RELATIONSHIP BETWEEN WELL PERFORMANCE AND STRUCTURAL SETTING IN THE MARCELLUS SHALE OF GREENE COUNTY, PENNSYLVANIA

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Agenda

- Overview of Residual Mapping
- Recap of Utica-Point Pleasant Shale observations presented at 2017 AAPG Eastern Section Conference
- New observations in the Marcellus Shale of Greene County
- Comparing and contrasting the Utica-Point Pleasant and Marcellus
- Possible explanations for differences
- Practical application of these observations
- Future work

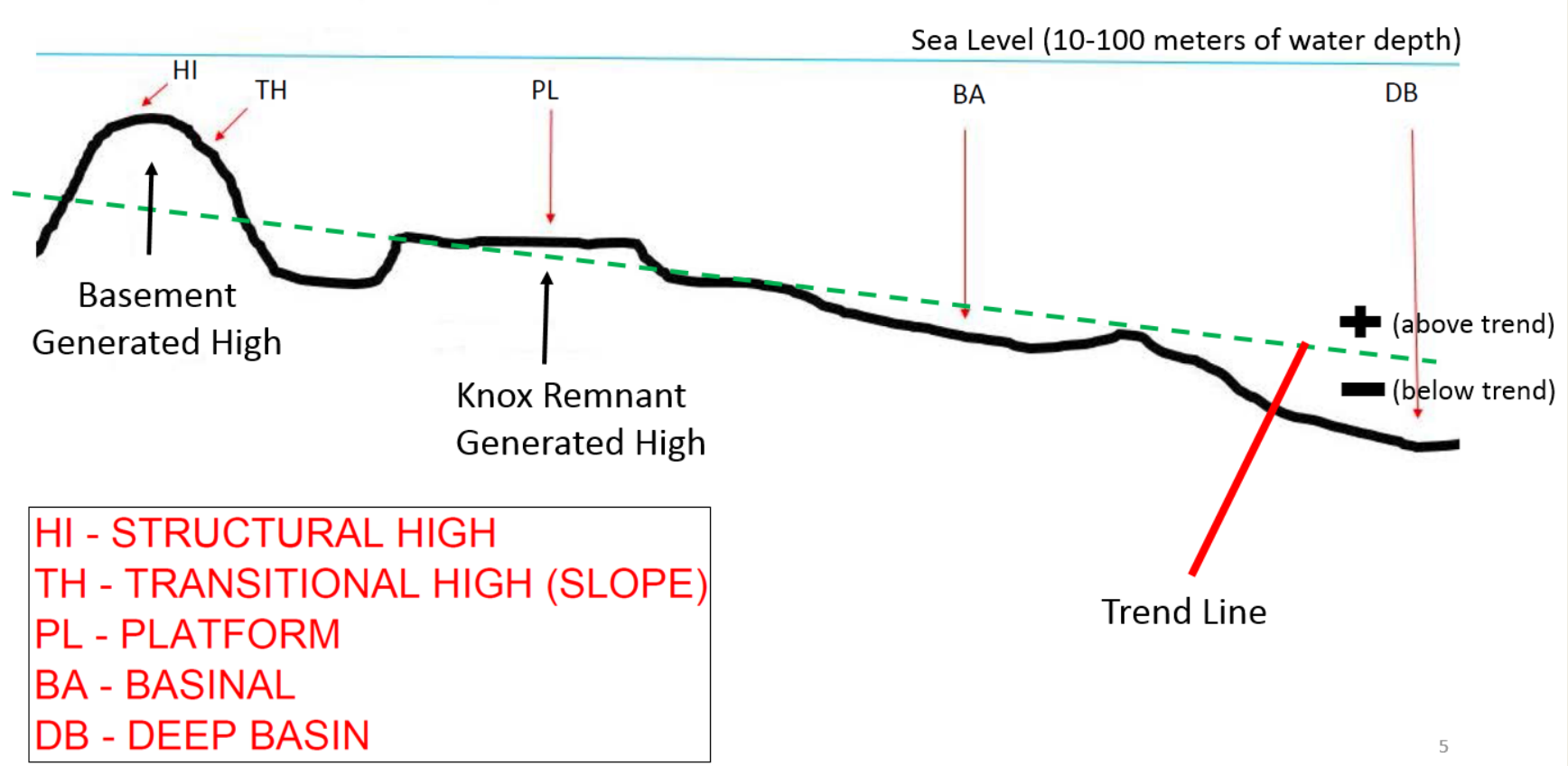
Residual Mapping

Layman's Description:

