grown rapidly as operators have adopted modern horizontal drilling and completion techniques. In the past 2 years alone, horizontal oil production more than doubled to eclipse 80 thousand barrels of oil per day of production. Oil volume growth has been primarily driven by the remarkable productivity of wells targeting the Uteland Butte member (UB) of the Green River Formation, Uinta Basin, Utah. UB horizontal wells in the core of the Uinta Basin deliver world-class production results, routinely producing more than 200 thousand barrels of oil in the first year of production. Oil deliverability in the core of the Uinta Basin is driven by the combination of organic shales and carbonate grainstones that comprise the UB along with strongly over-pressured fluid systems within the Uinta Basin source rock maturity window. The lateral extents of UB lacustrine facies belts have been mapped by previous authors to delineate the lateral limits of well productivity but vertical stacking patterns and depositional facies variation have received far less attention.

This study integrates geologic mapping with detailed petrophysical, core, and geochemical analyses to identify additional lacustrine systems within the Green River and Wasatch/Colton Formations with the intent of finding horizontal drilling targets with oil deliverability comparable to the UB. Our results outline multiple widespread, lacustrine depositional cycles within the Wasatch/Colton Formation. Furthermore, this study documents a widespread lacustrine depositional phase at the interface of the upper-most Wasatch/Colton and lower-most Green River Formations directly underlying the UB. We interpret these lacustrine cycles as evidence that the transition out the hyperthermal environment of the Paleocene/Eocene Thermal Maximum was episodic in nature before a stable climatic regime could be established in Uteland Butte time to support the widespread formation of Lake Uinta.

These widespread Wasatch/Colton deep lacustrine packages are interpreted to be primary drivers of Wasatch horizontal well productivity and may provide a first-order explanation for horizontal well productivity in the Wasatch Formation. Based on this concept, multiple horizontal wells were drilled to test the productivity of the upper-most Wasatch/Uteland Butte interface. These production tests demonstrate similar productivity profiles as UB laterals but with unique geochemical signatures. Incorporation of this additional target interval into drilling spacing unit (DSU) development plans has allowed for tighter well spacing, increased DSU-level oil recovery, and stronger financial returns.

Keywords – Uteland Butte, Uinta Basin, Green River Formation, Wasatch Formation, Colton Formation, unconventional, lacustrine

References

Birgenheier, L.P., Vanden Berg, M.D., Plink-Björklund, P., Gall, R.D., Rosencrans, E., Rosenberg, M.J., Toms, L.C., and Morris, J., 2019, Climate impact on fluvial-lake system evolution, Eocene Green River Formation, Uinta Basin, Utah, USA: GSA Bulletin, v. 132, no. 3-4, p. 562–587.

Bradley, W. H., 1931, Origin and microfossils of the oil shale of the Green River Formation of Colorado and Utah: US Government Printing Office, Professional Paper 168.

Brinkerhoff, R., and Millard, M., 2019, Using pore system characterization to subdivide the burgeoning Uteland Butte play, GreenRiver Formation, Uinta Basin, Utah: AAPG Rocky Mountain Section Meeting, Denver, Colorado, doi: 10.1306/11272 Brinkerhoff2019.

Chidsey, T.C., 2010, Major Oil Plays in Utah and Vicinity, Utah Geological Survey –Survey Notes, Vol. 42, Number 1

Gall, R.D., Birdwell, J.E., Brinkerhoff, R., Vanden Berg, M.D., 2022, Geologic Characterization and Depositional History of the Uteland Butte Member, Green River Formation, Southwestern Uinta Basin, Utah in Vanden Berg, M.D., Brinkerhoff, R., Birdwell, J.E., Jagniecki, E.A., Birgenheier, L.P., editors, The Lacustrine Green River Formation: Hydrocarbon Potential and Eocene Climate Record, Utah Geological Association no. 50, p.28-54

Rueda Chapparro, F., Machel, H.G., and Vanden Berg, M.D., 2019, Dolomitization in the Uteland Butte Member of the Eocene Green River Formation,Uinta Basin, Utah: Utah Geological Survey Open-File Report 700

Oil and Gas Plays Uintah and Ouray Reservation (bia.gov) UINTAH AND OURAY RESERVATION

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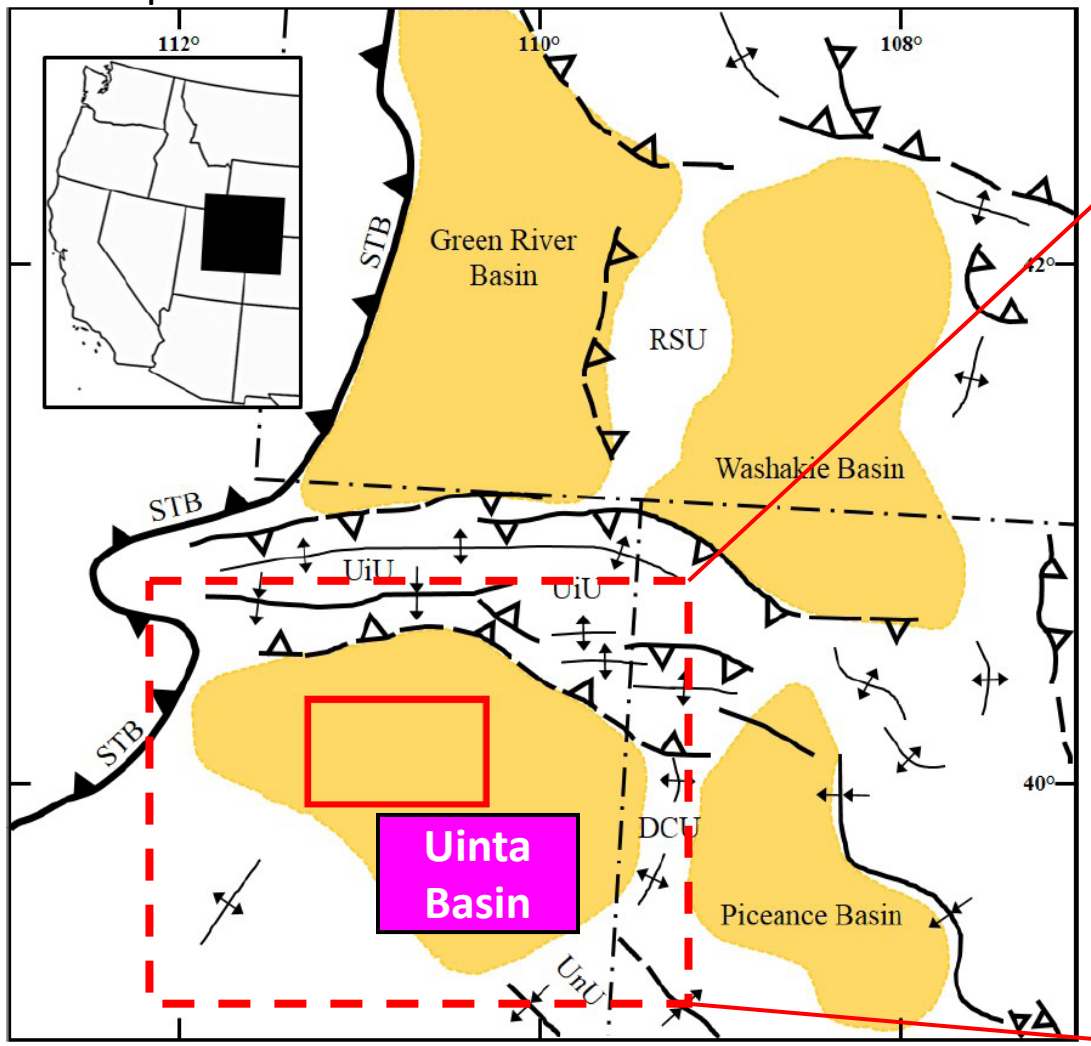
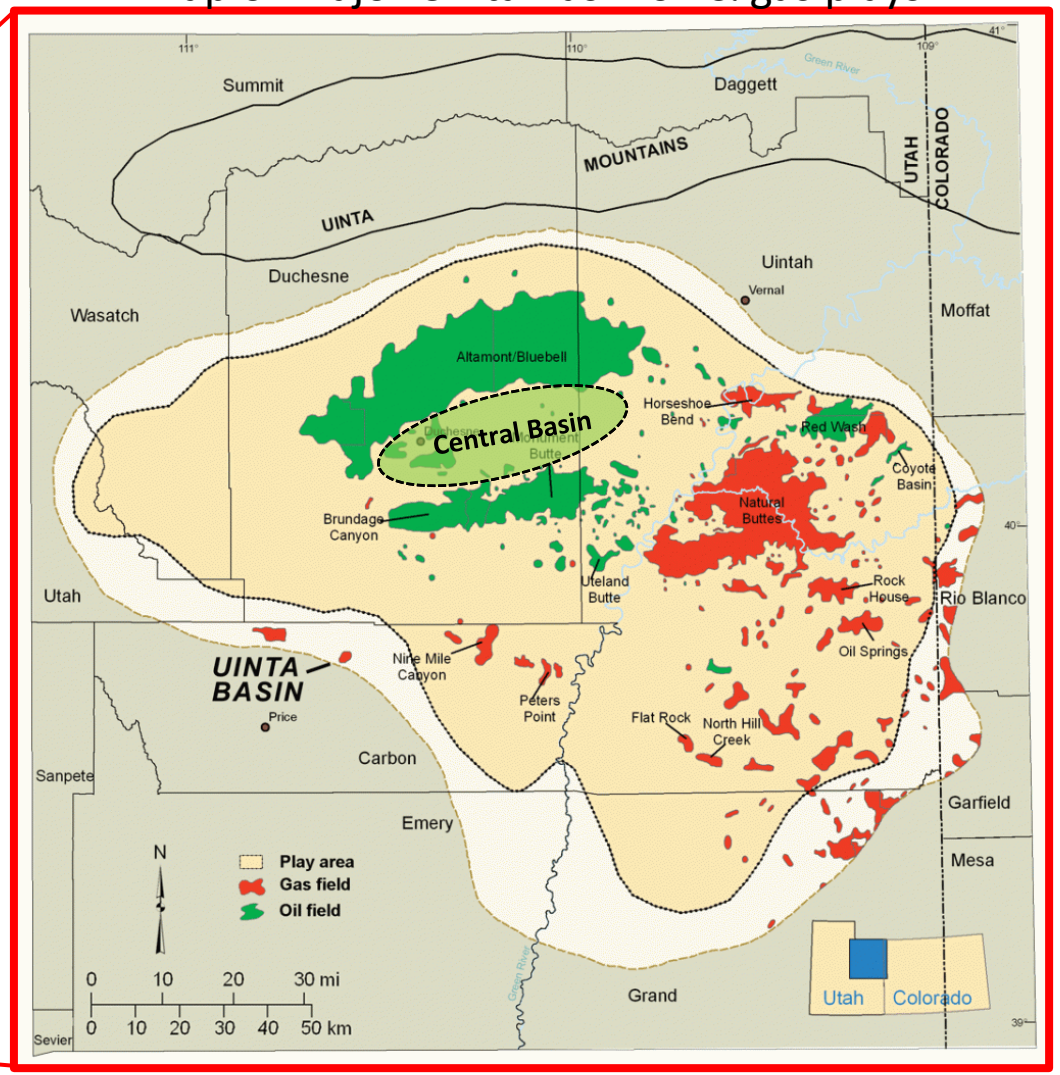
Uinta Basin Locator Slide

