Optimizing Lateral Placement and Production While Minimizing Completion Costs: an Eagle Ford Case Study*

Rick Schrynemeeckers[1]

Search and Discovery Article #42030 (2017)**
Posted March 13, 2017

*Adapted from oral presentation given at 2016 AAPG Pacific Section and Rocky Mountain Section Joint Meeting, Las Vegas, Nevada, October 2-5, 2016

[1]Amplified Geochemical Imaging, The Woodlands, TX, USA (Schrynemeeckers@AGIsurveys.net)

Abstract

Shale plays are an extremely difficult arena in which to explore. Lack of heterogeneity is not the only problem. The Eagle Ford play, for example, has numerous hydrocarbon sources and multiple stacked zones, which result in mixed drilling success. Conventional logging technologies provide important information during drilling as to the presence of hydrocarbons. However, these logging technologies do not measure hydrocarbons directly, but rather measure hydrocarbon proxies and infer hydrocarbon presence and phase based on this data. These technologies, while sophisticated, can lack specificity and sensitivity when trying to accurately identify hydrocarbons. This case study shows how Downhole Geochemical Logging was used to create a granular hydrocarbon profile throughout the well. This enabled identification of optimum selection for placement of the horizontal well. Additionally, cutting analysis from the lateral well enabled identification of lateral sweet spots containing higher porosity and hydrocarbon intensity. The data was also able to aid the client in determining the optimum number of fracture stages required for the lateral well resulting in a potential savings of approximately $600,000 while maintaining similar production.

In the lateral well, the data helped to:

- Improve production by focusing lateral placement in hydrocarbon & porosity rich zones
- Reduce completion costs by optimizing the number of fracing stages
- Identify when drilling efforts were in or out of the target formation

In the vertical well, the data helped to:

- Clearly distinguish between various hydrocarbon phases (i.e. gas, condensate, or oil)
- Infer separate sources in the San Miguel, Austin Chalk, and Lower Eagle Ford Fms
- Identify by-passed pay
- Infer seals at the top of the Anacacho Fm and Eagle Ford Fm
- Infer there was no seal between the San Miguel Fm and the Olmos Fm

- Infer there was no seal throughout the Eagle Ford, Buda, and Del Rio Fms

Selected References

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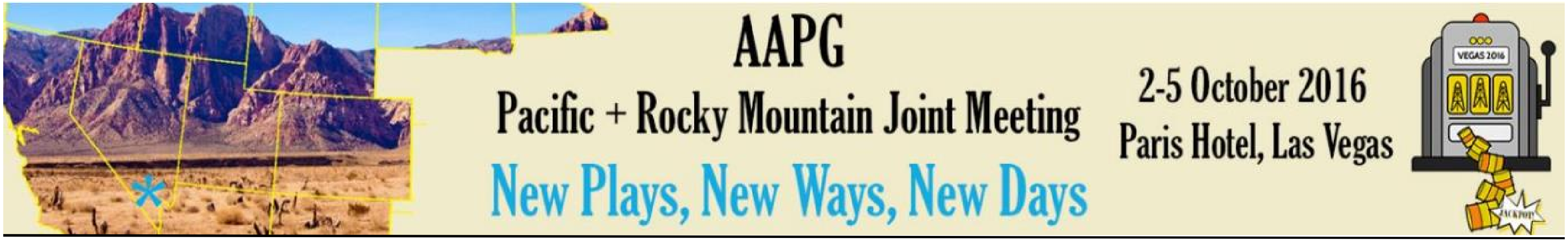
Snedden, J.W., and R.S. Jumper, 1990, Shelf and shoreface reservoirs, Tom Walsh–Owen field, Texas: in Barwis, J.H., McPherson, J.G., and Studlick, R.J., eds., Sandstone petroleum reservoirs: New York, Springer-Verlag, p. 415–436.

Snedden, J.W., and D.G. Kersey, 1982, Depositional environments and gas production trends, Olmos Sandstone, Upper Cretaceous, Webb County, Texas: Gulf Coast Association of Geological Societies Transactions, v. 32, p. 497–518.

Tyler, N., and W.A. Ambrose, 1986, Depositional systems and oil and gas plays in the Cretaceous Olmos Formation, south Texas: Austin, Tex., University of Texas, Bureau of Economic Geology Report of Investigations No. 152, 42 p.



Optimizing lateral placement and production while minimizing completion costs: an Eagle Ford case study

by Rick Schrynemeeckers
Schrynemeeckers @AGI surveys.net

Downhole Geochemical Logging

ÅCuttings are collected in polypropylene jars, directly from the shaker table during drilling

ÅMud blanks are also collected as well

ÅAnalyses normally done in 2 weeks

1,000 time more sensitive than traditional methods

Focuses on hydrocarbon fluids in various zones

Å Measures from the C_2 to C_{20} carbon range

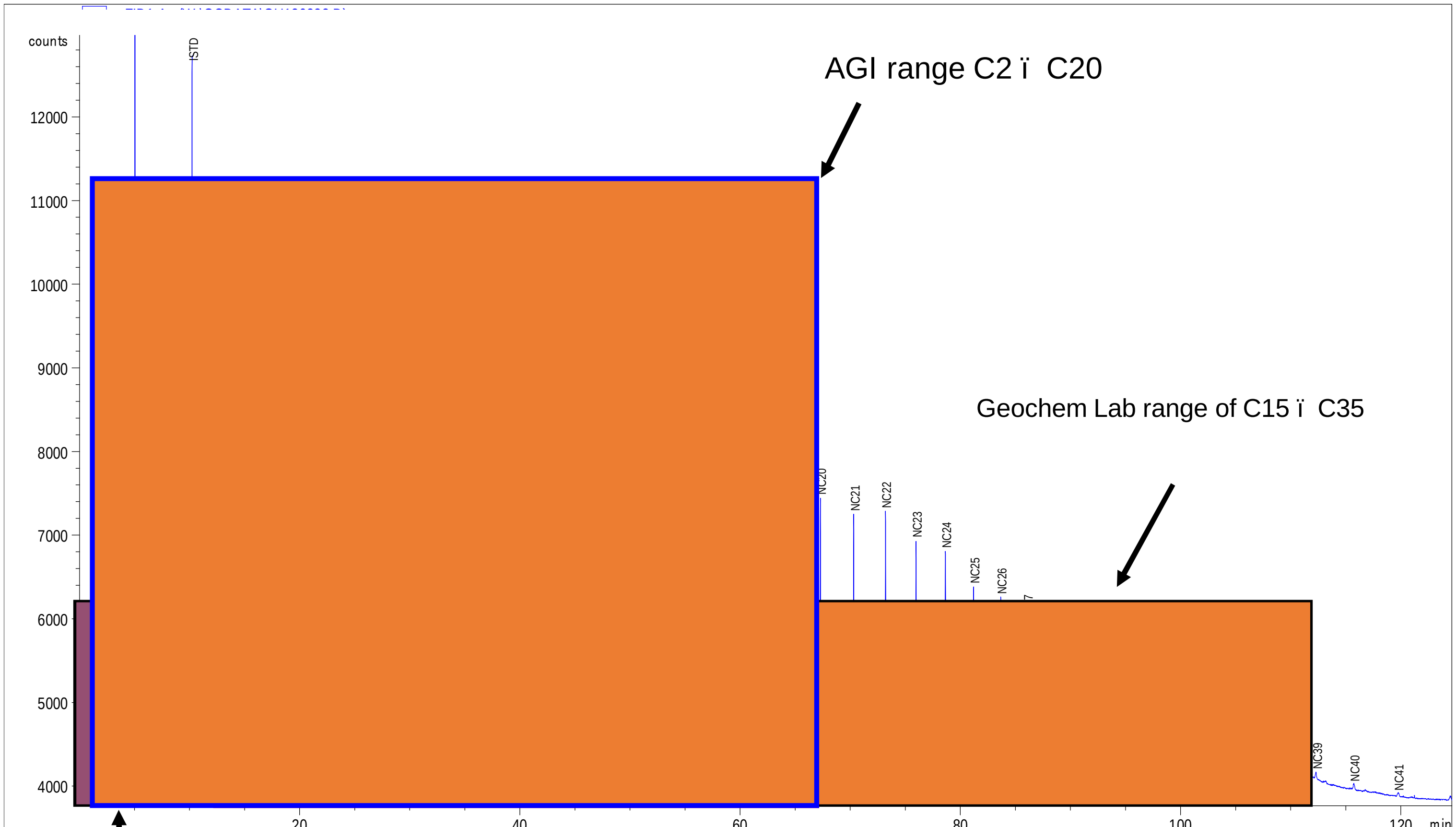
Å Easily differentiates between multiple phases