Approximating the surface topography at the time of deposition by canceling out regional dip, which was largely influenced by post-depositional tectonics

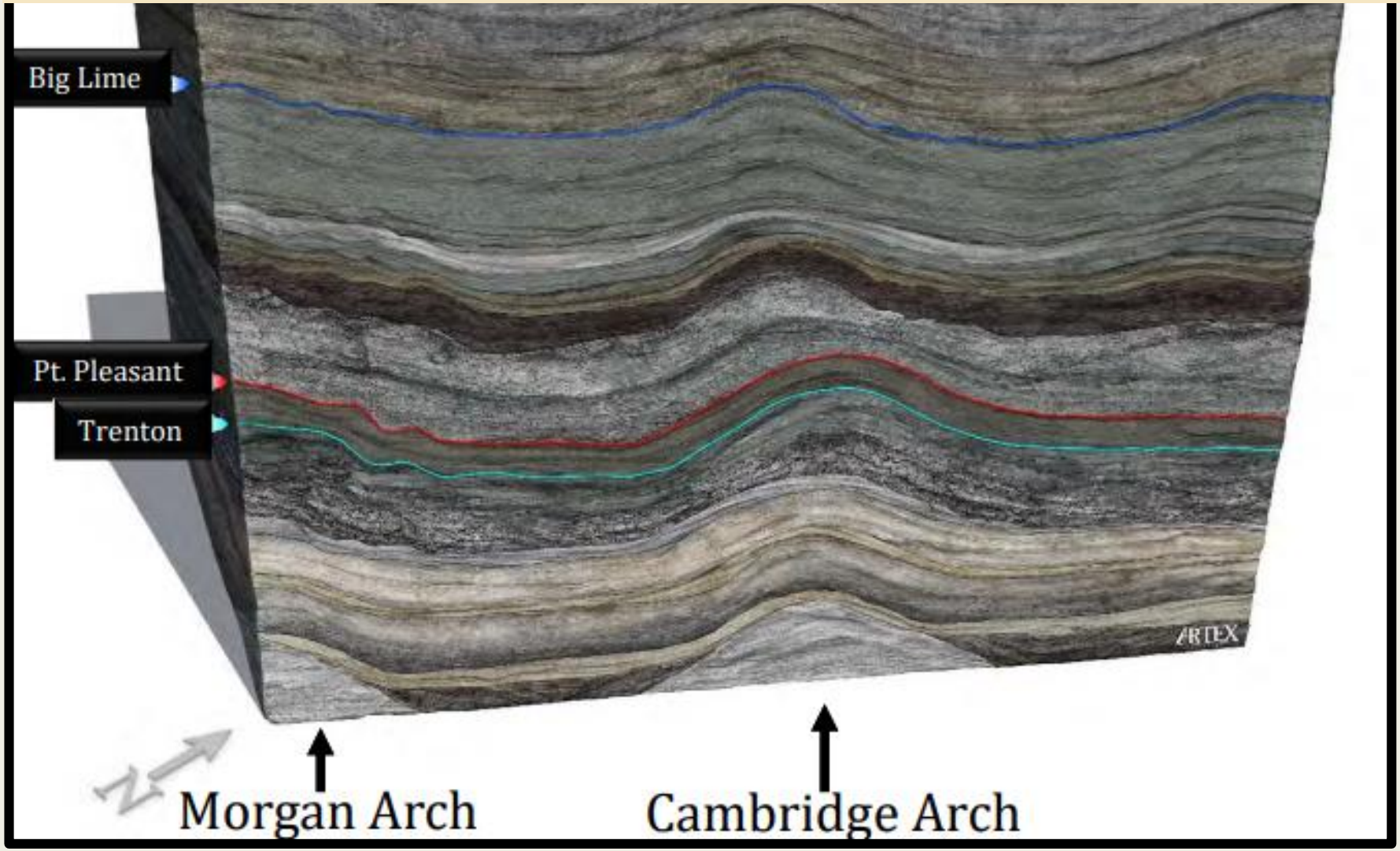
Residual Mapping

Utica-Point Pleasant Example (from 2017 presentation)