Map of western U.S. Laramide lacustrine basins



Modified from Rueda Chaparro 2019

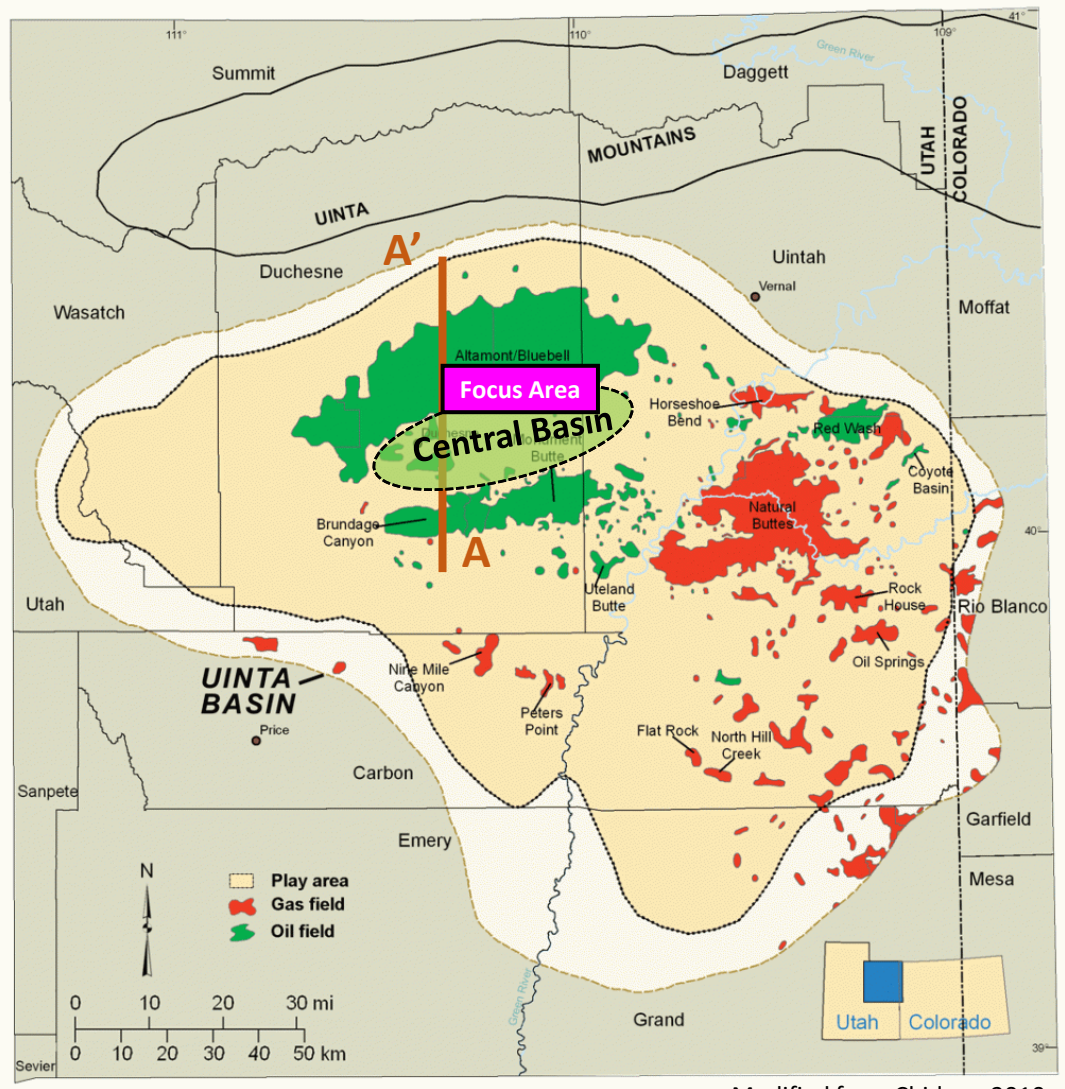
Map of major Uinta Basin oil & gas plays



Modified from Chidsey 2010

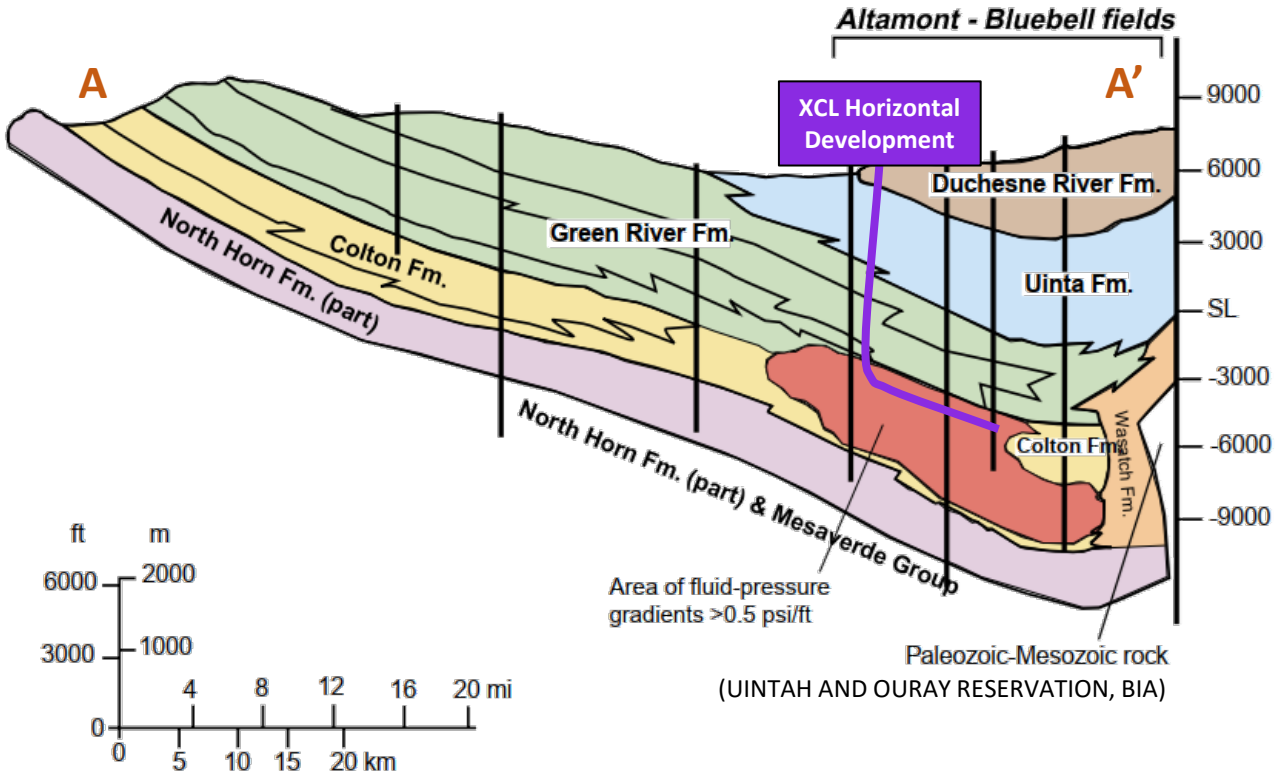
Uinta Basin Overview

Green River Fm - World Class Source Rock



Modified from Chidsey, 2010

- Uinta Basin oil production at Altamont/Bluebell since 1970's and Monument Butte since 1980's
- Vertical production from Eocene Green River/Colton (Wasatch)/Flagstaff formations
- Modern Horizontal plays target lacustrine source rocks of Green River and Wasatch Formations
- Asymmetric basin configuration resulted in deepest lacustrine deposits stacked along northern margin of Uinta "Central Basin"

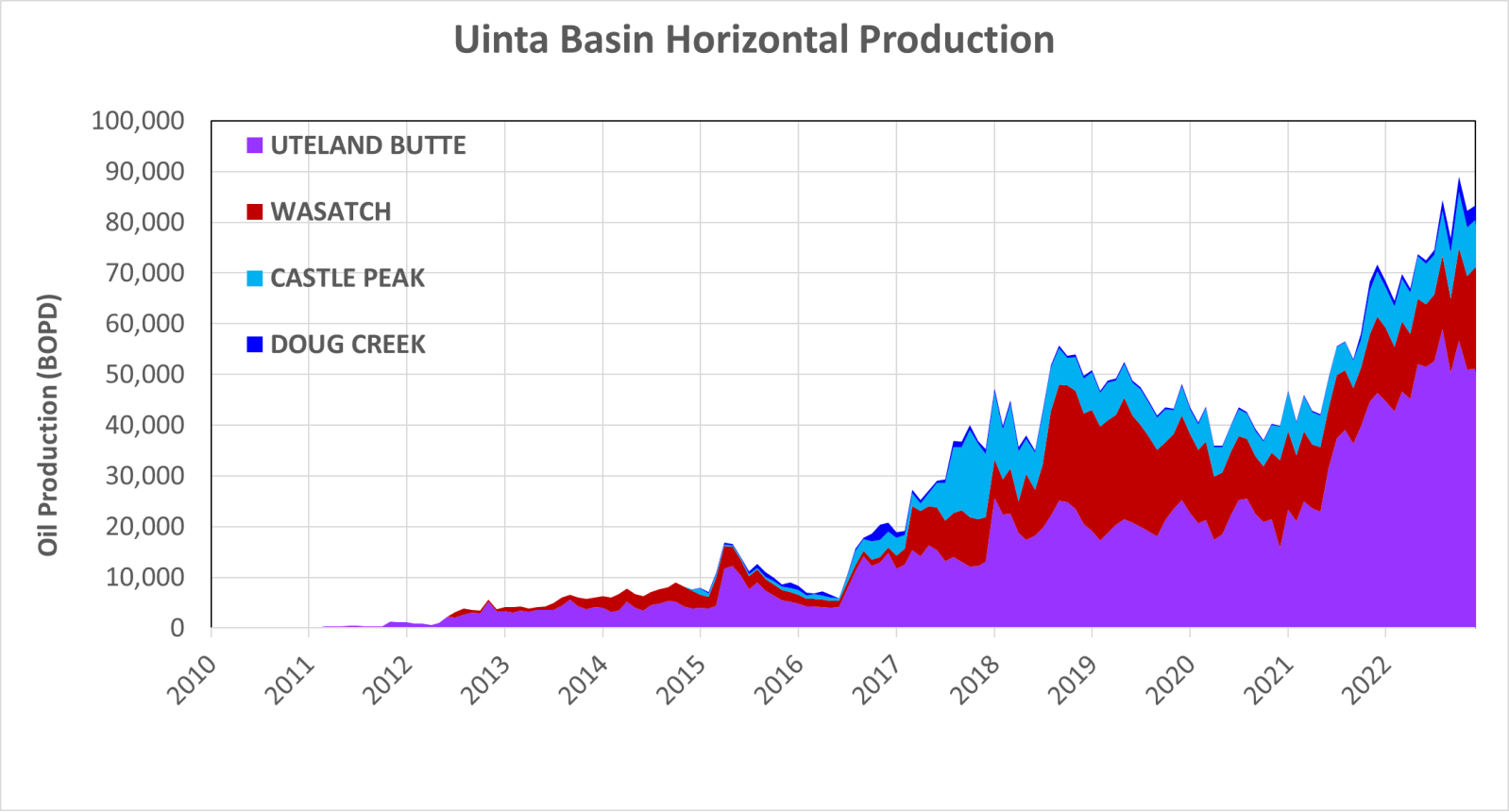


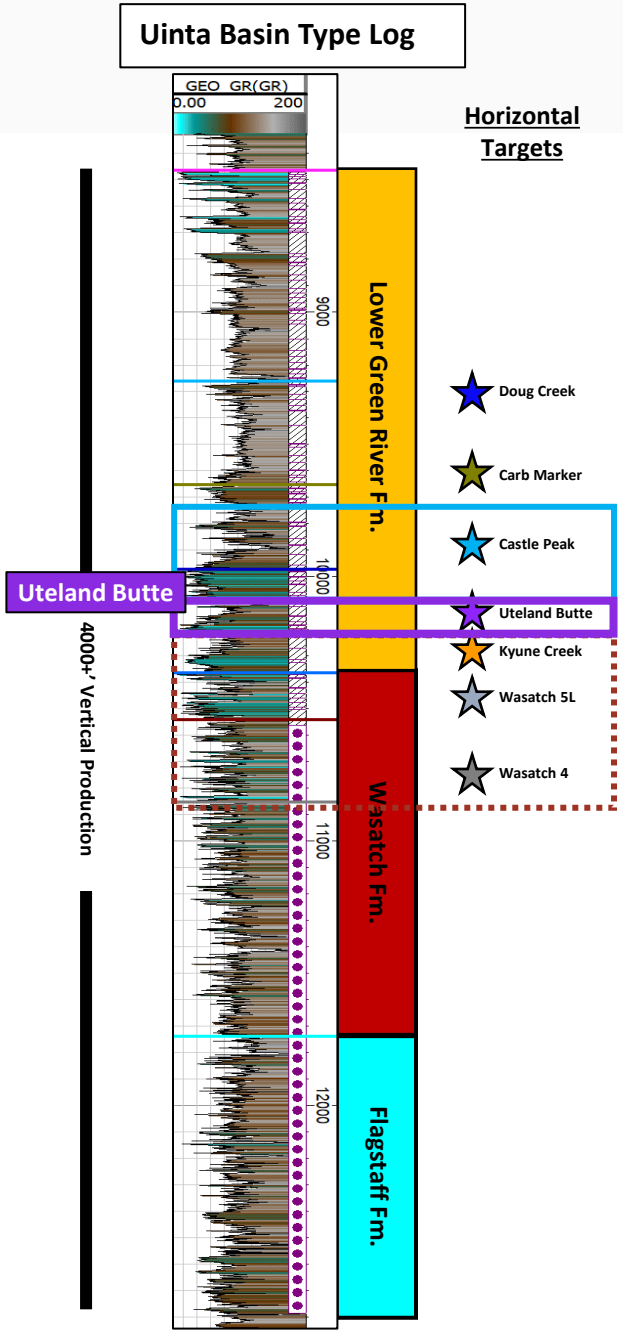
(UINTAH AND OURAY RESERVATION, BIA)