Å Identifies reservoir compartmentalization

Å Identify by-passed pays

Does this work with all drilling muds?
> ***No – Not with Diesel-based muds***

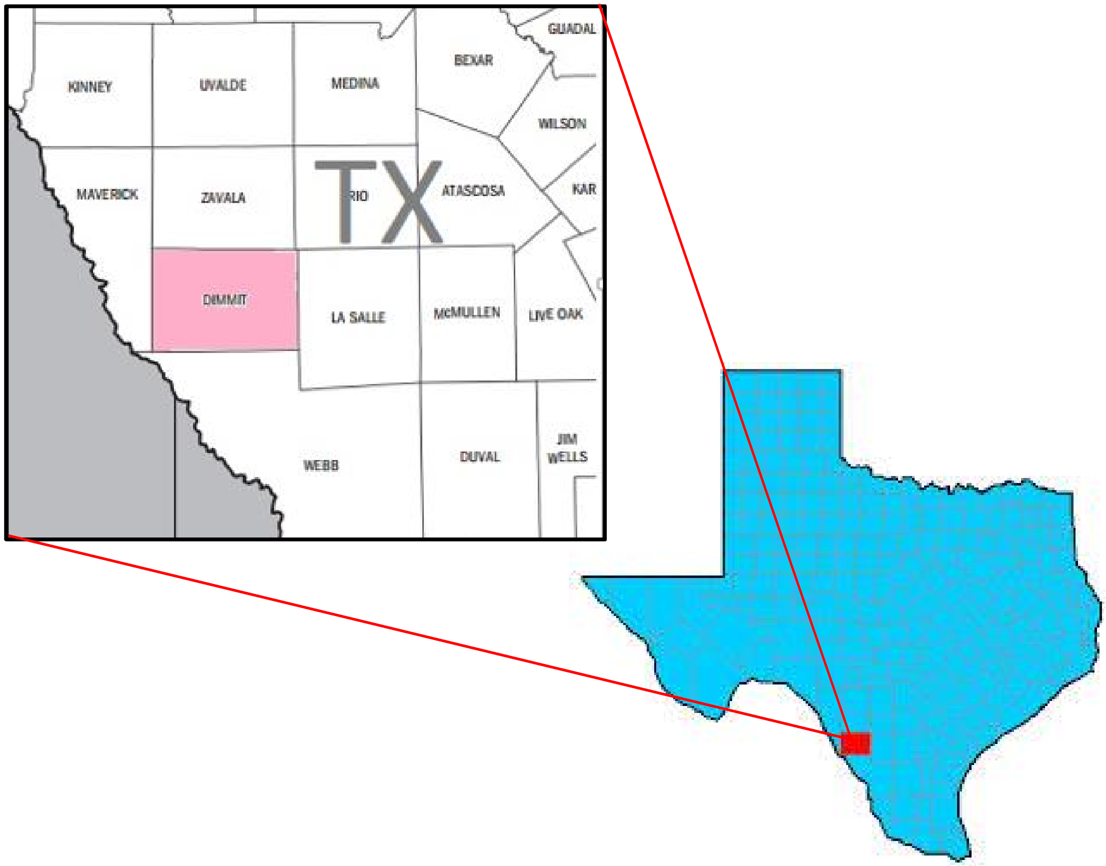
Conventional Hydrocarbon Analyses



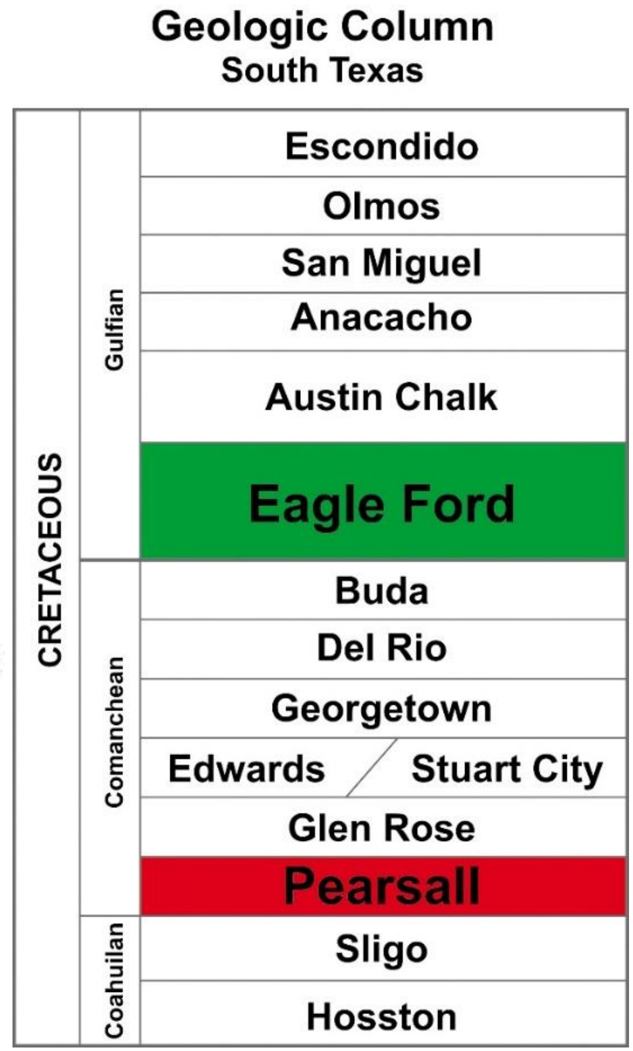
Traditional gas range of C1 ï C5

An Eagle Ford Case Study

Location & Stratigraphic Information

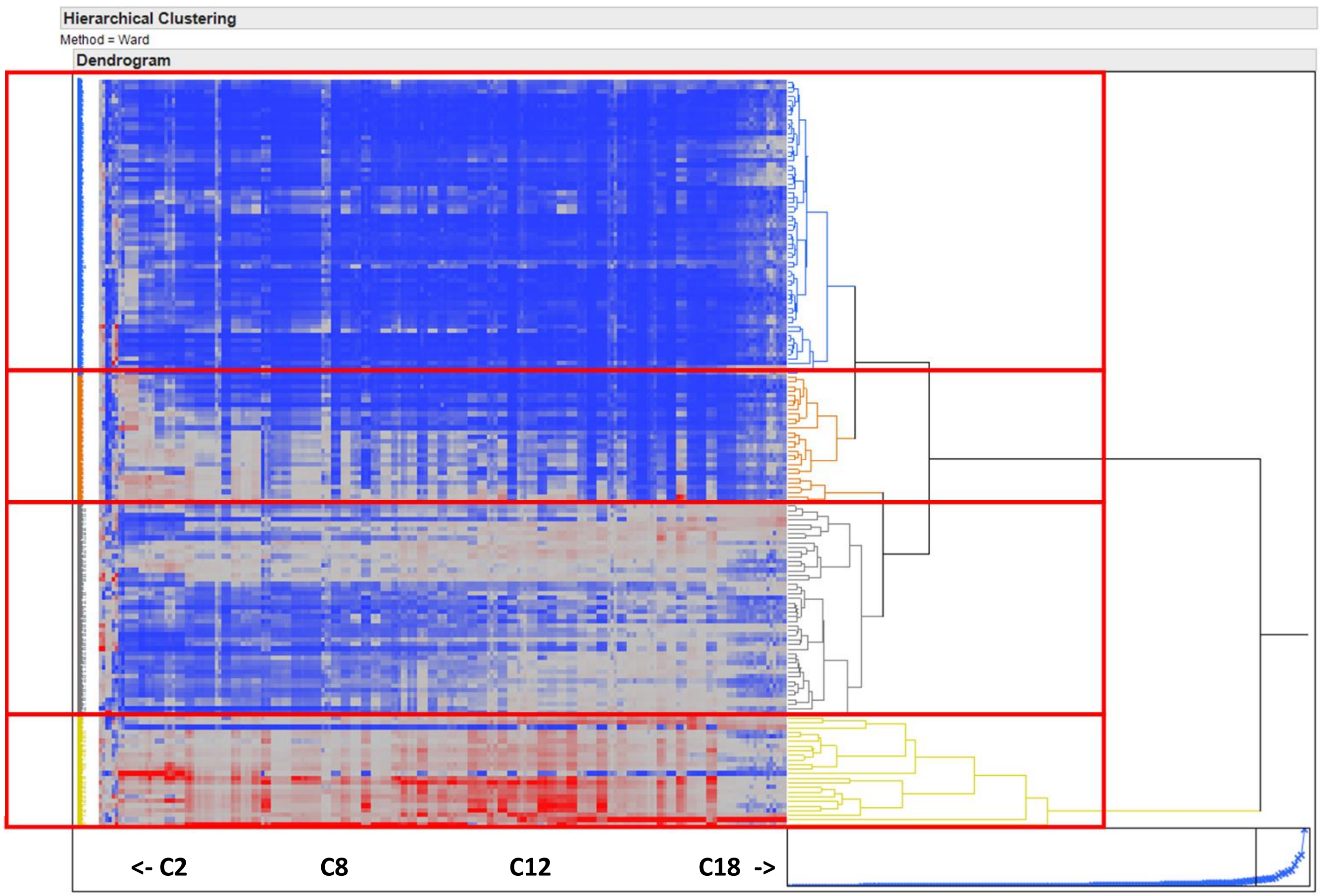


The Maverick Basin in Dimmit County



Hierarchical Cluster Analysis

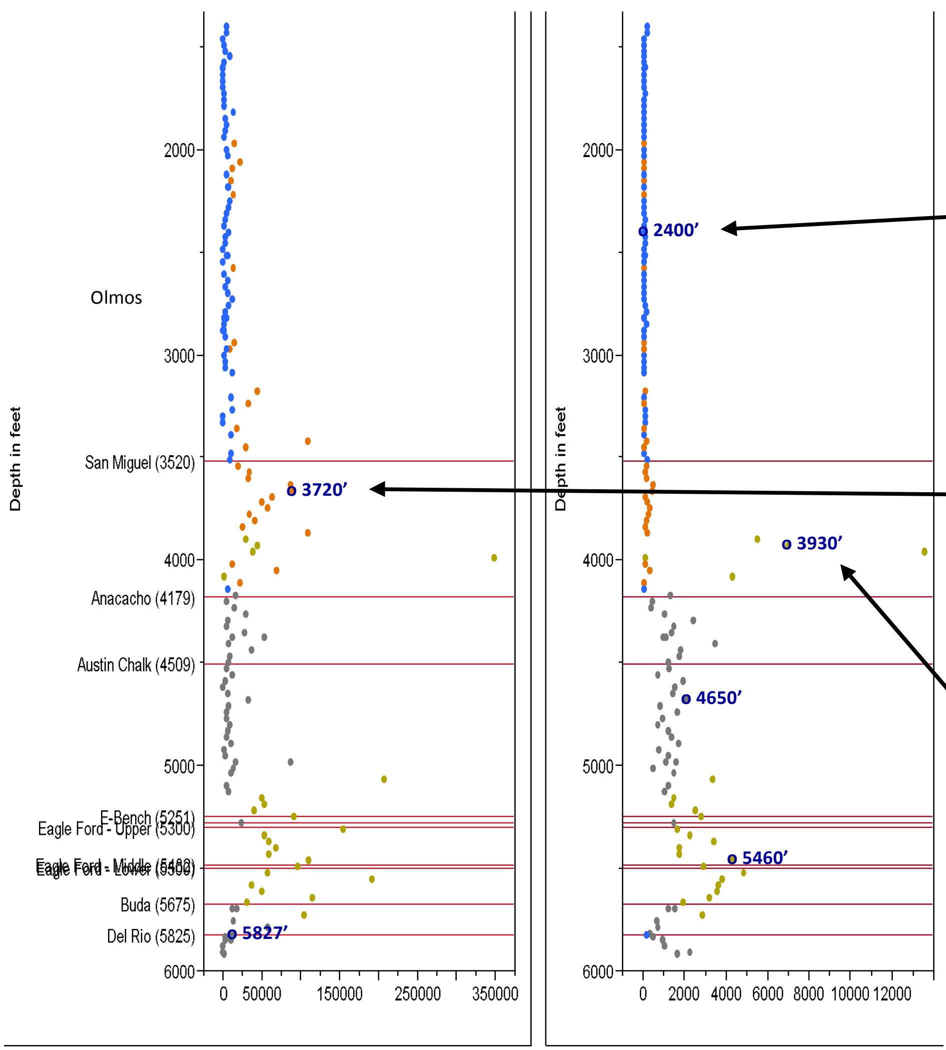
HCA #1 Groups



It is thought that there are three main sources of oil and gas in the assessed formations: Upper