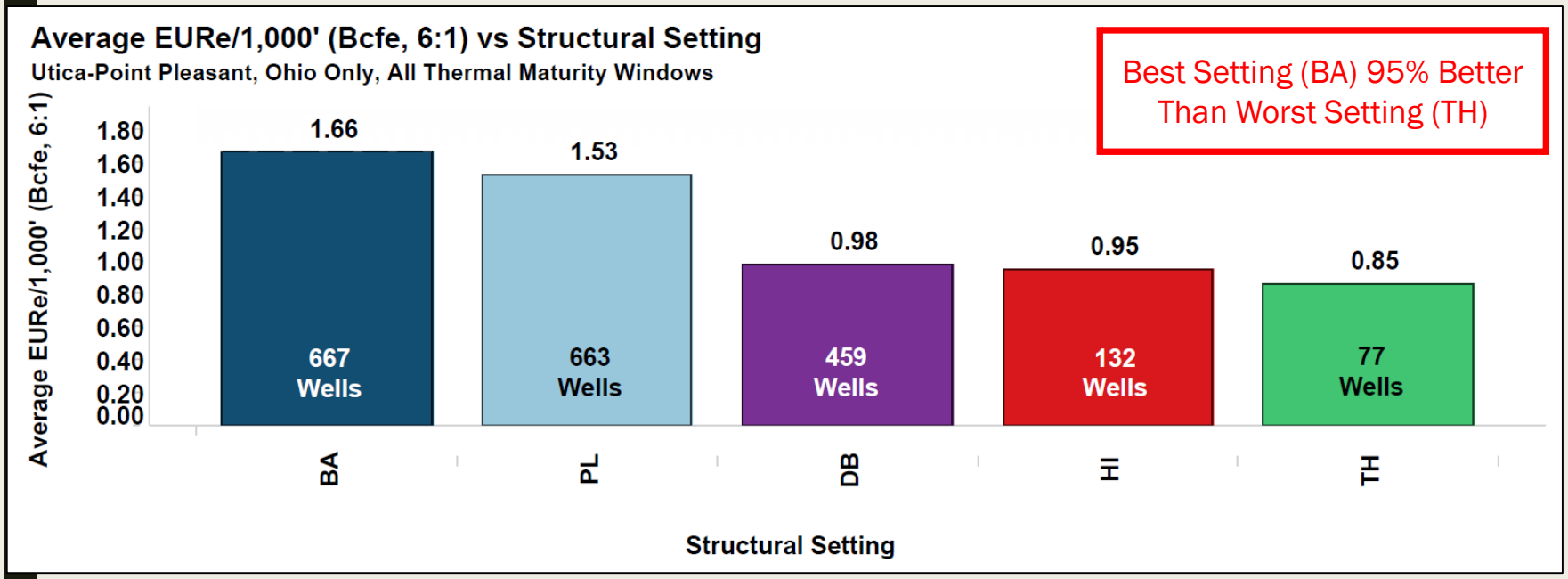
Source: "Structural Control of the Point Pleasant Formation Deposition and Production"; Fitzgerald, Casto, Thomas; AAPG Eastern Section Conference 2017; Morgantown, WV