Uinta Basin Horizontal Production

The House Uteland Built

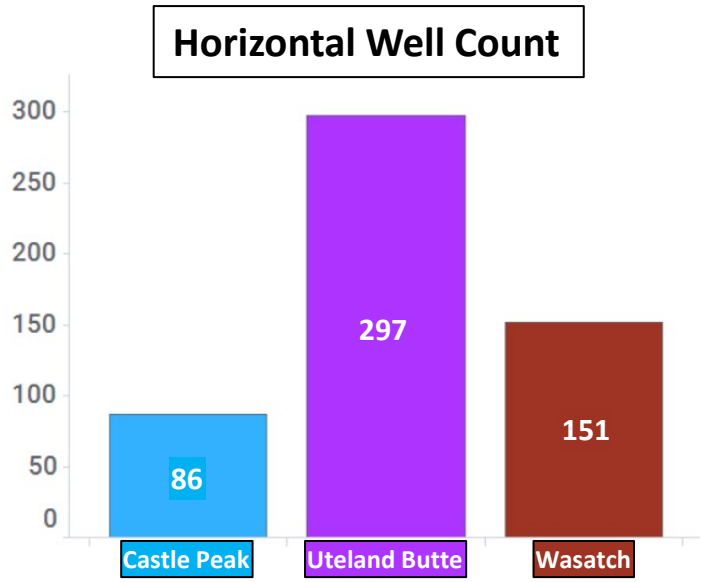
- Uinta Basin horizontal drilling began in the Uteland Butte (UB)
- Laterals landed in 7+ benches of the Lower Green River and Wasatch Formations
- Significant production from Castle Peak and Wasatch benches but UB is king

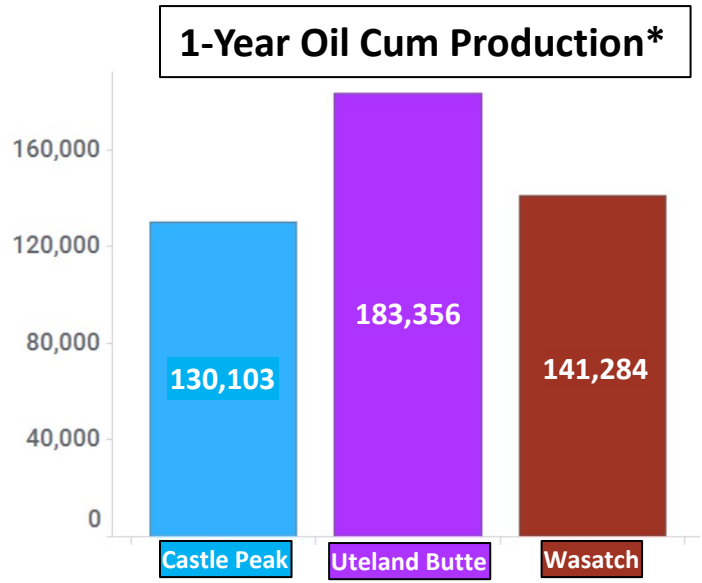




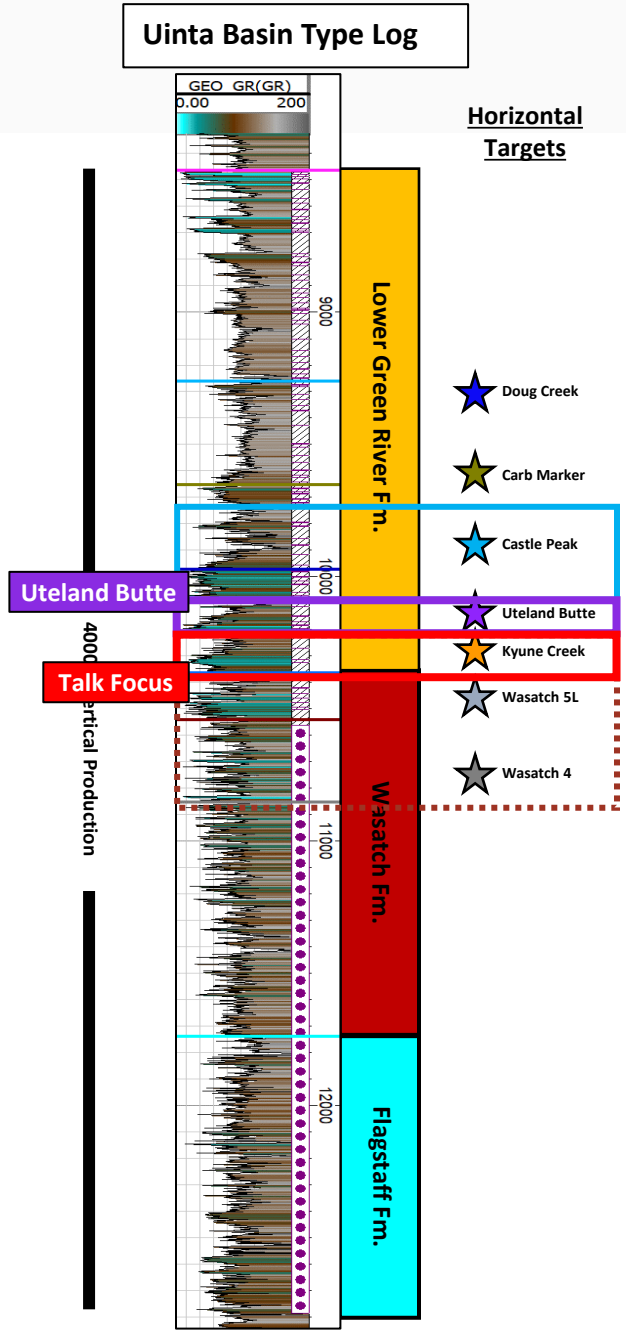
Uinta Basin Horizontal Production

- Significant production from Castle Peak and Wasatch benches but UB is king
- 2-3x more UB wells drilled relative to secondary formations
- Hard to argue with extra 40-50 MBO in 1st year cum from UB wells (20-30% uplift)
- Extensive UB drilling means greater dispatch of inventory – Where do we get more UB?





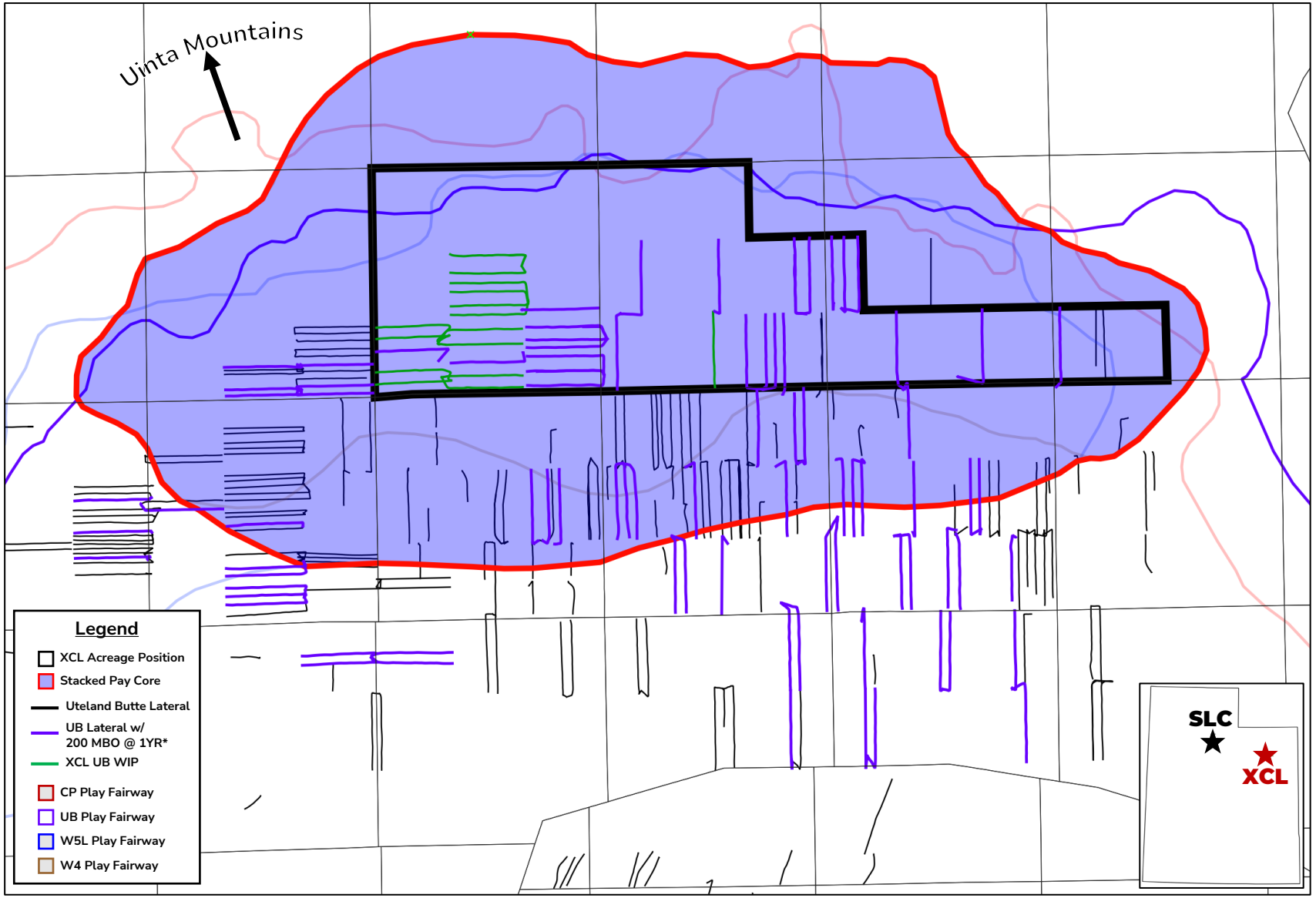
*Data Filtered to Horizontal Completions since 2018



Before we go Beyond – Hail to the King

Uteland Butte Production Trends Demonstrate Unparalleled Performance

- Post-Covid refined frac recipes and updated production practices have brought the Uteland Butte to new highs
- Every corner of the horizontal fairway has realized 200 MBO+ 12Mo Cum Oil
- Since 2020 WEM, OVV, and Altamont have been expanding the bounds of these top tier wells
- Tthe horizontal fairway has increased by 20-30% in ~2 years!!
- This is all great, but is just means we're still dispatching inventory!
- **I've got a fever and the only cure is more Uteland Butte…**