Jurassic Smackover Formation and Upper Cretaceous Austin and Eagle Ford Groups. Oils thought to have a Smackover source are mainly found in the far western part of the study area, and oils thought to have an Eagle Ford or Austin source are located in the north-central part; oils having a mixed Smackoverï Austinï Eagle Ford origin are produced in the central part of the Maverick Basin (M.D. Lewan, written commun., 2003; S.M. Condon and T.S. Dyman, 2003).

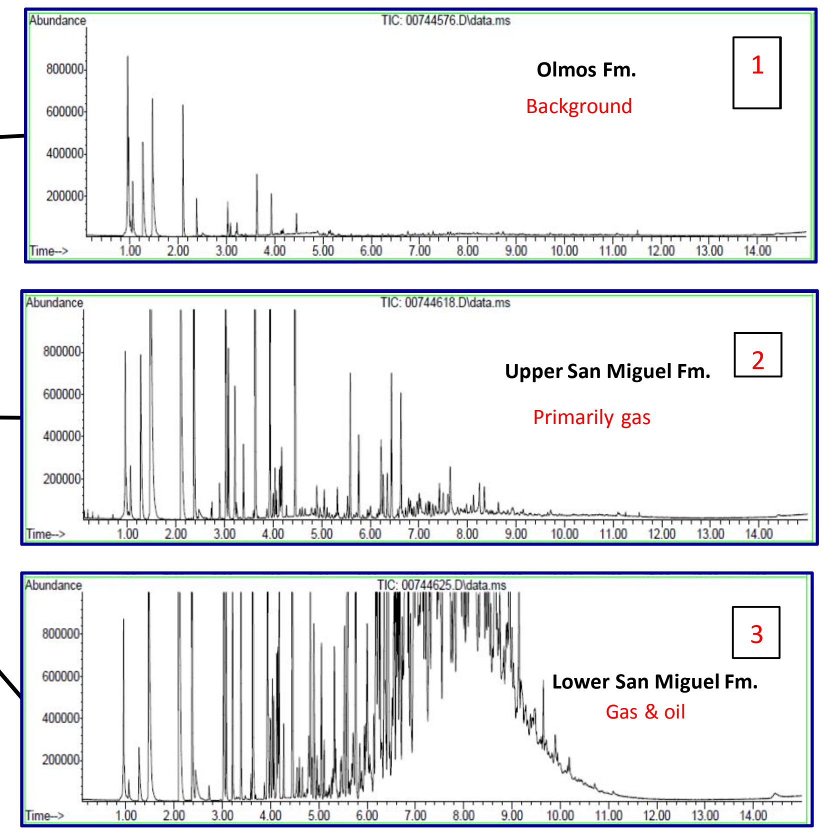
Depth Profile with Fingerprints

Select signatures from various zones showing different hydrocarbon signatures and differing intensities.