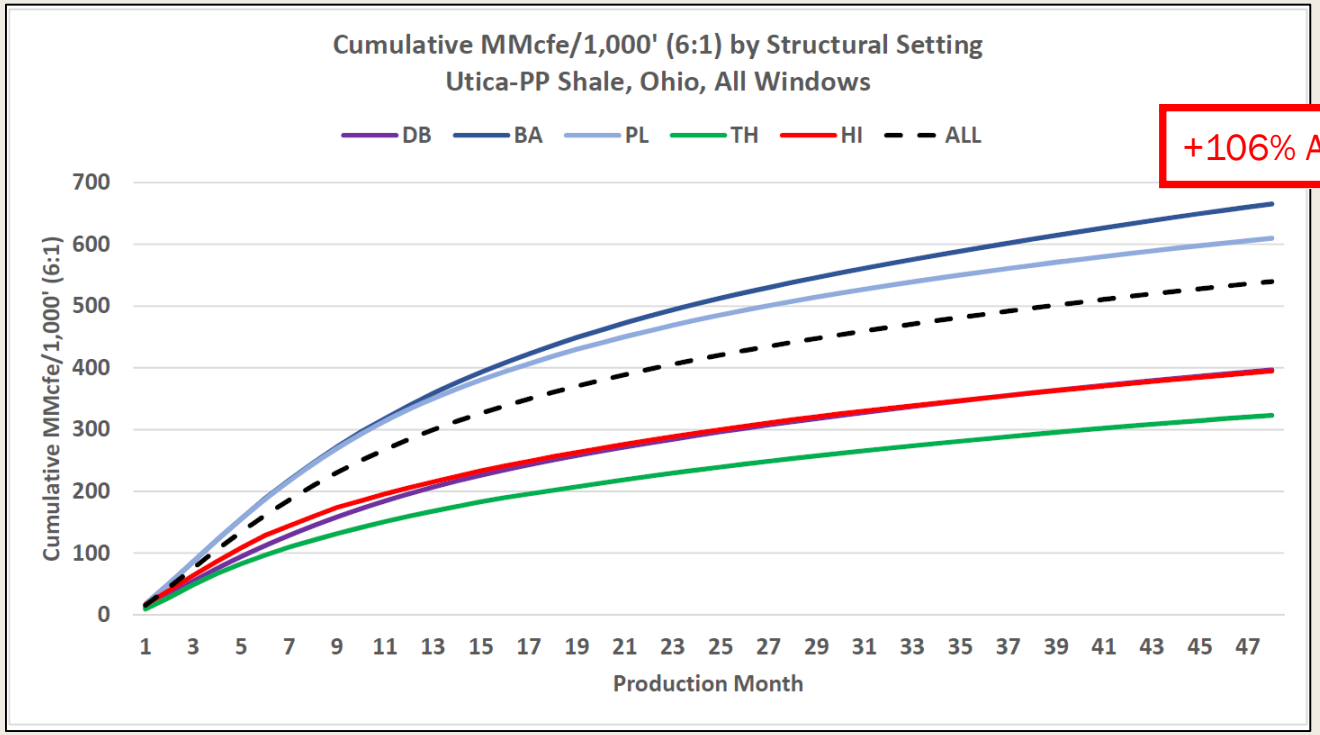
Example of basement structures translating all the way up to shallower formations with many more penetrations. Using shallower zones allows us to create a residual map with much higher resolution than if we only used wells penetrating the zone of interest.