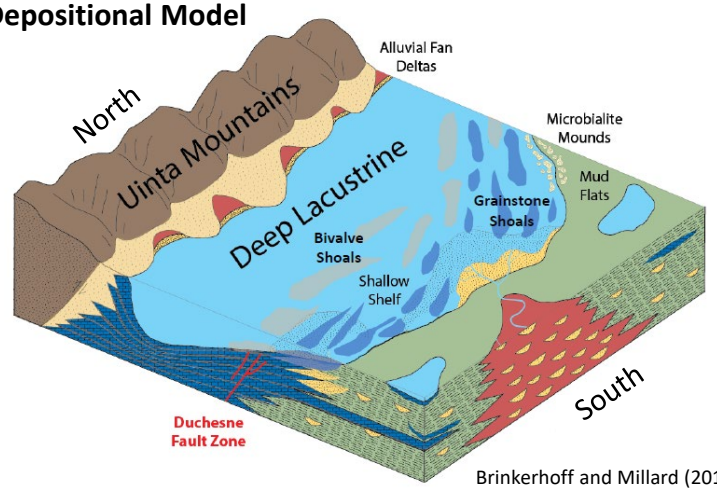


Uteland Butte – The Basal Green River

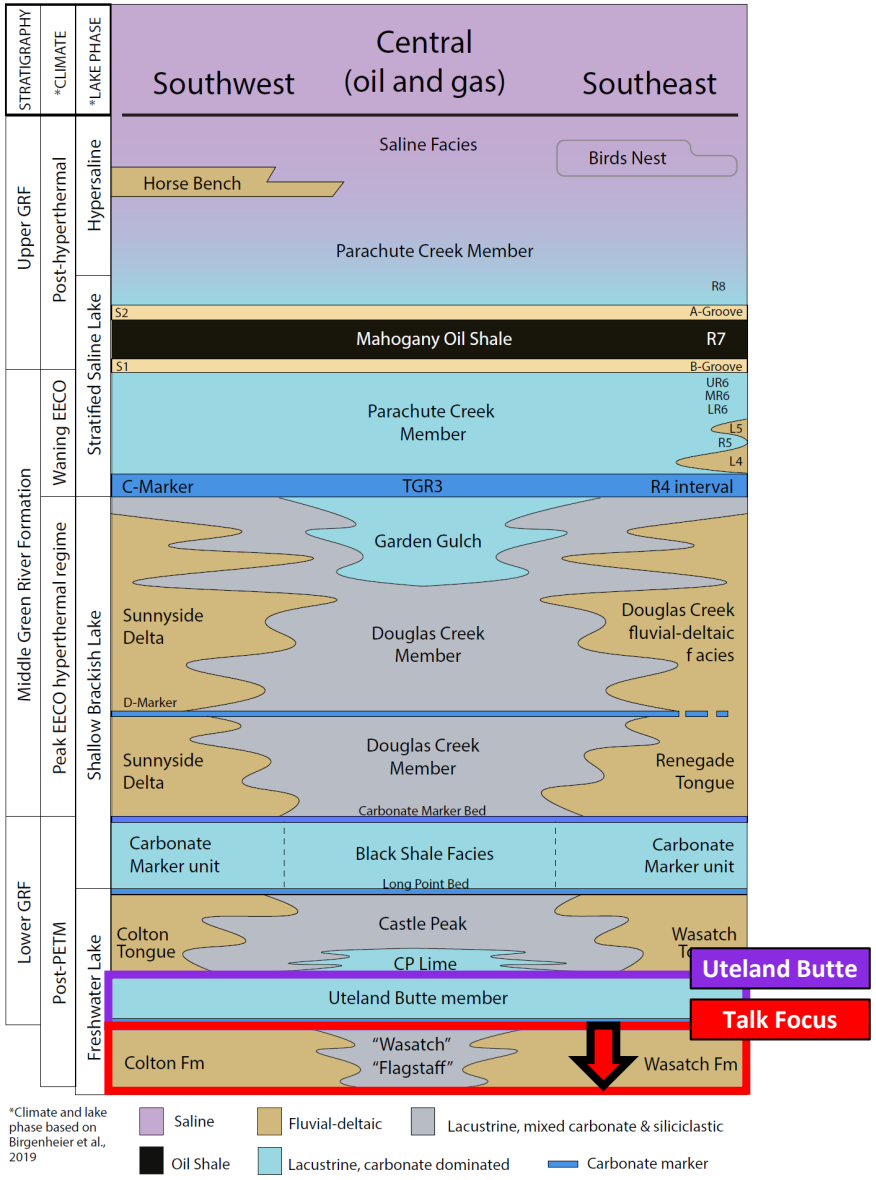
Finding Oil Where it's Already Been Found

- How do we find more resource in a stacked play? Think vertically!
- Uteland Butte originally described by Bradley (1931) as "first lacustrine phase of the Green River Formation" from Willow Creek Outcrop
- Uteland Butte also known to preserve deeper facies in the center of Lake Uinta
- Lacustrine depositional cycle documented throughout the Wasatch and Flagstaff
- Have deeper lacustrine cycles been mapped in other outcrops?
- <u>Can we map out extensive lacustrine depositional cycles below the Uteland Butte?</u>

Uteland Butte Depositional Model



Brinkerhoff and Millard (2019)

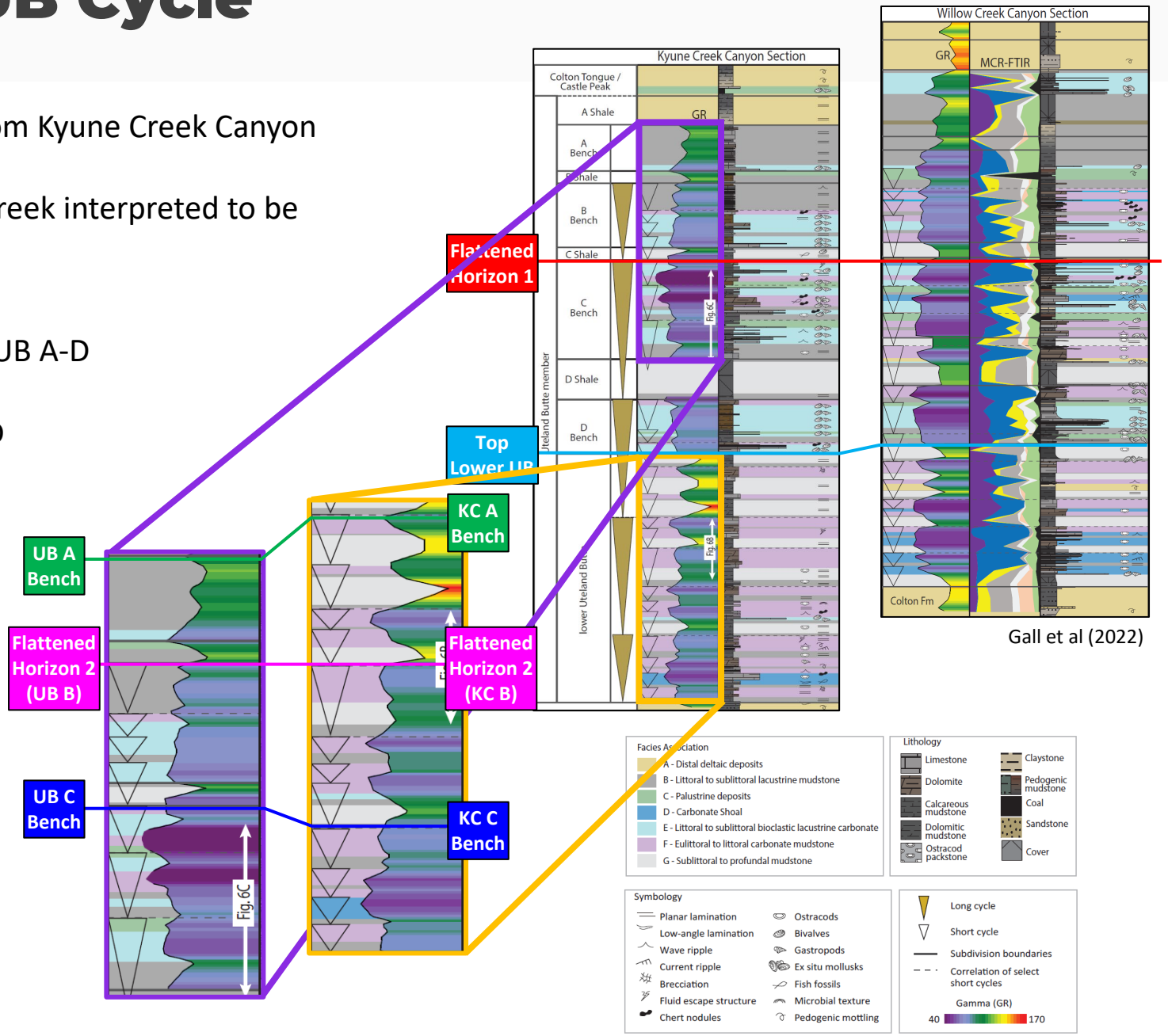


Gall (Unpublished)

Kyune Creek Deeper UB Cycle

New Outcrops, New Observations

- Gall et al (2022) presented new outcrop study from Kyune Creek Canyon
- UB A-D well preserved in both outcrops; Kyune Creek interpreted to be more distal than Willow Creek
- Both outcrops present lacustrine systems below UB A-D
- Lower Uteland Butte notably deeper than UB A-D at Kyune Creek
- Striking similarity at Kyune Creek between UB A-C and exposed Lower Uteland Butte
- Is the Lower Uteland Butte at Kyune Creek a distinctly separate lacustrine cycle from the Uteland Butte?
- Can we map out the Kyune Creek (KC) in the subsurface?

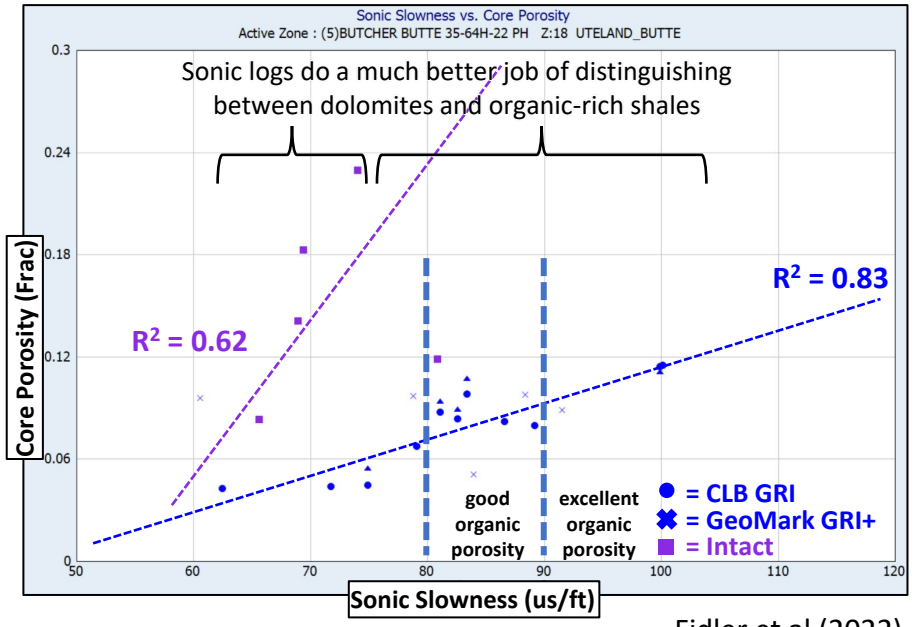


Gall et al (2022)

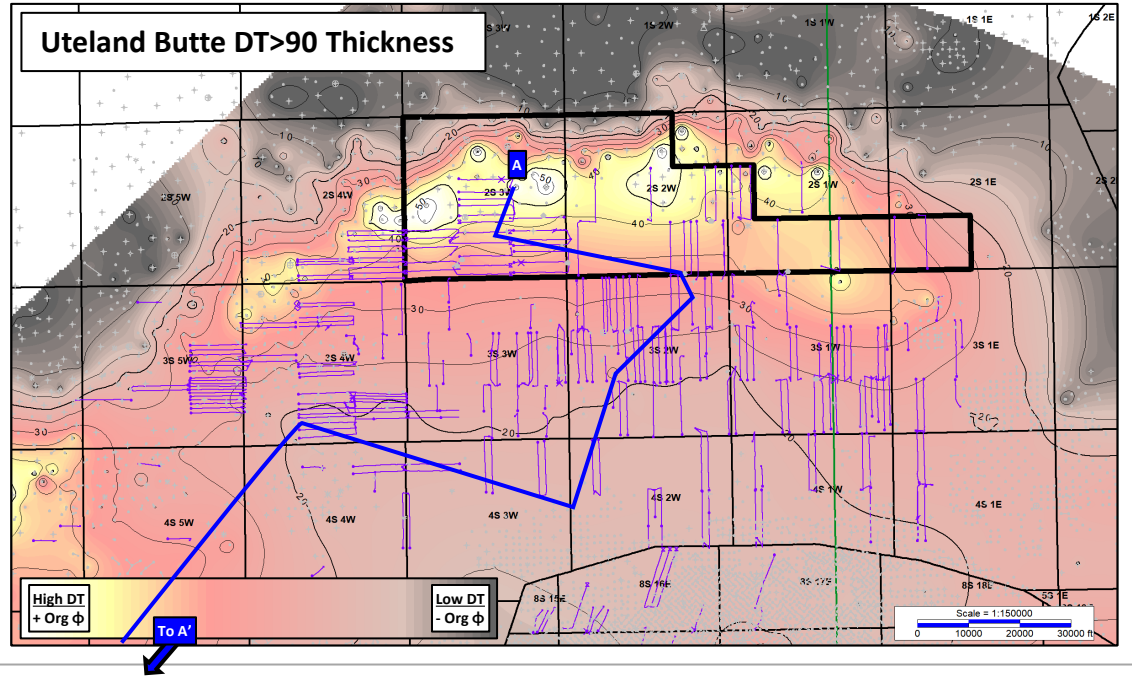
Uteland "Beaut" & More

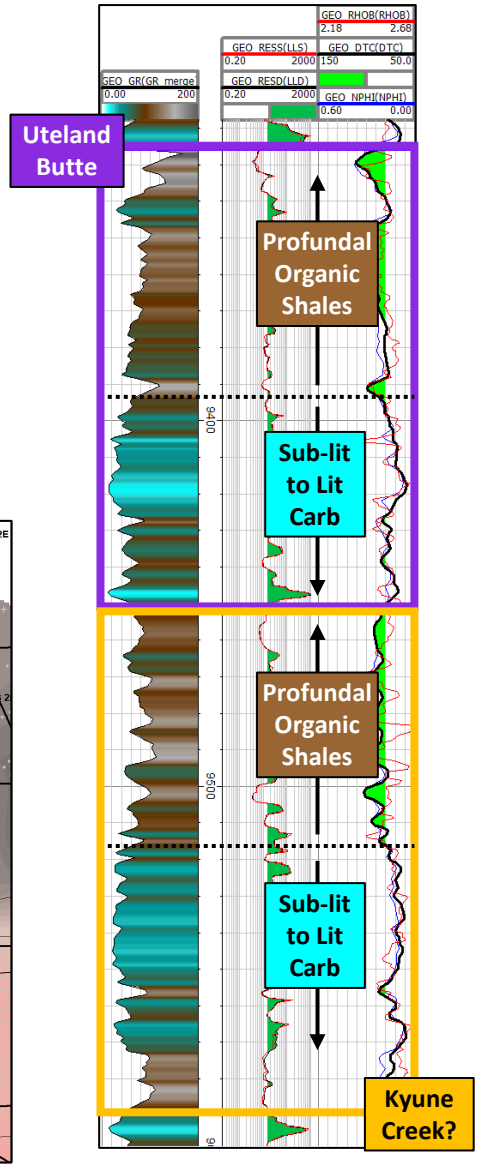
Mapping Uinta Basin Lacustrine Source Rocks