Gas Range Sum C2 – C6

Oil Range Sum C10 – C18

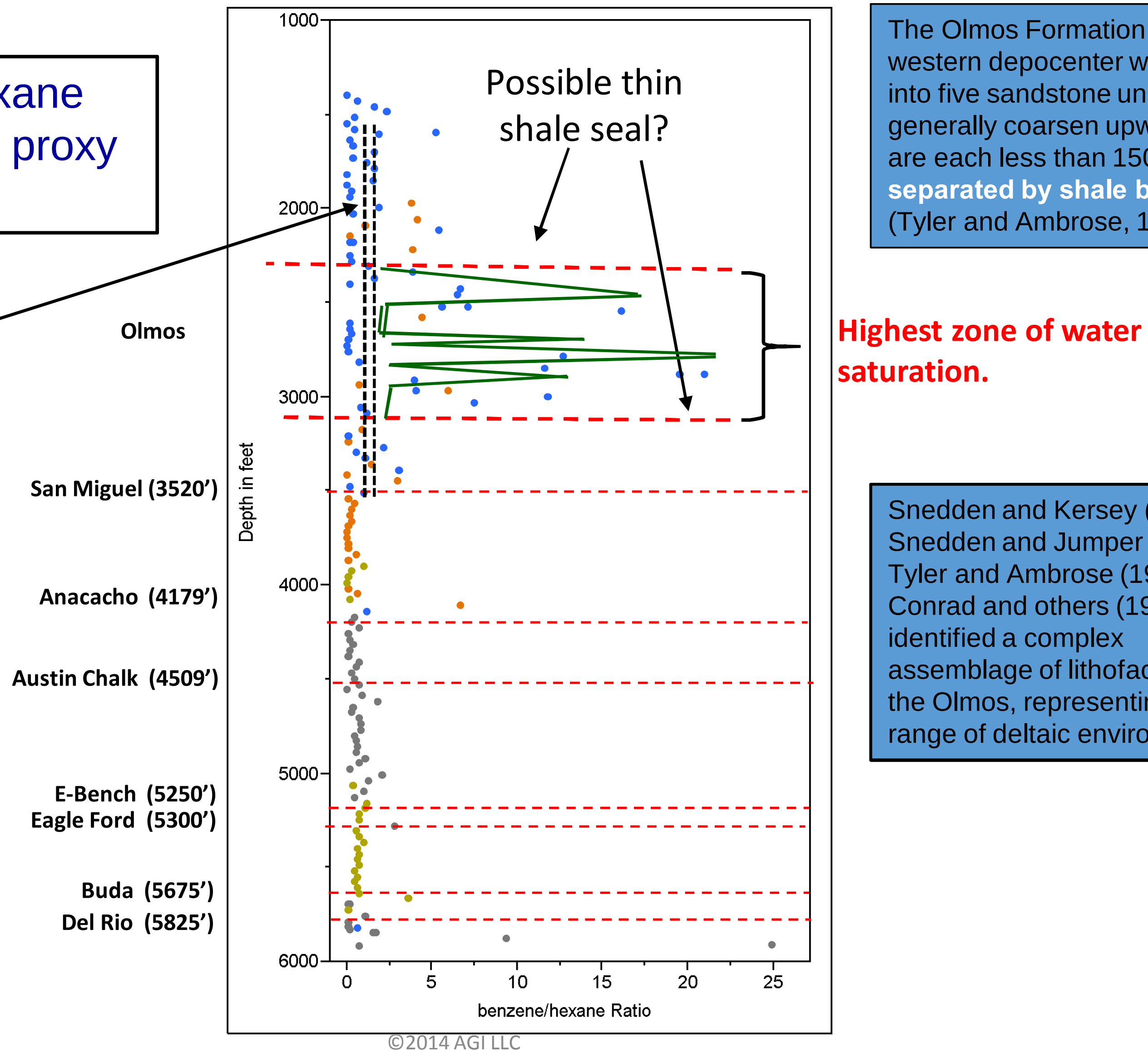


Much of the original porosity of the San Miguel sandstone beds was occluded by kaolinite or calcite cement (Jacka, 1982). Two periods of calcite dissolution created secondary porosity, which was subsequently partly filled by late-stage cements.

Water Saturation Plot

The Benzene/Hexane ratio can be a Sw proxy at times.

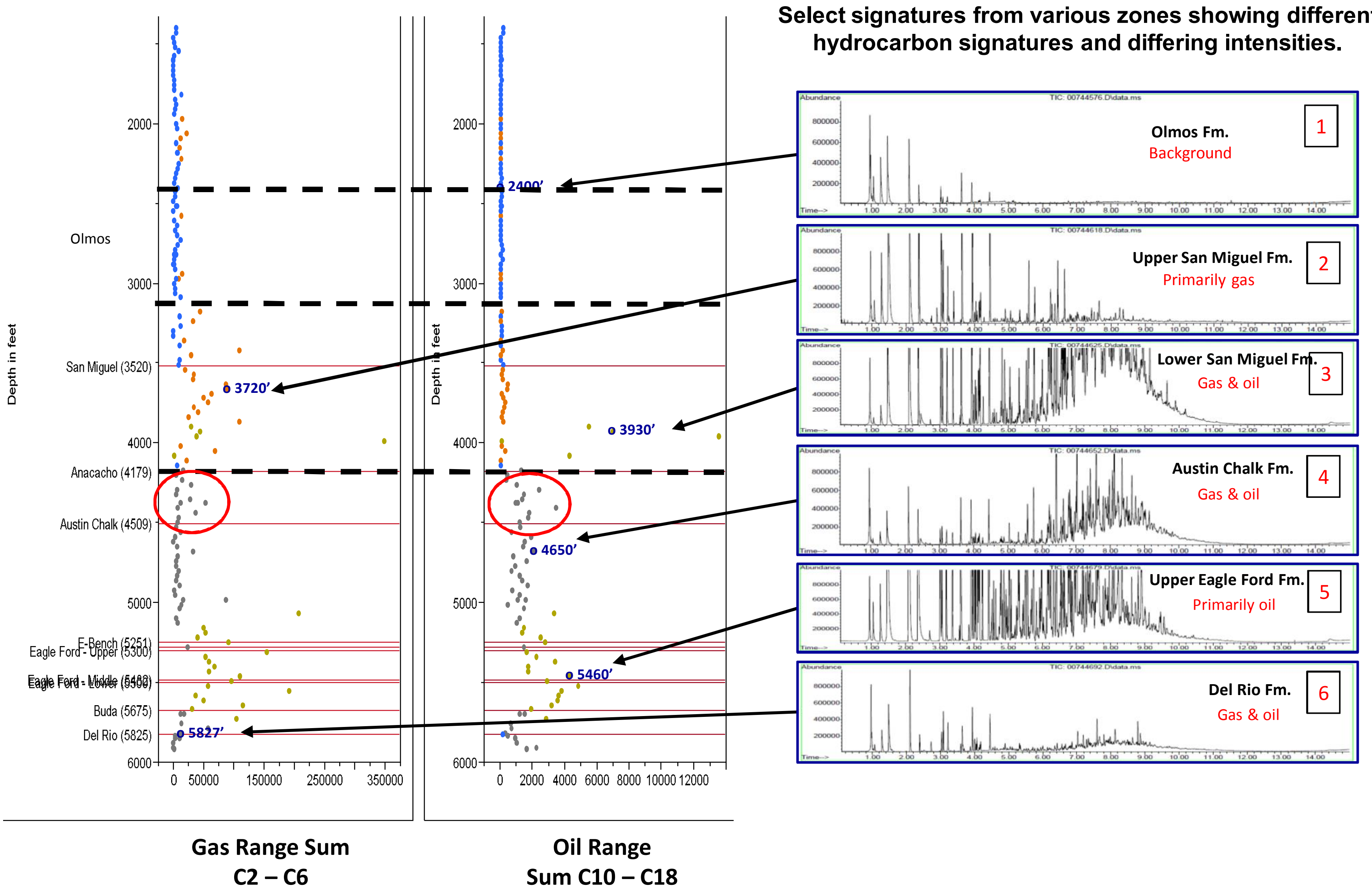
Depth plot of Benzene/Hexane (nC6)



The Olmos Formation in the western depocenter was divided into five sandstone units, which generally coarsen upward and are each less than 150 ft thick, **separated by shale breaks** (Tyler and Ambrose, 1986).

Snedden and Kersey (1982), Snedden and Jumper (1990), Tyler and Ambrose (1986), and Conrad and others (1990) identified a complex assemblage of lithofacies within the Olmos, representing a range of deltaic environments.