Performance vs. Structural Setting

Ohio Utica-Point Pleasant Example

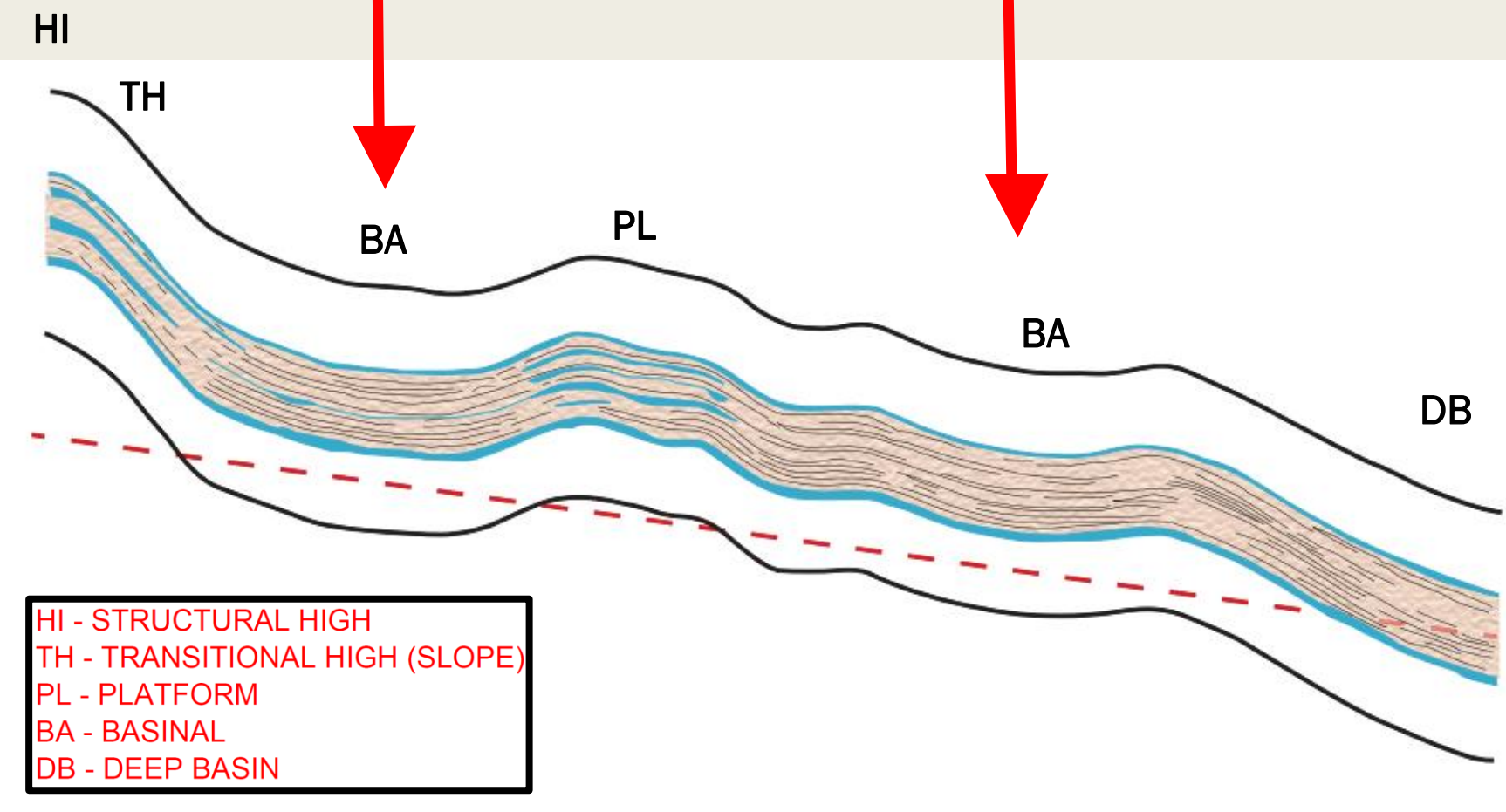


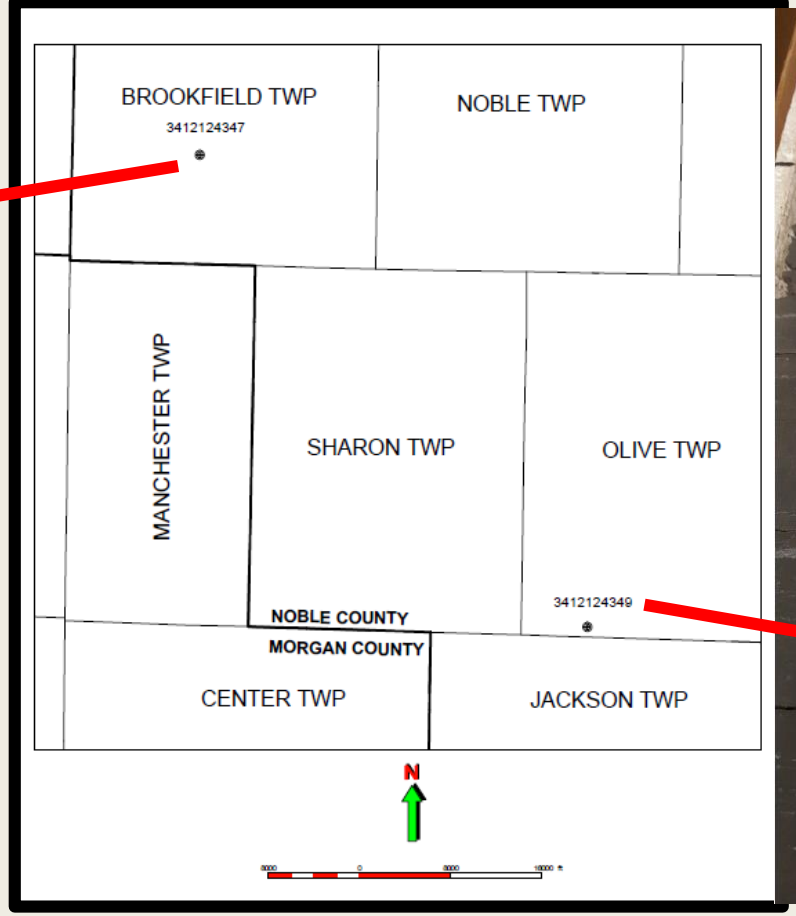


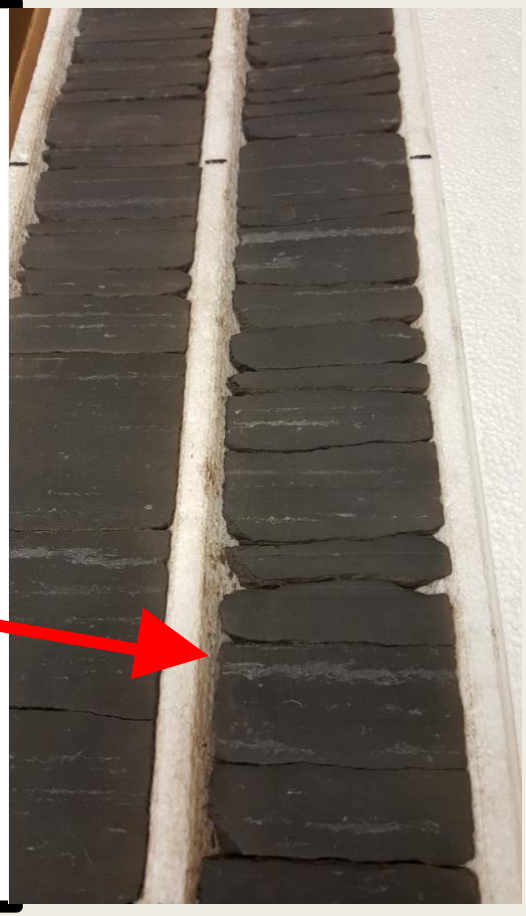
Source of Well Data: James Knobloch Petroleum