- Fidler et al. (2022) showed a strong correlation between sonic slowness and organic porosity in the UB
- Highest concentration of UB organo-porosity in the North Central Uinta Basin
- Distinct lack of organo-porosity in the "Wasatch Wedge" to the north
- Interpreted to be the largest accumulation of profundal oil source rocks in Lake Uinta during Uteland Butte time
- Repeated stacking pattern of organic-rich profundal shales & sublittoral-littoral carbonates in UB and preceding strat package
- **Strikingly similar to the Kyune Creek!**



Fidler et al (2022)

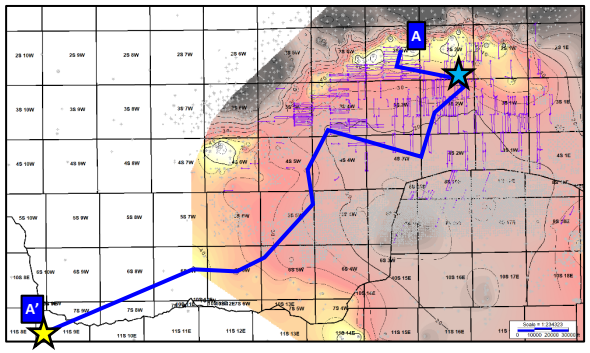


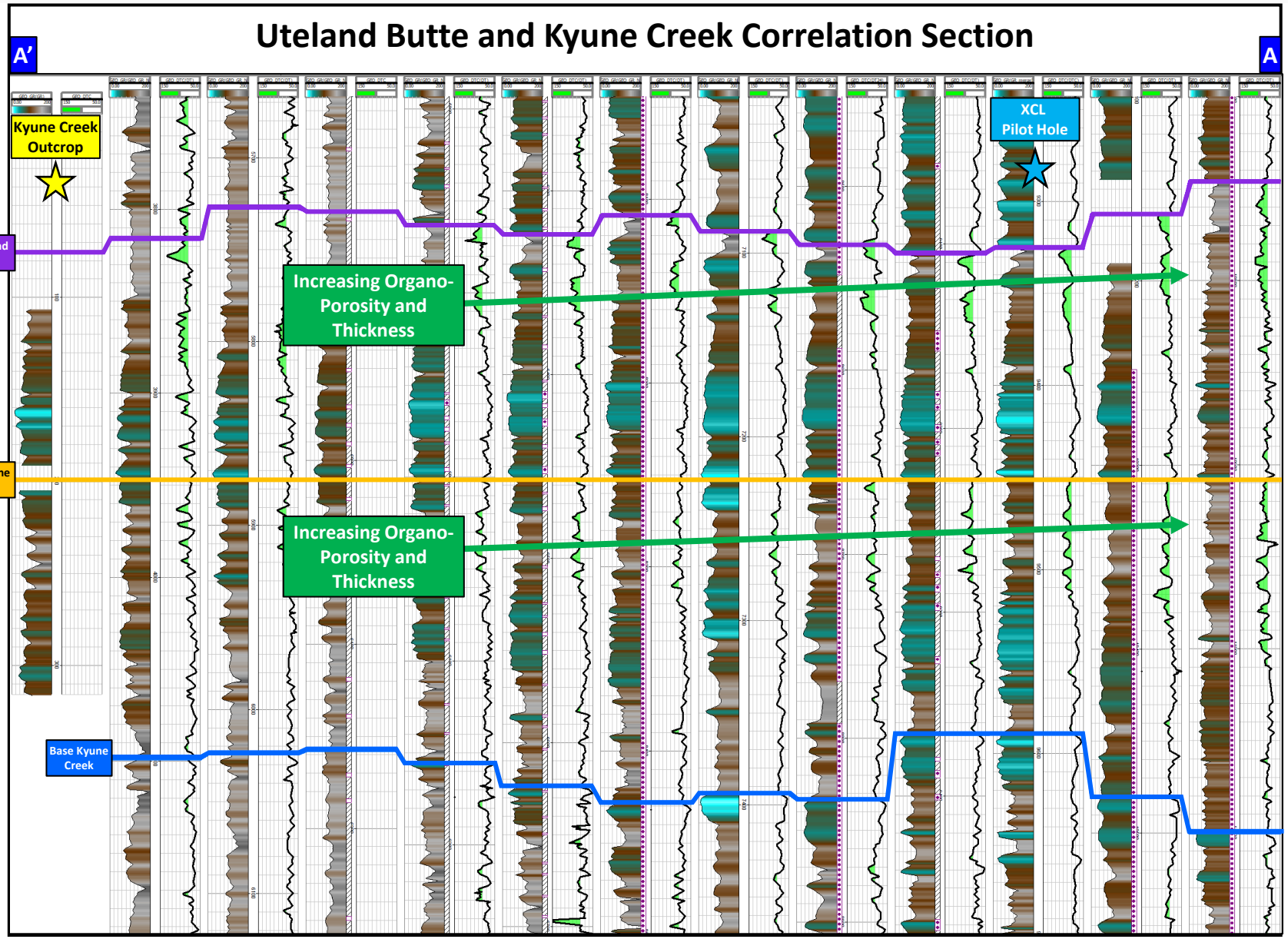


Regionally Correlative Lacustrine Depositional Cycles

Mapping the Uteland Butte and Kyune Creek Intervals

- UB is one of the most faithful strat picks in the Uinta Basin
- UB shale and carbonate stacking patterns are regionally consistent
- If UB is the archetype for Uinta Basin lacustrine carbonate depositional cycles, the Kyune Creek is its understudy (in the deep basin)
- Logs are certainly similar, but does the Kyune Creek look like the UB in core?