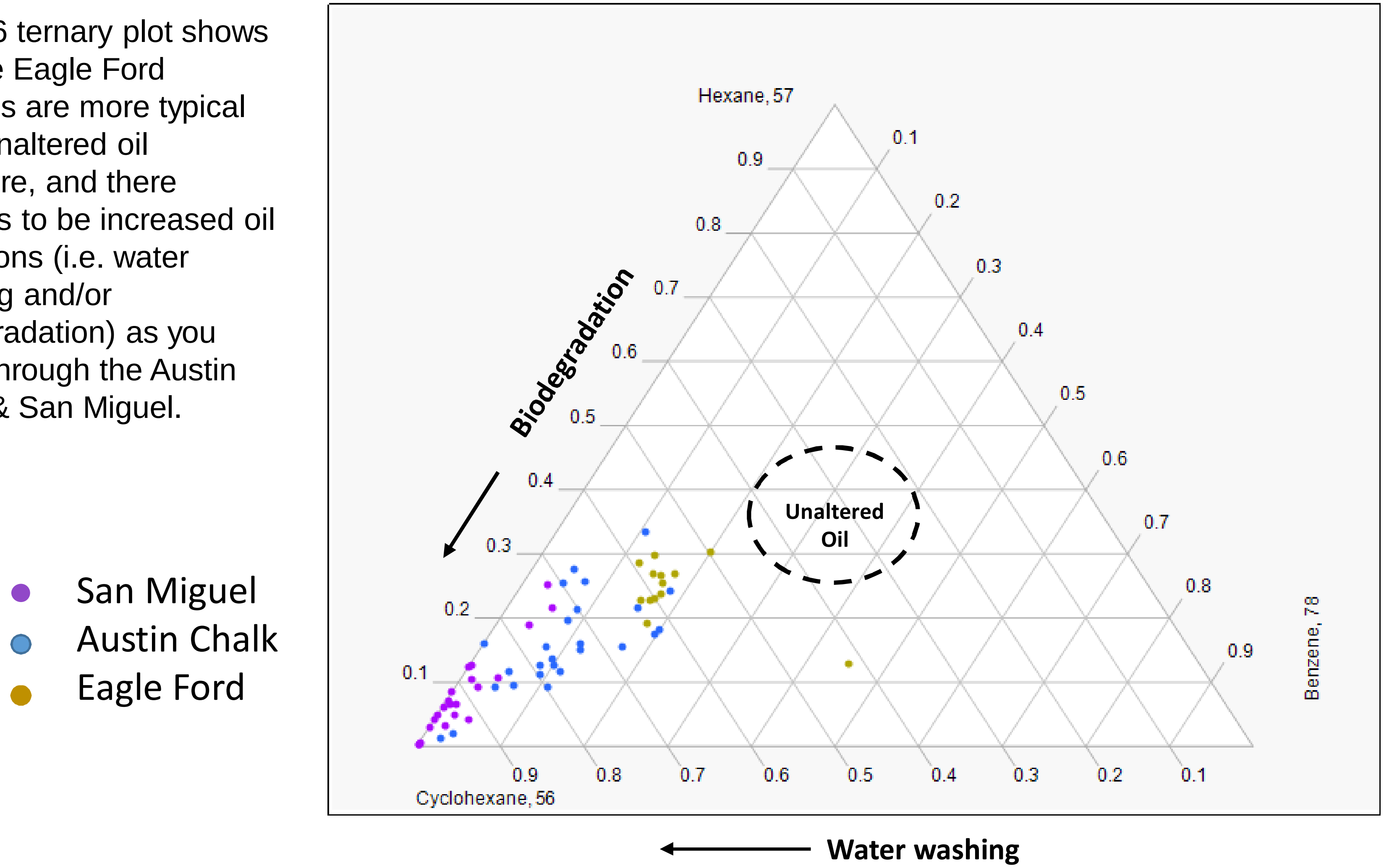
Depth Profile with Fingerprints



Oil Alteration Plot

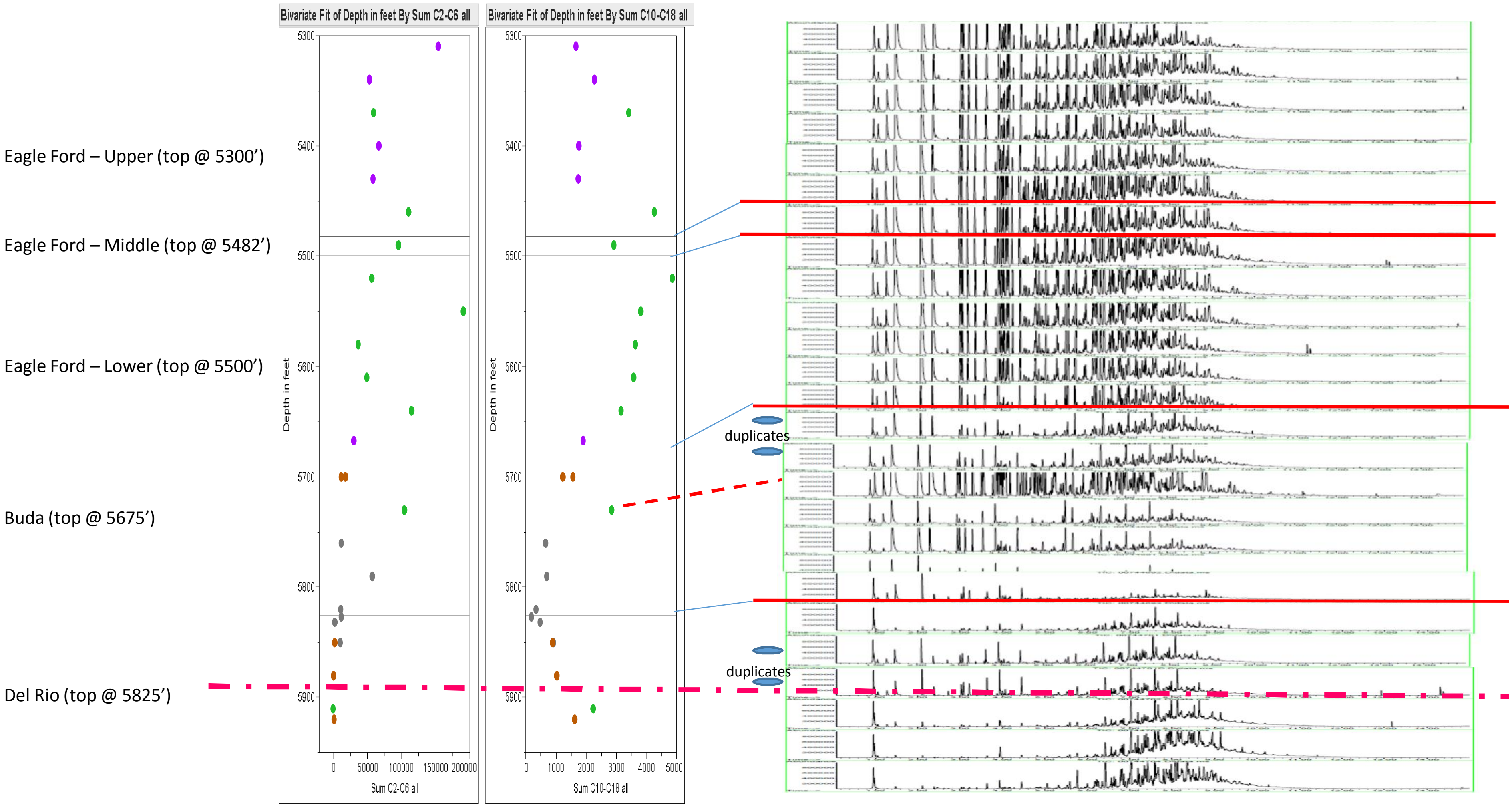
The geochemistry data seems to indicate a separate source for the San Miguel Fm.

This C6 ternary plot shows that the Eagle Ford samples are more typical of an unaltered oil signature, and there appears to be increased oil alterations (i.e. water washing and/or biodegradation) as you move through the Austin Chalk & San Miguel.