Consultants Appalachian Well Database

Basinal Setting

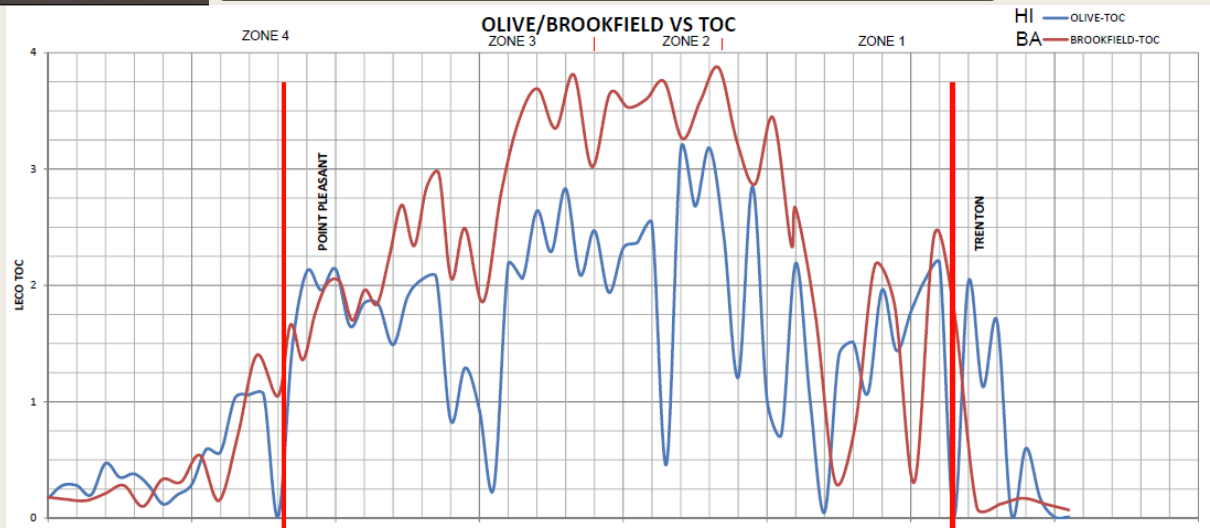
-Best producing setting
-Lower oxygen levels
-Most organic preservation
-Low energy environment
-Continuity of organic beds
-Highest TOC