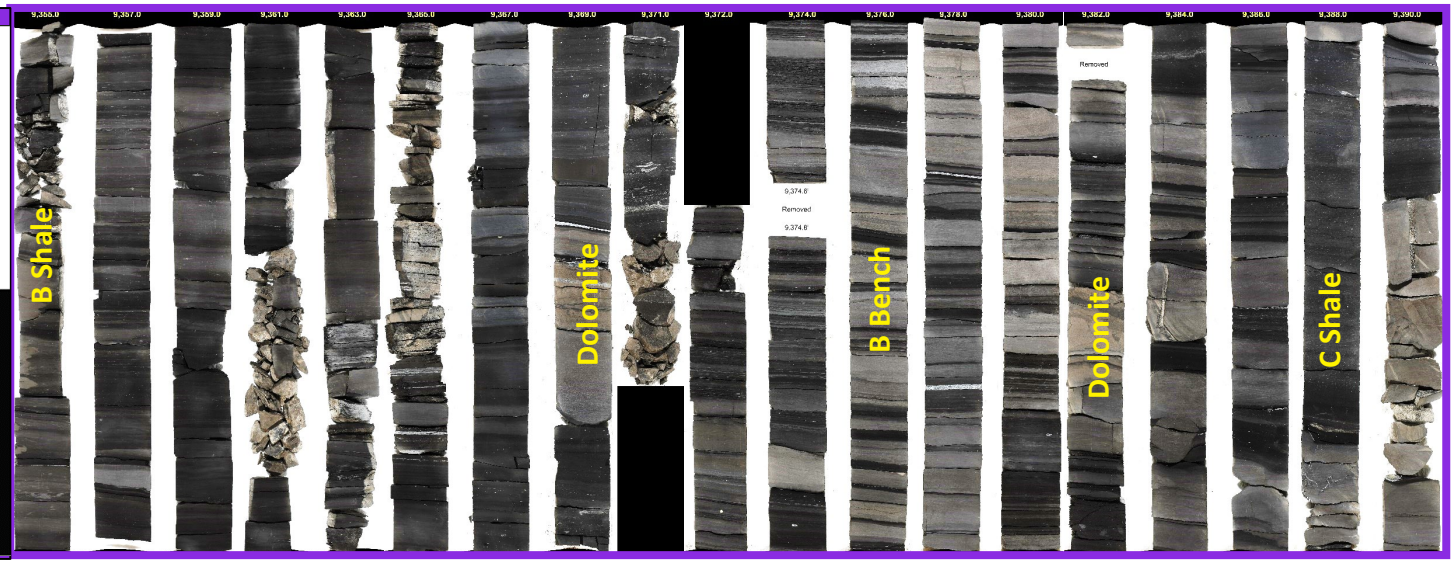




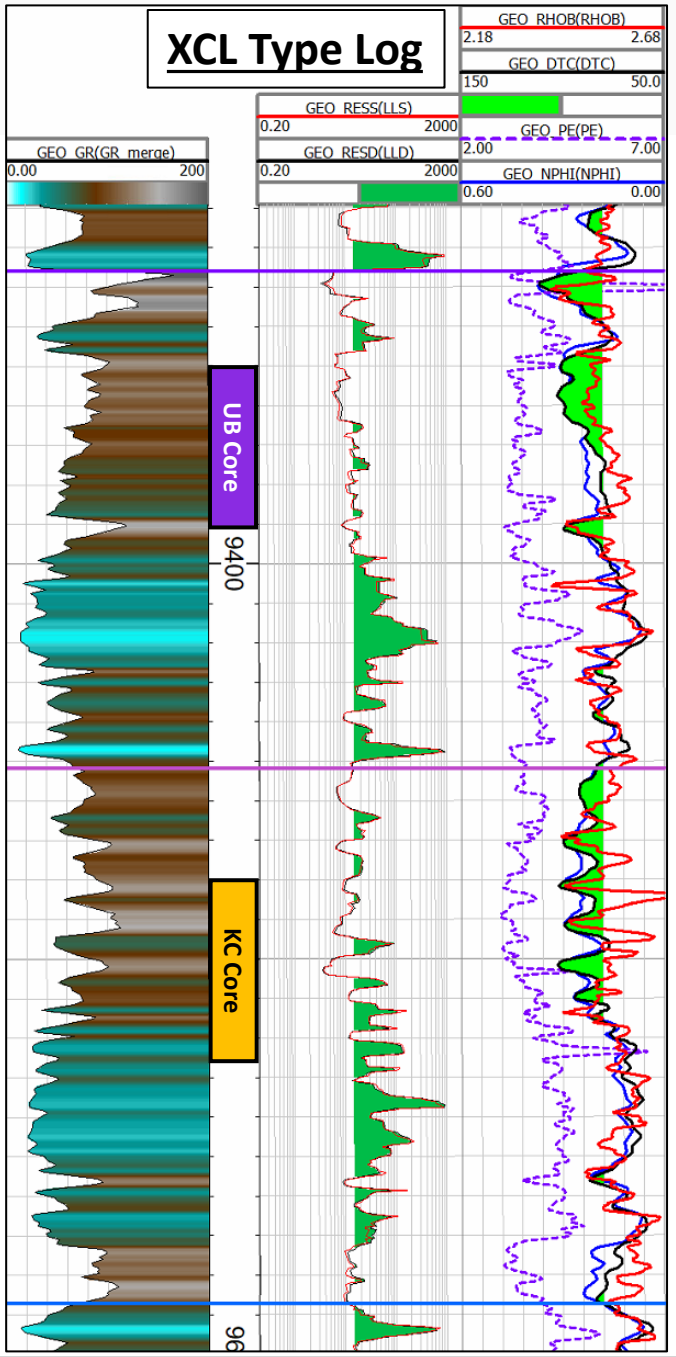
Core Comparison

Contrast-Enhanced Photos of the Twins

UTELAND BUTTE
Contrast & Brightness Increased 40%

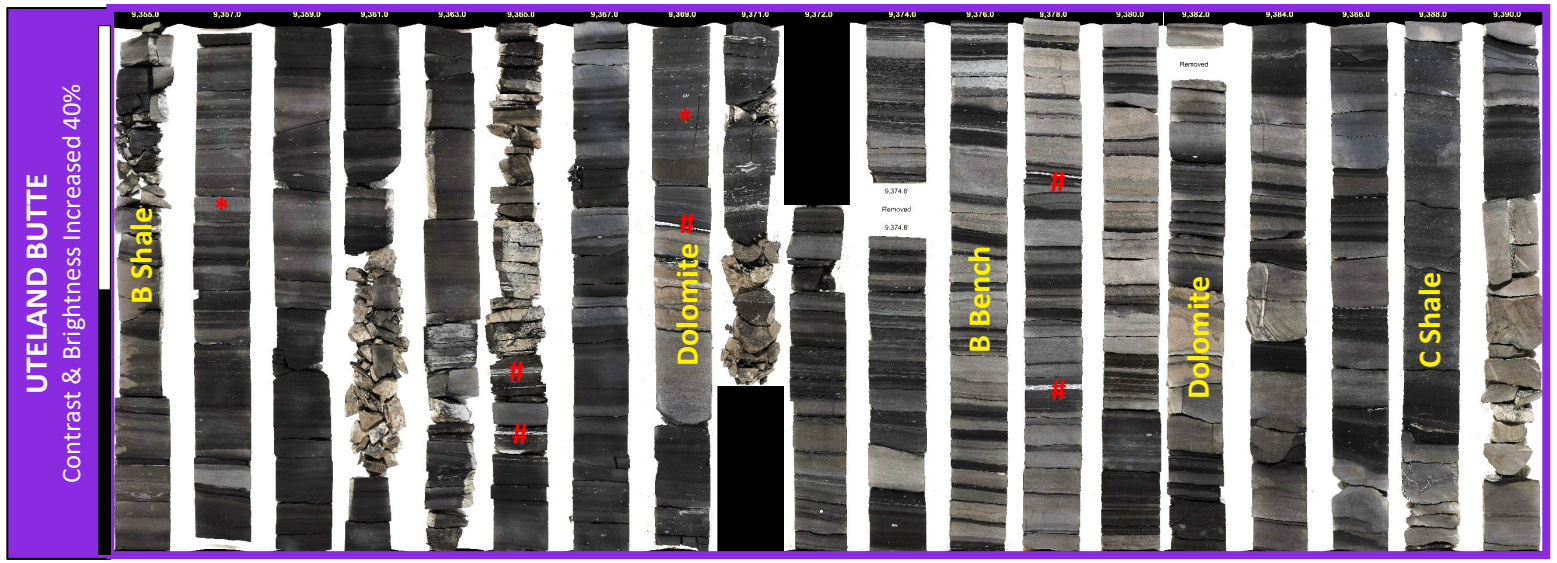


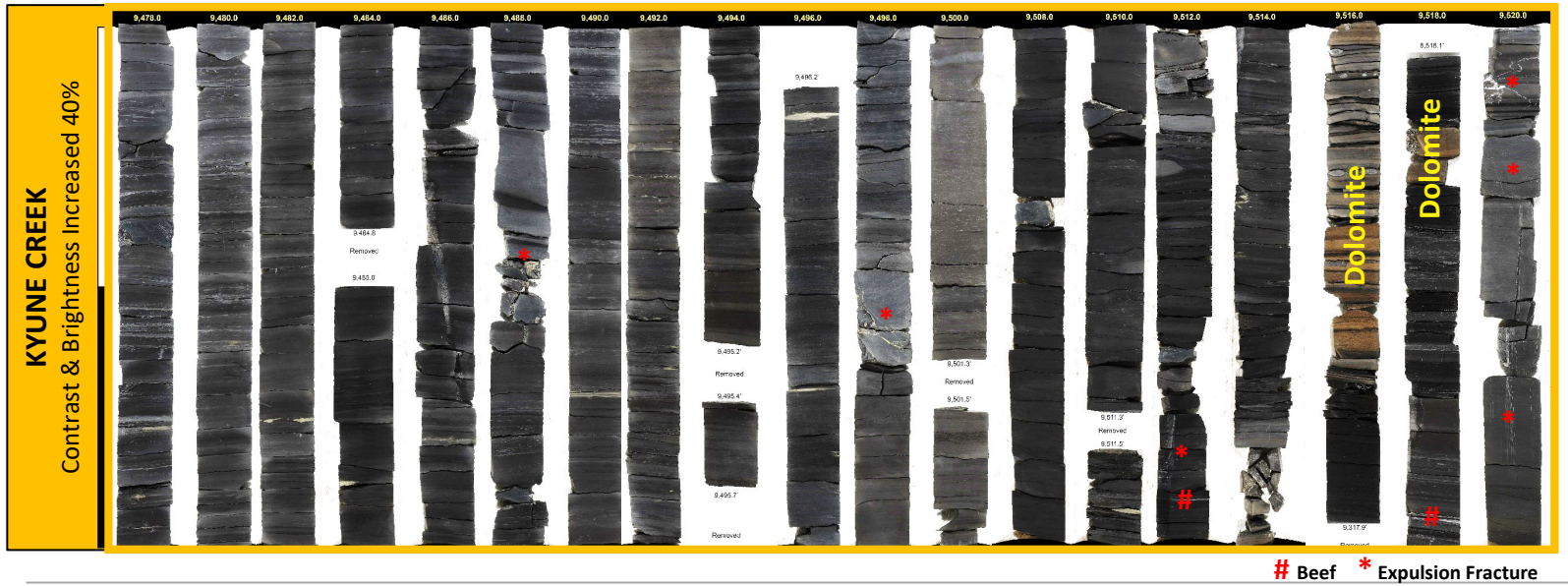
KYUNE CREEK
Contrast & Brightness Increased 40%



Core Characteristics and EODs

Comparing Two Deep Lacustrine Cycles





Beef * Expulsion Fracture

Characteristic	XCL UB B	XCL KC
Dolomite Thickness	<1’	1 – 2’
Beef & Expulsion Fractures	Common	Common
Color	Dk gray to black, dk brown	Dk gray to black, dk brown
Fossils	Common bivalves, pelecypods, turritella	Minor bivalves, pelecypods, turritella
Depositonal Environment	Sublittoral to profundal	Subittoral to profundal

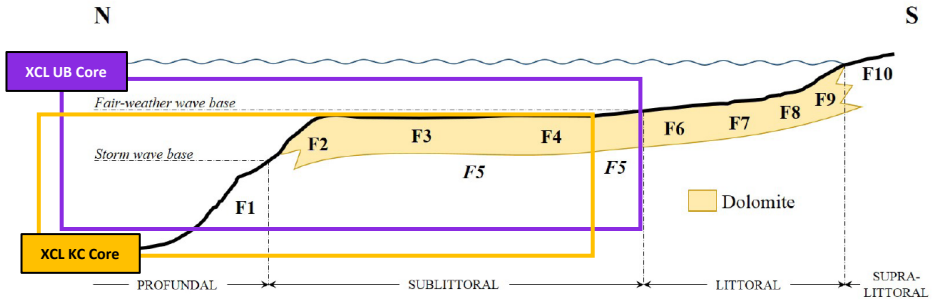
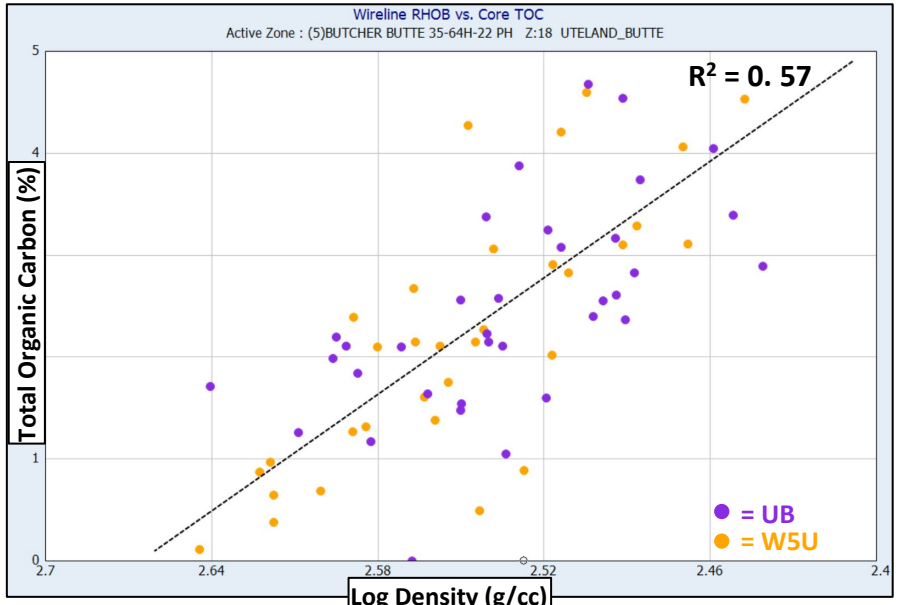
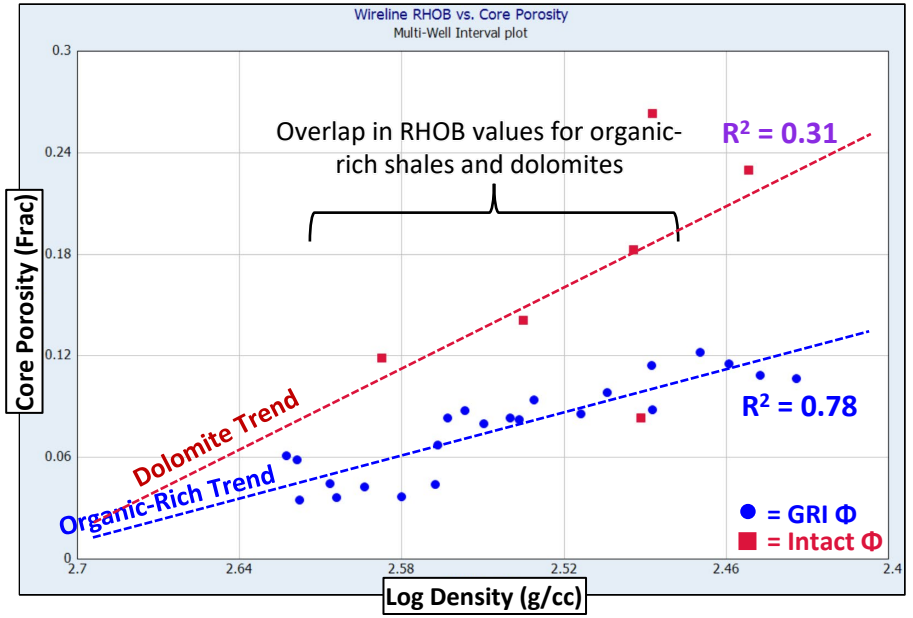


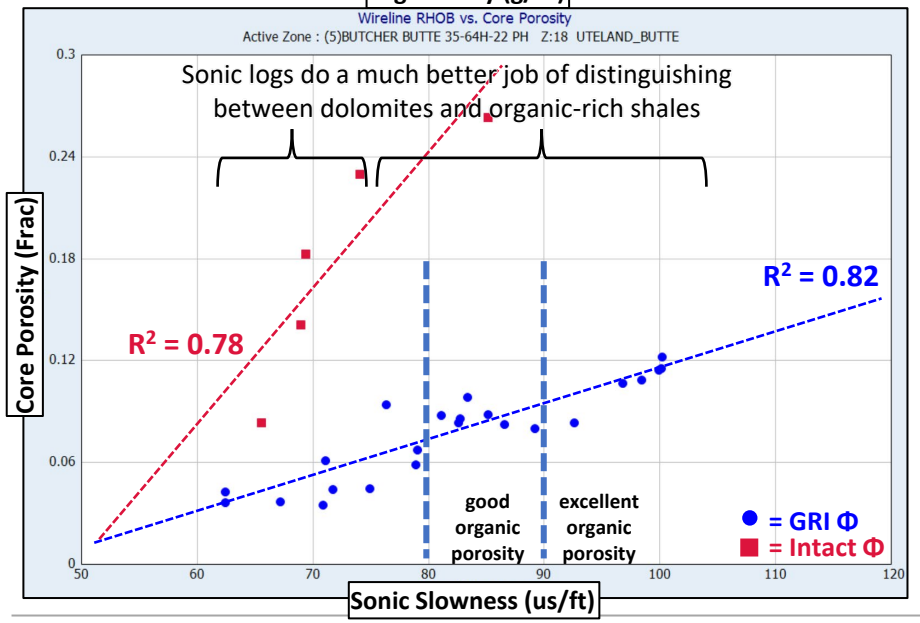
Figure 4.16. Schematic representation of facies distribution and dolomitization. F5 was not dolomitized.