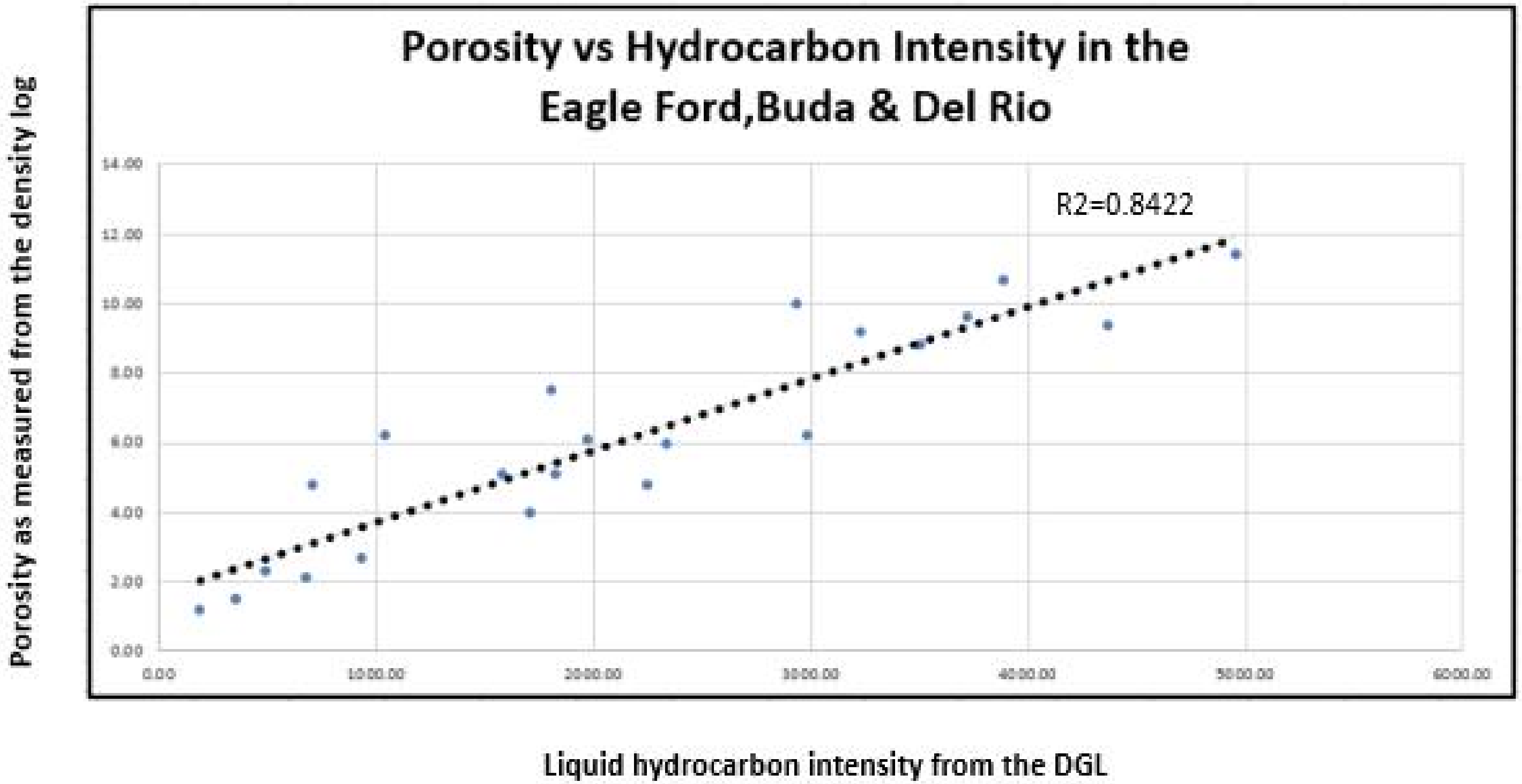
Depth Profile with Fingerprints

Depth profile by summed mass, color-coded by HCA group, with Fm tops and TIC profiles



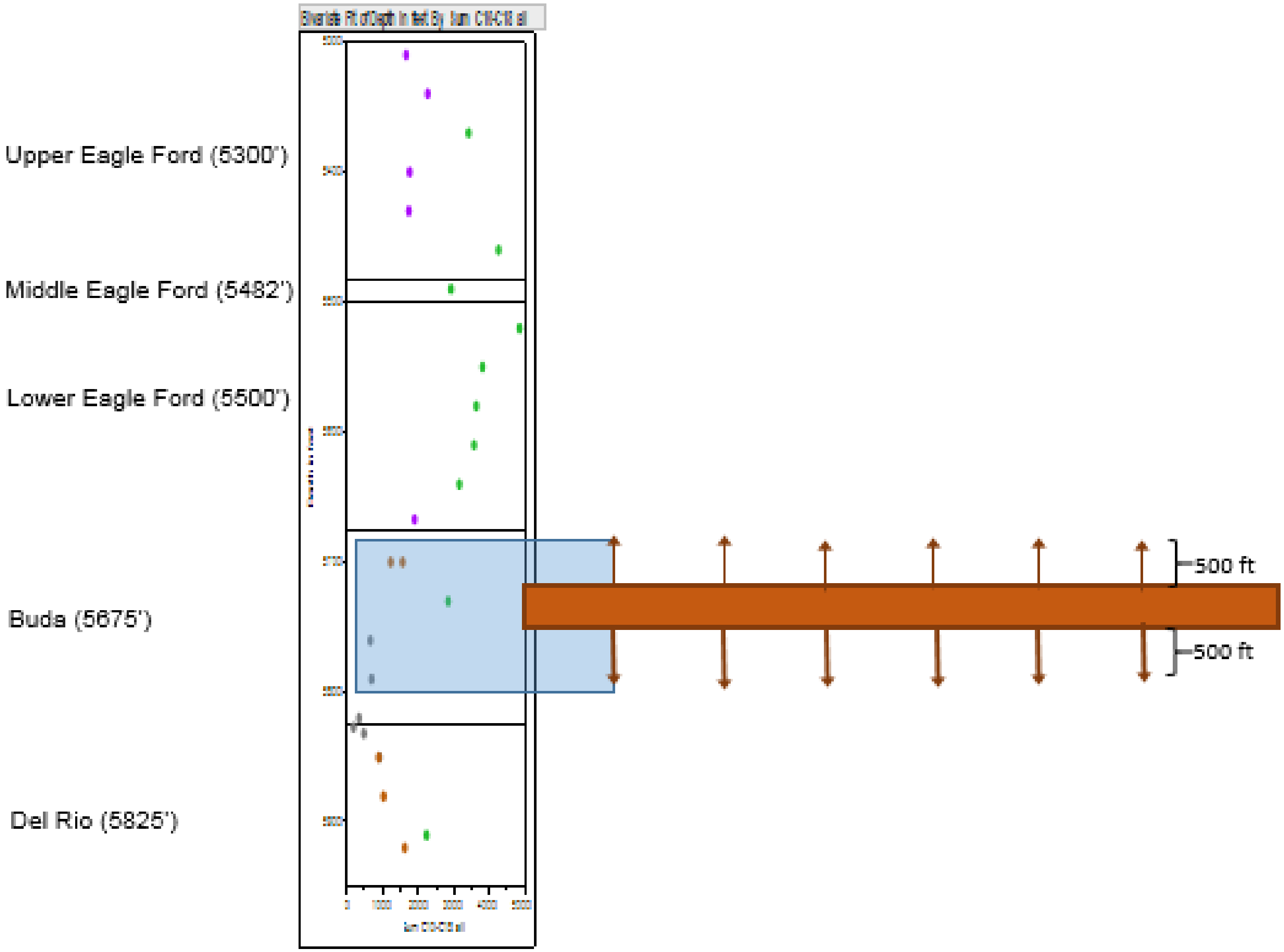
The organic-rich lower shales and condensed section have the highest hydrocarbon-generating potential of any part of the Eagle Ford Group (Dawson, 2000).