BA: Max TOC 4%



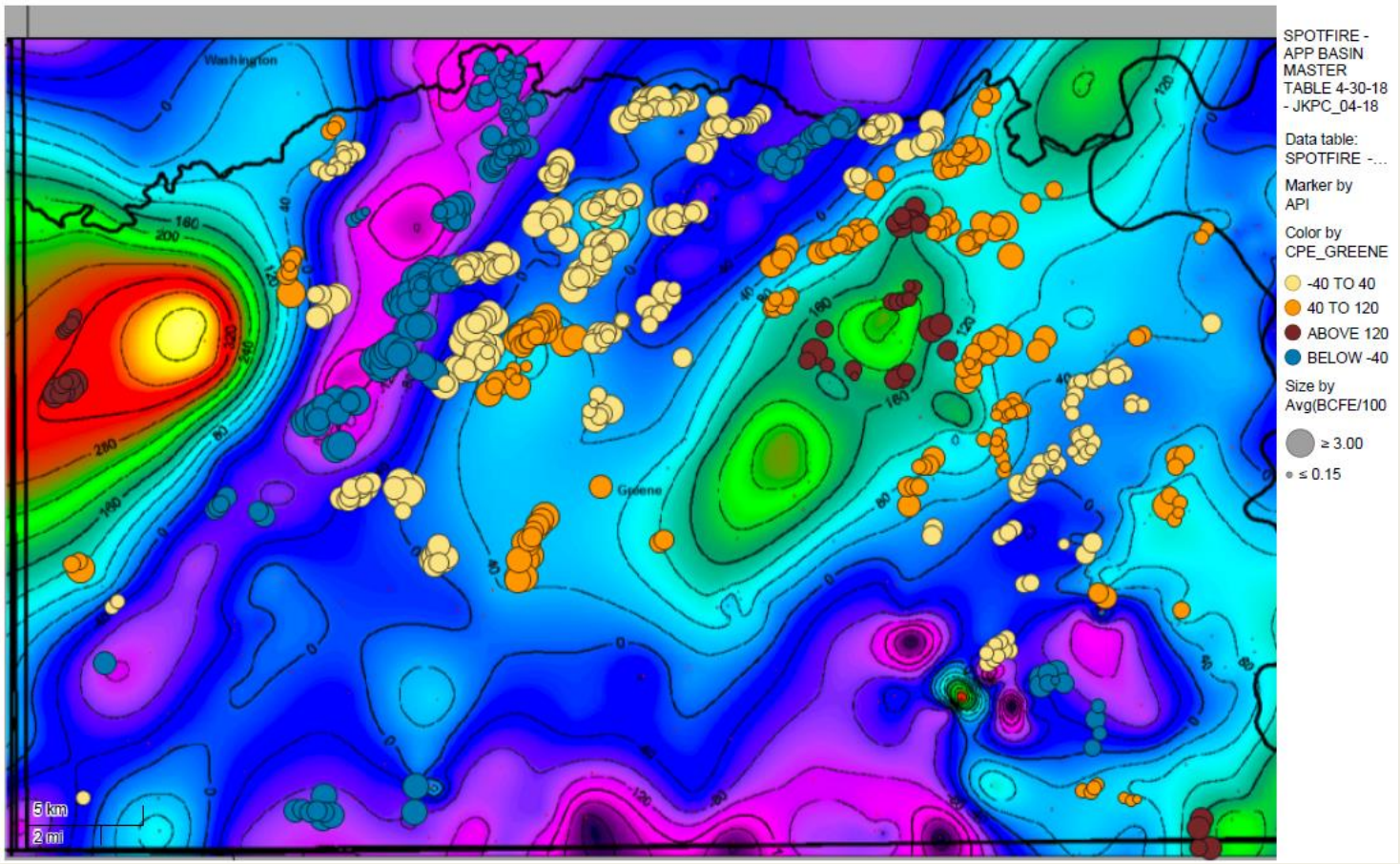
HI: Max TOC 3%

What We Learned in the Utica-PP

- There is a correlation between well performance and structural setting
- There is a correlation between TOC and structural setting
- Therefore, one of the reasons we observe poorer well performance in certain structural settings is likely because of diminished preservation of organics in those environments
- Another reason performance suffers in certain structural settings is that staying in zone is much more difficult when starting on a high or transitional high. This is partly due to the lack of distinction in the gamma ray log due the Utica-Point Pleasant's unique minerology.