Modified from Rueda Chaparro 2019

Core & Log Data Relationships



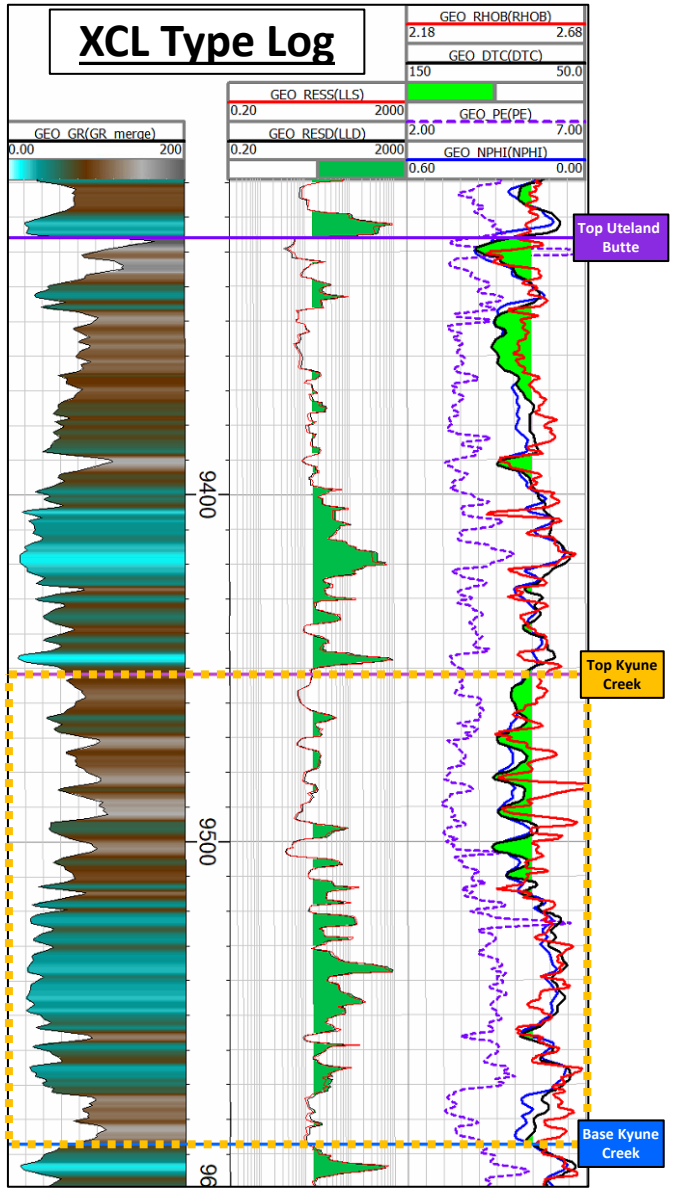


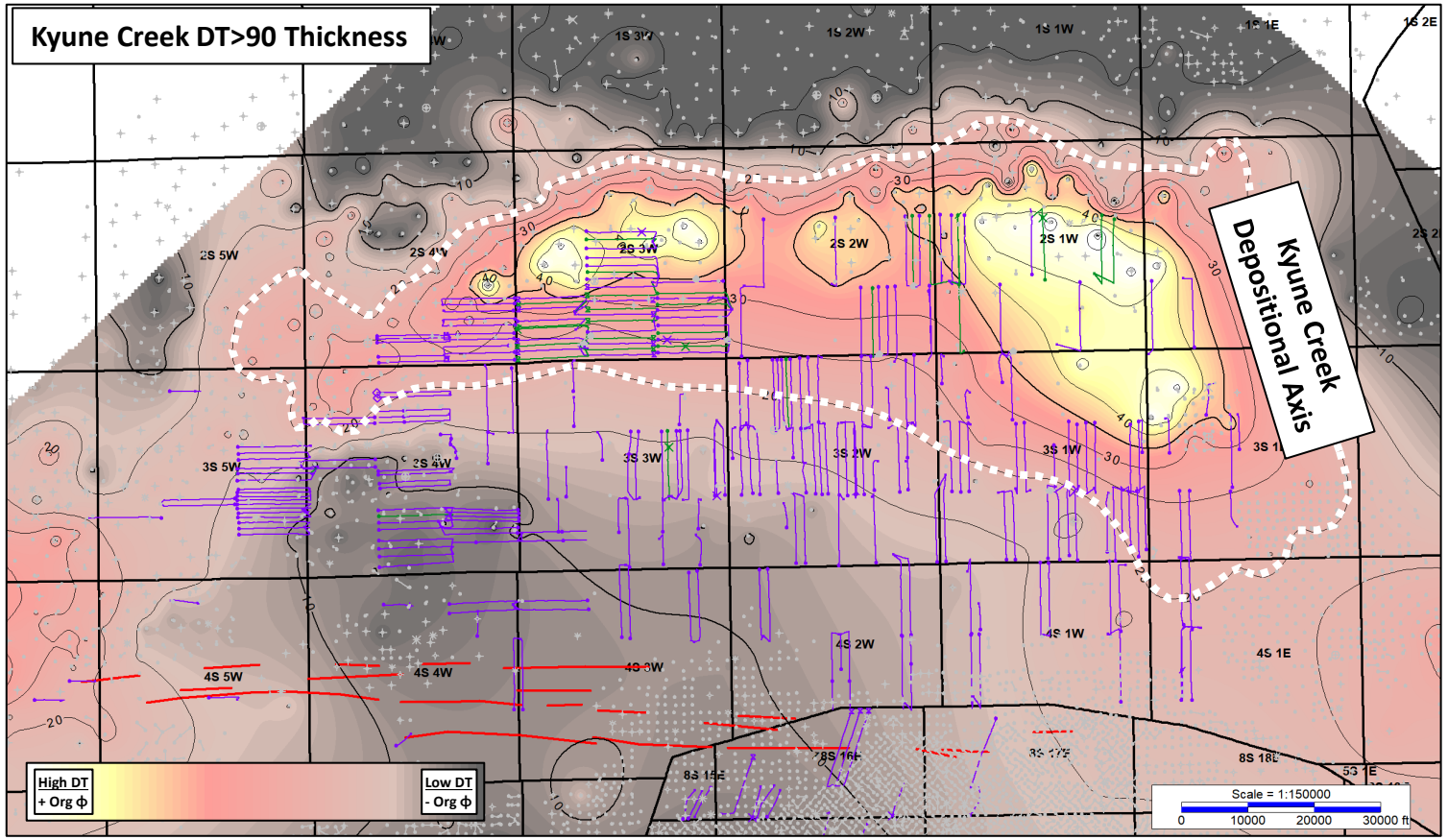


- Fidler et al (2022) documented a strong correlation between wireline RHOB, DT and core TOC in the UB, adding KC data onto the plots strengthens the link
- Wireline RHOB has an excellent relationship to TOC but is also influenced by both dolomite intergranular porosity; Sonic is less sensitive to stiff dolomites
- Sonic looks to be an effective tool for mapping the distribution of organo-porosity in the Kyune Creek

Kyune Creek Sonic Mapping

Widespread Lacustrine Deposition Preceding the Uteland Butte

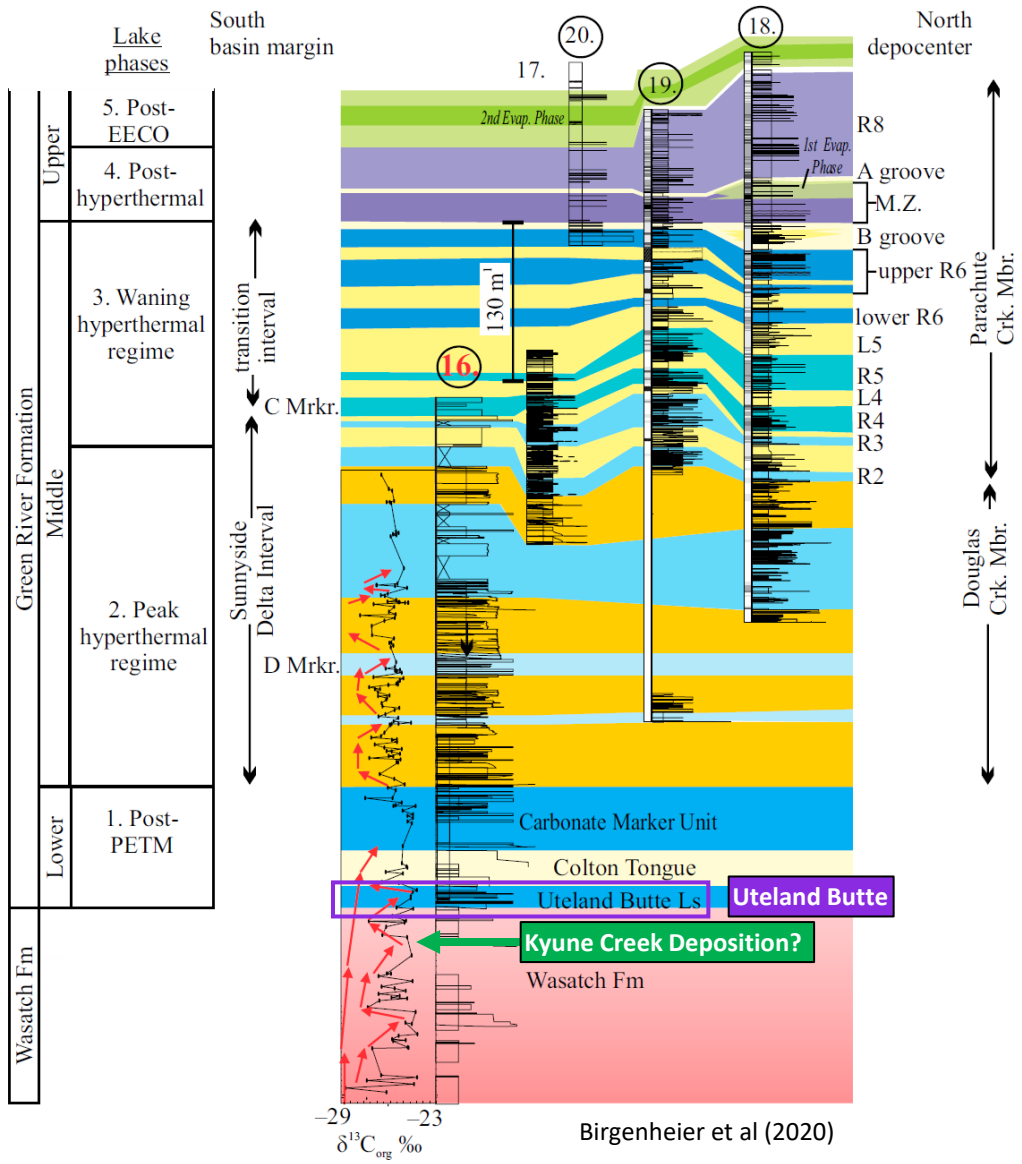




- Kyune Creek depositional trends identical to the Uteland Butte in the deep basin
- Deepest profundal depositional axis is directly south of the Wasatch Wedge
- Limited organic content also apparent in 3S/4W and 4S/4W
- **Suggests KC had a more limited deep lacustrine phase than UB**