Hydrocarbon Intensity Relates to Porosity

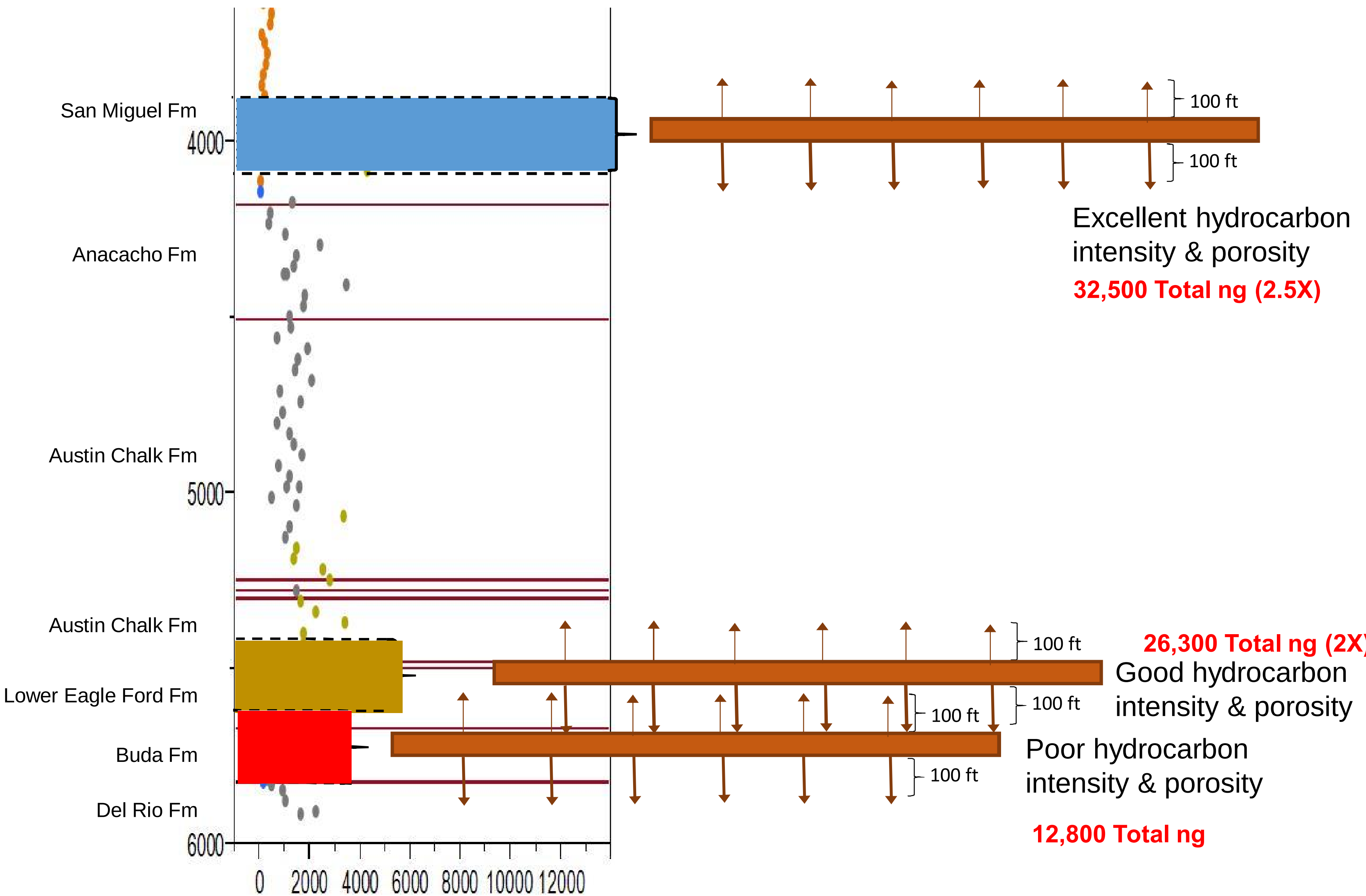


Lateral Placement and Optimization

Selected Lateral Placement

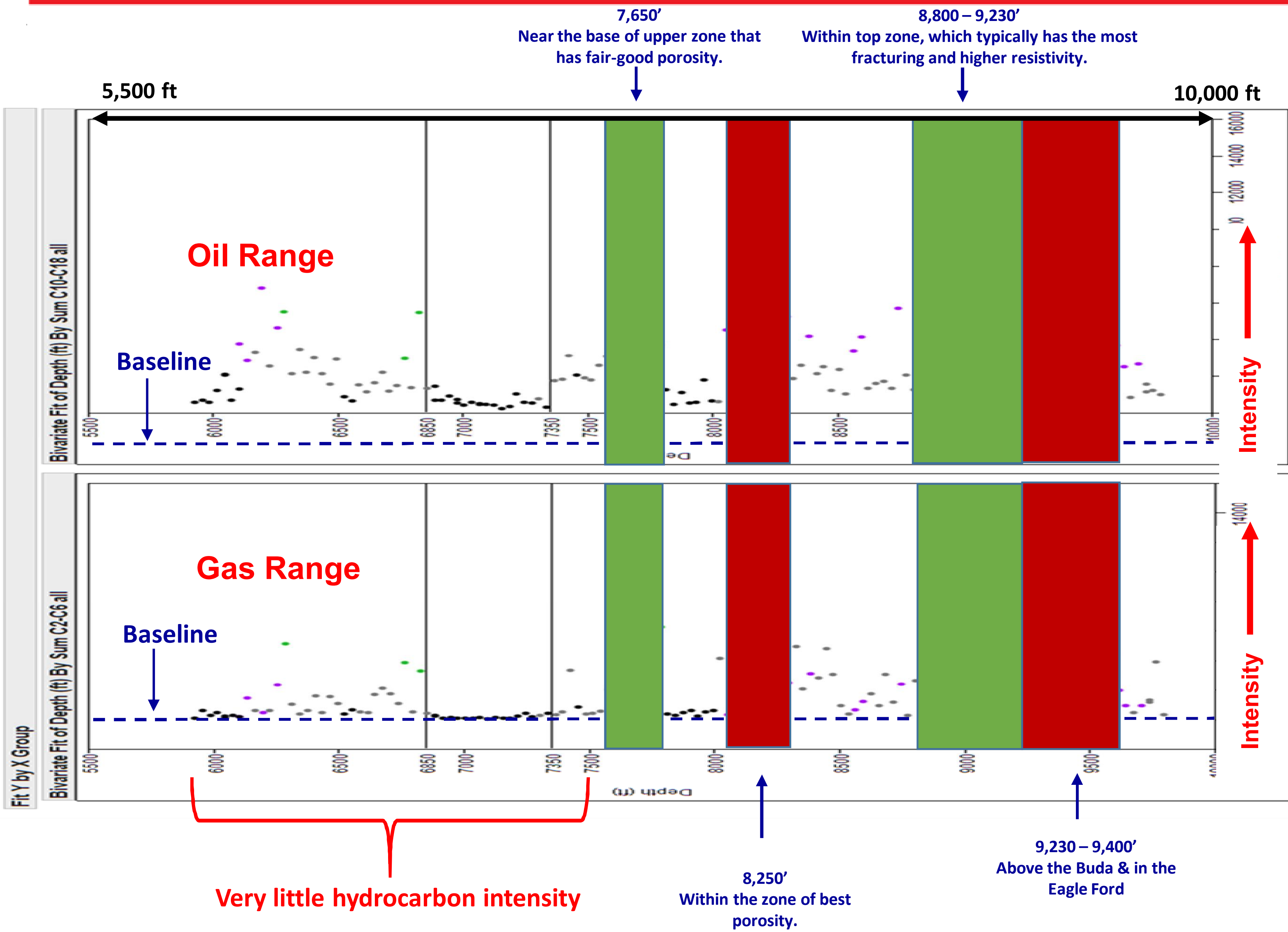


Lateral Placement and Hydrocarbon Richness



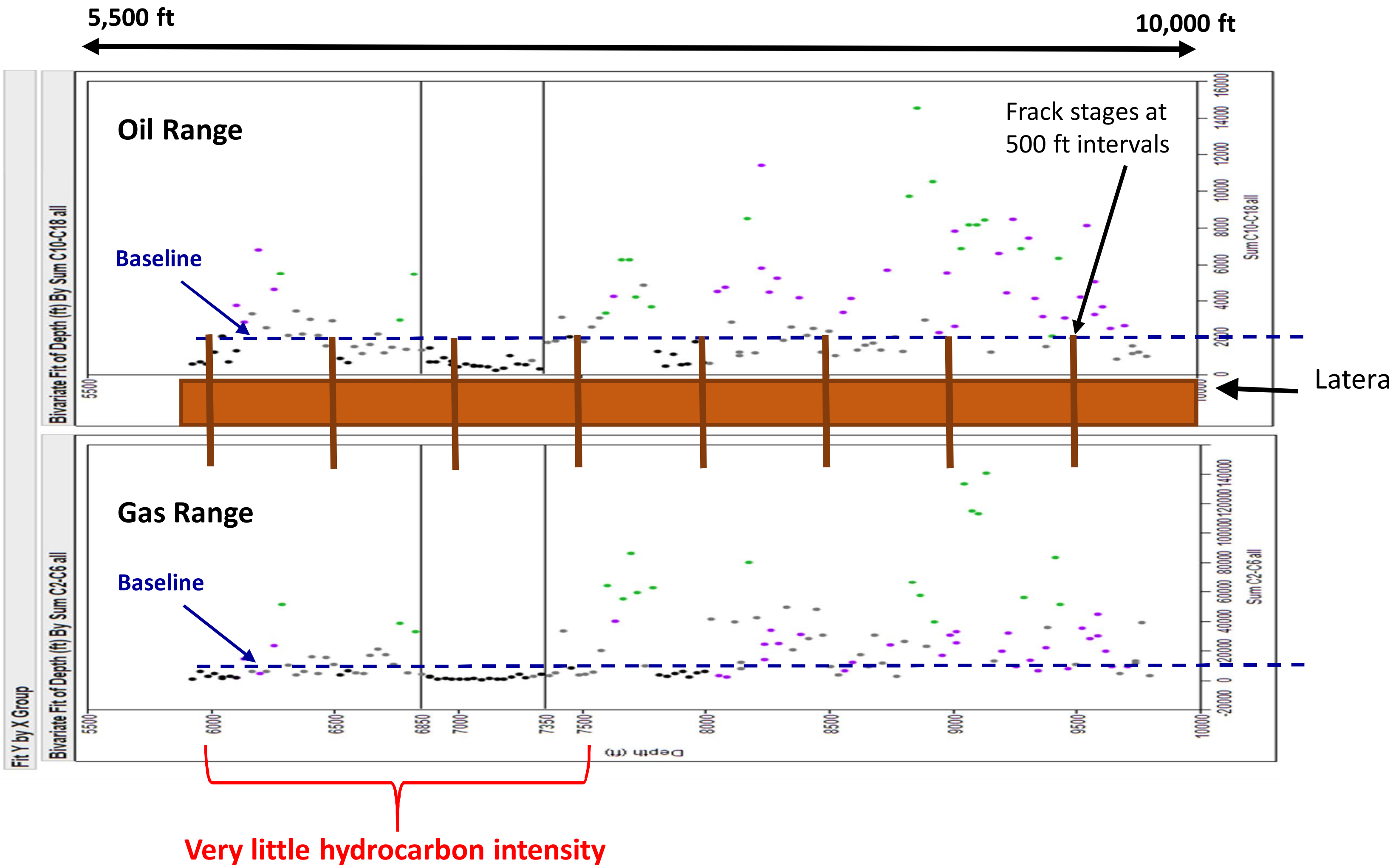
Optimizing Frack'ing Stages & Placement

Lateral Hydrocarbon Richness



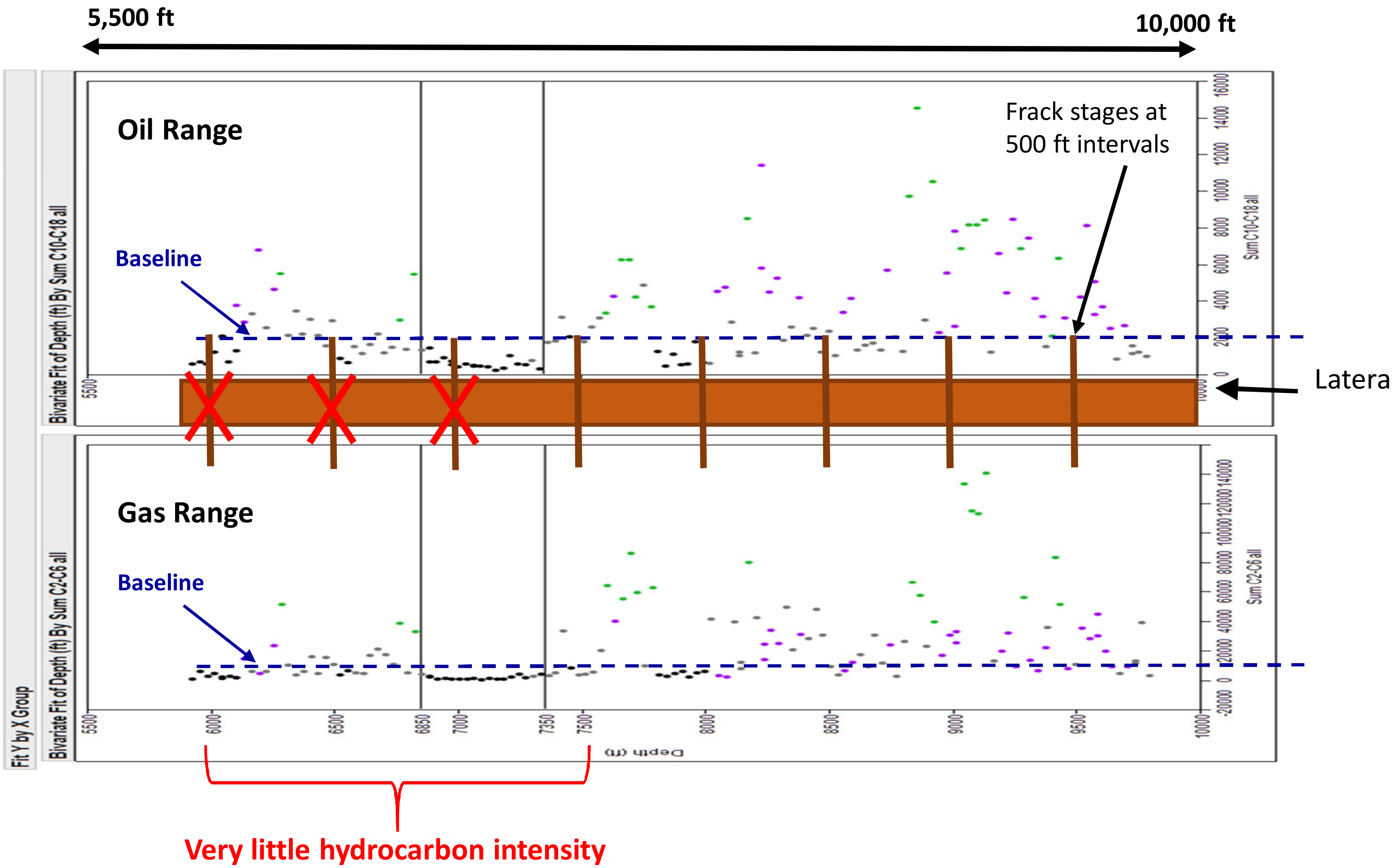
Optimizing Fracking Stages

8 Frac stages at $200,000
each = **$1.6 mm**



Optimizing Fracking Stages

5 Frac stages at $200,000
each = **$1.0 mm ($600K less)**



Conclusions

AGI Downhole Geochemical Logging data can help to:

Å **Increase production** by focusing laterals in zones with the **best hydrocarbon richness (i.e. most productive zones)** and **best porosity**. Since DGL is measuring hydrocarbons, not a proxy, DGL intensity readings directly reflect hydrocarbon richness. In unconventional wells DGL hydrocarbon intensity can also reflect porosity.

Å **Reduce completion costs** by optimizing the number and placement of fracking stages**.**

Å **Infer vertical compartmentalization and seals.** Numerous DGL studies have shown that DGL data can definitely infer seals through hydrocarbon signals that return to baseline or noting changes in hydrocarbon signals from one formation to another. This can provide powerful information for completion strategies.

Å **Identify by-passed pay.** With its 1000-fold lower detection limit, DGL can easily detect by-passed pays missed my e-logs and other technologies. As a result, this can increase your reserve estimations.

Å **Identify water saturated zones or oil/water contacts**. Since aromatics (i.e. benzene) are much more water soluble than alkanes (i.e. hexane) this ratio serves as an excellent proxy for water saturation.

In a Permian well we showed hydrocarbons in every single sample in every formation.

But, only 15% of the samples showed elevated (**i.e. economic**) levels of hydrocarbons.

So, itôs not just about drilling and completing wells as fast as you can ï thatôs yesterdayôs paradigm.

Itôs about completing laterals effectively to make the most money possible with each and every well.

Thank You!

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