Eocene Climate Implications

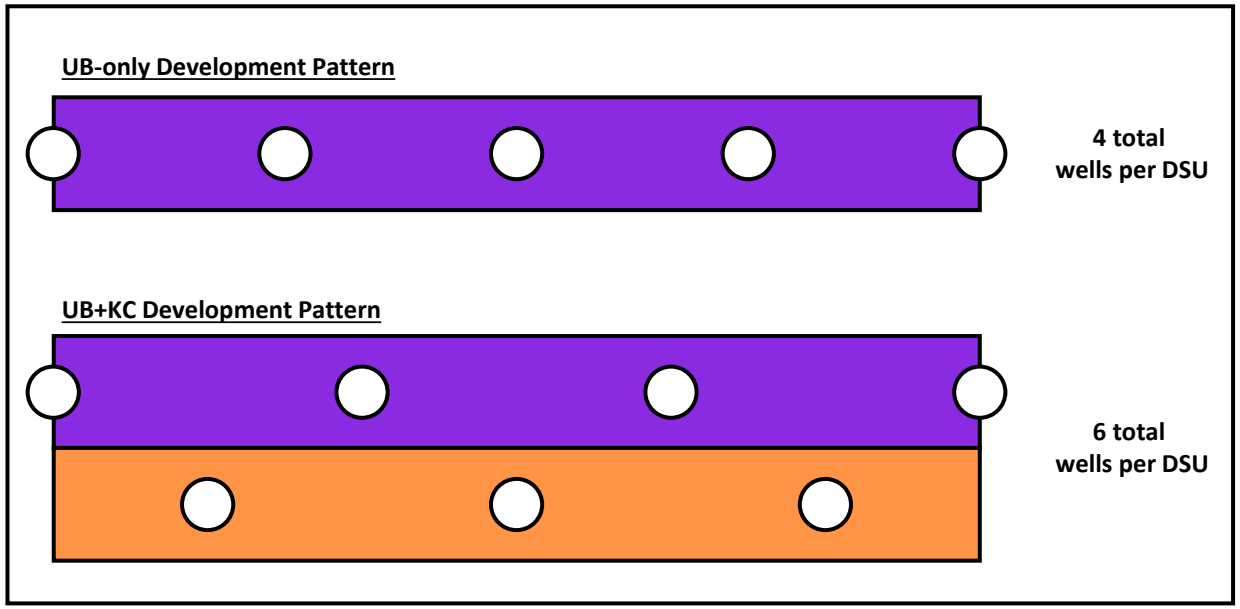
- Kyune Creek mapping and core evaluation confirms findings of Gall et al (2022), Fidler etal (2023), and others that document widespread lacustrine deposition during the latest Wasatch
- Clear evidence that the transition from PETM to post-PETM recovery phase was transitional
- Our findings are in line with $\delta 13C_{org}$ data presented by Birgenheier et al (2020) from Hay Canyon and may record a carbonate depositional phase associated with latest Wasatch positive $\delta 13C_{org}$ shifts

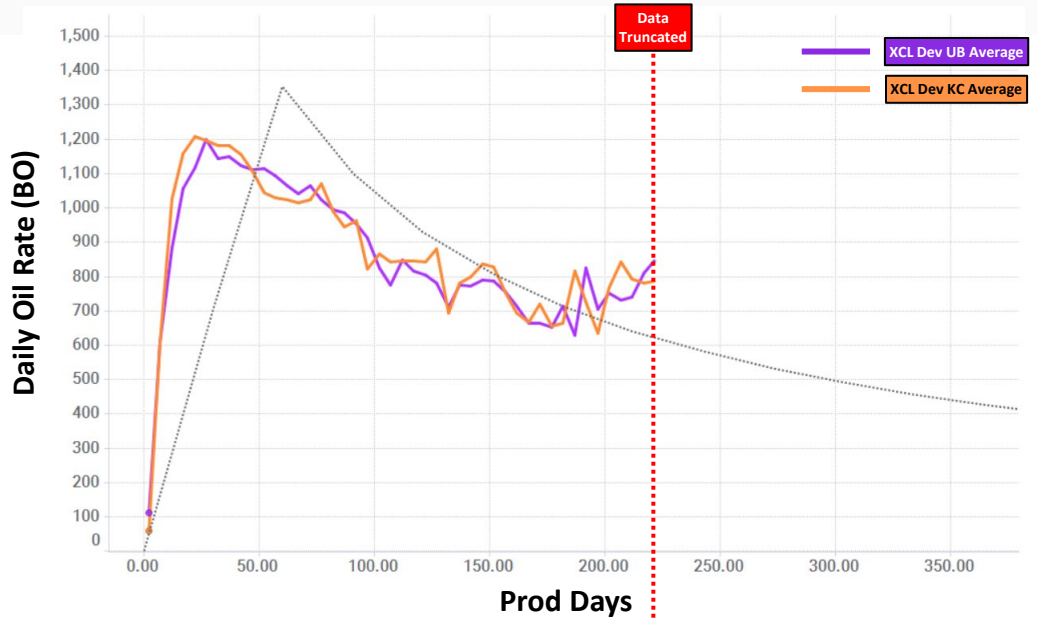


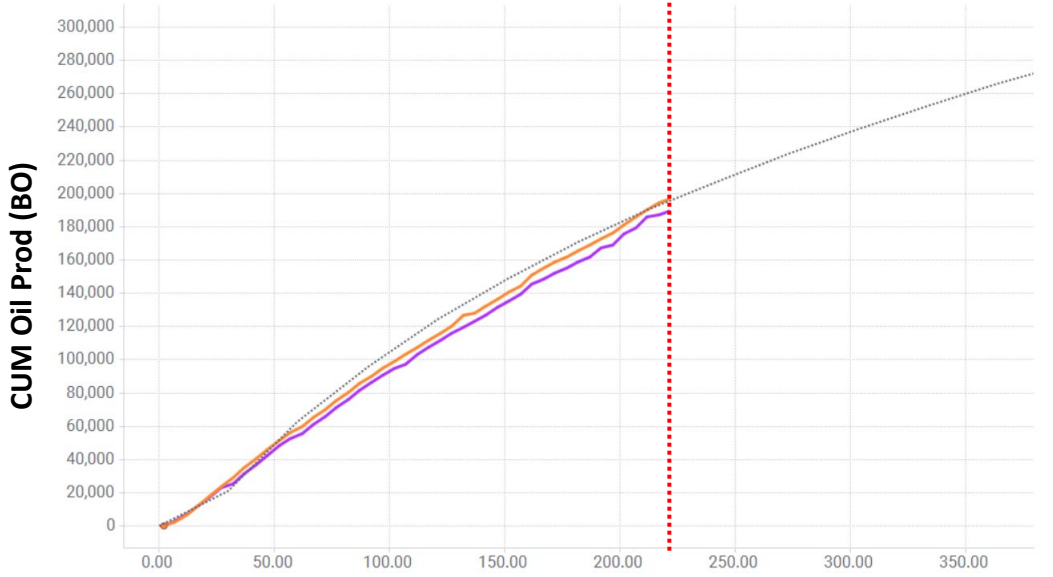
Development Impact of Kyune Creek Delineation

Finding AND Developing the Kyune Creek Resource

- Since 2019 XCL planned, tested and implemented a wine-rack development pattern between the UB and KC
- As part of XCL cube development drilling we have 9 UB and 7 KC horizontals with over 180 days of production – Both intervals hitting type curves
- Wine-rack development of the UB and KC has increased XCL's inventory of UB equivalent wells by 50% with no impact to well EUR
- Potential to push spacing tighter in future cubes to further increase returns

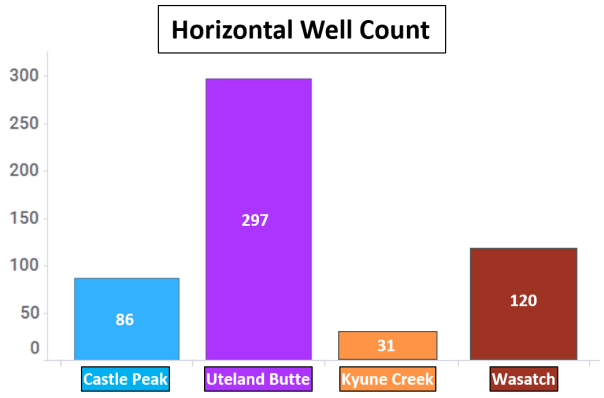


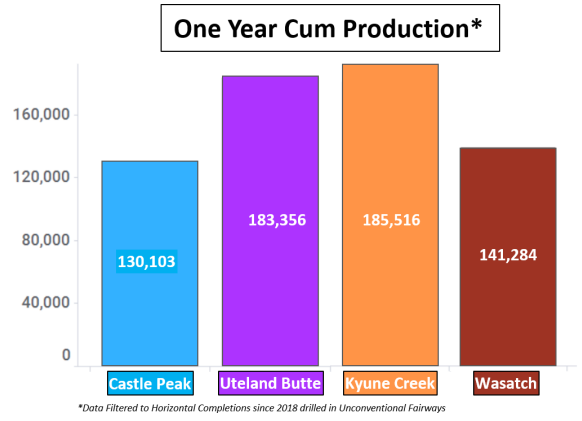


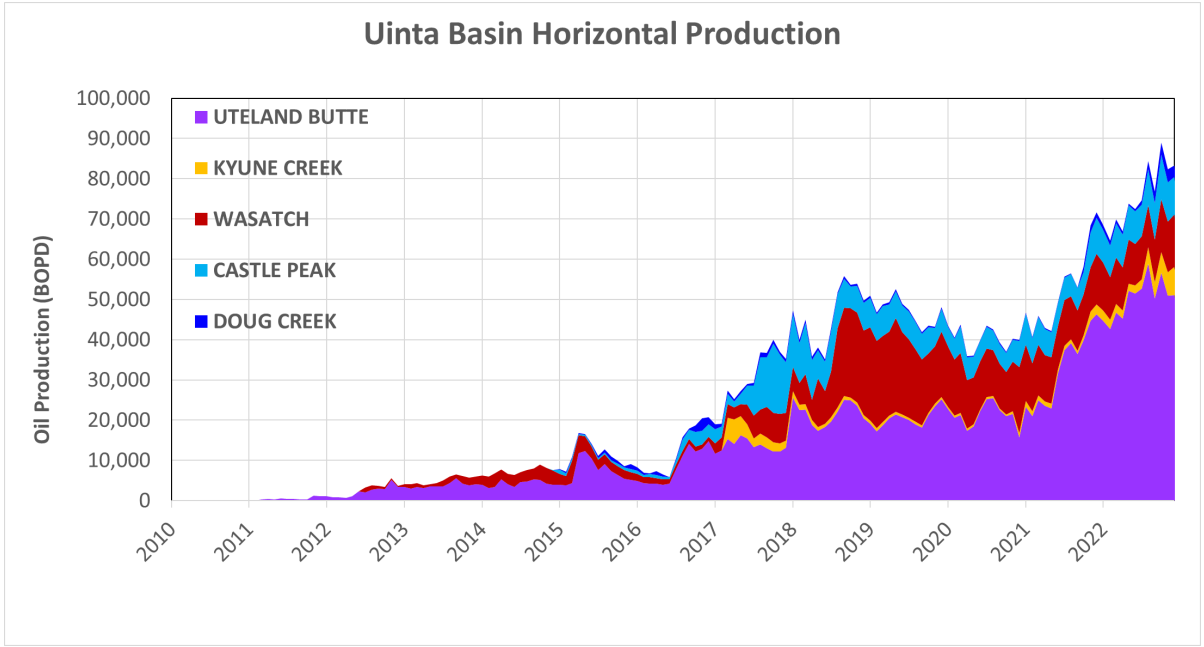


Conclusions

- Kyune Creek represents a type locality for a mappable lacustrine package that is deposited throughout the subsurface of the deep Uinta Basin
- Sonic mapping is a reliable tool for mapping lacustrine organo-porosity in Kyune Creek and generally within the Uinta Basin
- Logs, Core and well results confirm that the Kyune Creek interval is a highly productive oil-bearing zone in the deepest parts of the Uinta Basin
- Wine-rack development of the Kyune Creek with the Uteland Butte yields premium well results that add significant return to XCL development projects







Acknowledgments

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Mike Vanden Berg

UGS Staff

Riley Brinkerhoff

References

Birgenheier, L.P., Vanden Berg, M.D., Plink-Björklund, P., Gall, R.D., Rosencrans, E., Rosenberg, M.J., Toms, L.C., and Morris, J., 2019, Climate impact on fluvial-lake system evolution, Eocene Green River Formation, Uinta Basin, Utah, USA: GSA Bulletin, v. 132, no. 3-4, p. 562–587.

Bradley, W. H., 1931, Origin and microfossils of the oil shale of the Green River Formation of Colorado and Utah: US Government Printing Office, Professional Paper 168.

Brinkerhoff, R., and Millard, M., 2019, Using pore system characterization to subdivide the burgeoning Uteland Butte play, Green River Formation, Uinta Basin, Utah: AAPG Rocky Mountain Section Meeting, Denver, Colorado, doi: 10.1306/11272 Brinkerhoff2019.

Chidsey, T.C., 2010, Major Oil Plays in Utah and Vicinity, Utah Geological Survey – Survey Notes, Vol. 42, Number 1

Gall, R.D., Birdwell, J.E., Brinkerhoff, R., Vanden Berg, M.D., 2022, Geologic Characterization and Depositional History of the Uteland Butte Member, Green River Formation, Southwestern Uinta Basin, Utah in Vanden Berg, M.D., Brinkerhoff, R., Birdwell, J.E., Jagniecki, E.A., Birgenheier, L.P., editors, The Lacustrine Green River Formation: Hydrocarbon Potential and Eocene Climate Record, Utah Geological Association no. 50, p.28-54

Rueda Chapparro, F., Machel, H.G., and Vanden Berg, M.D., 2019, Dolomitization in the Uteland Butte Member of the Eocene Green River Formation, Uinta Basin, Utah: Utah Geological Survey Open-File Report 700,

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