Residual Mapping

Greene County – Base of Big Injun



Source of Well Data: James Knobloch Petroleum Consultants Appalachian Well Database

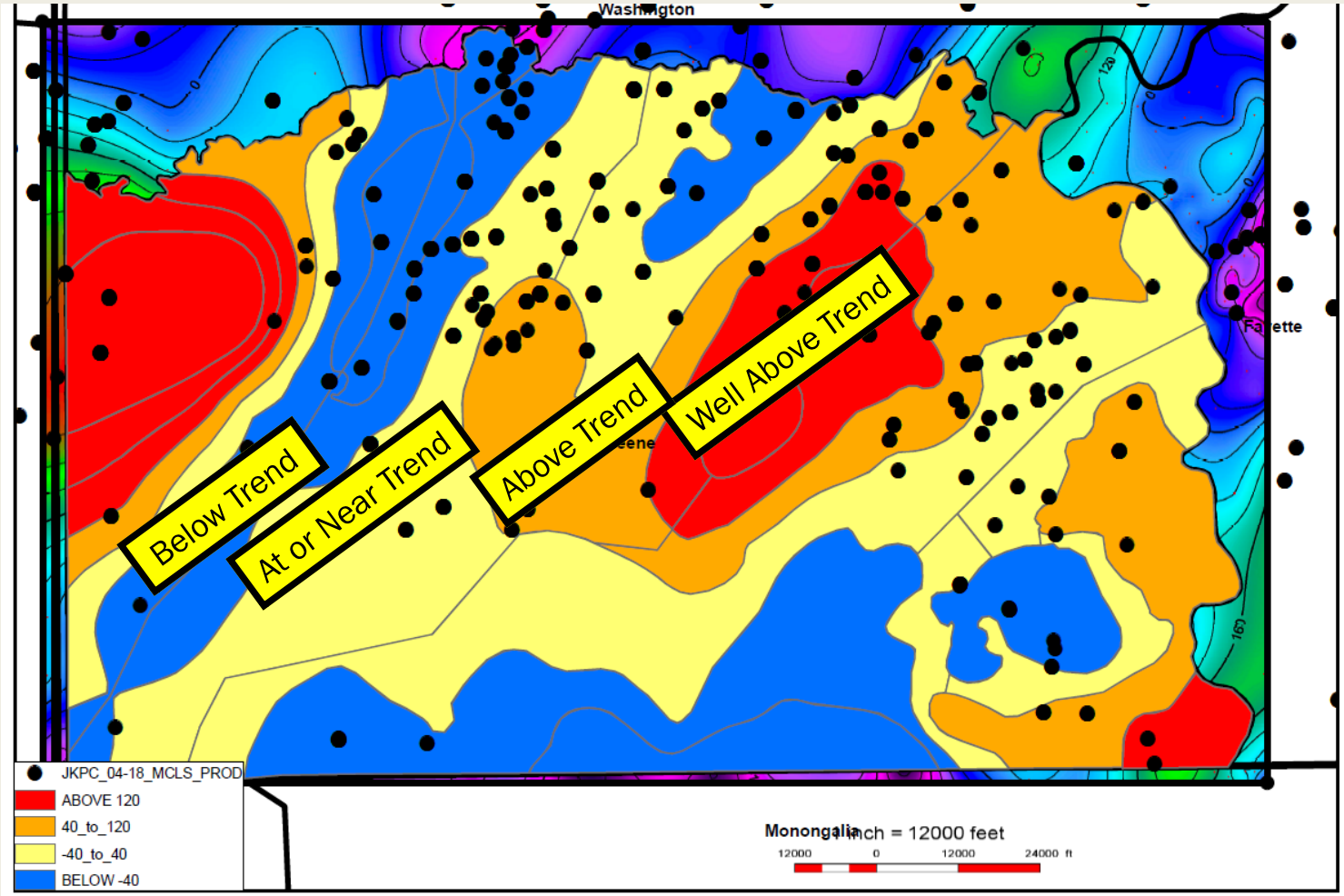
Divided into Four Structural Settings:

(Height above or below trend surface)

1. Below Trend (Below -40 meters)
2. At or Near Trend (-40 to 40 meters)
3. Above Trend (40 to 120 meters)
4. Well Above Trend (Above 120 meters)

Residual Mapping

Greene County – Base of Big Injun



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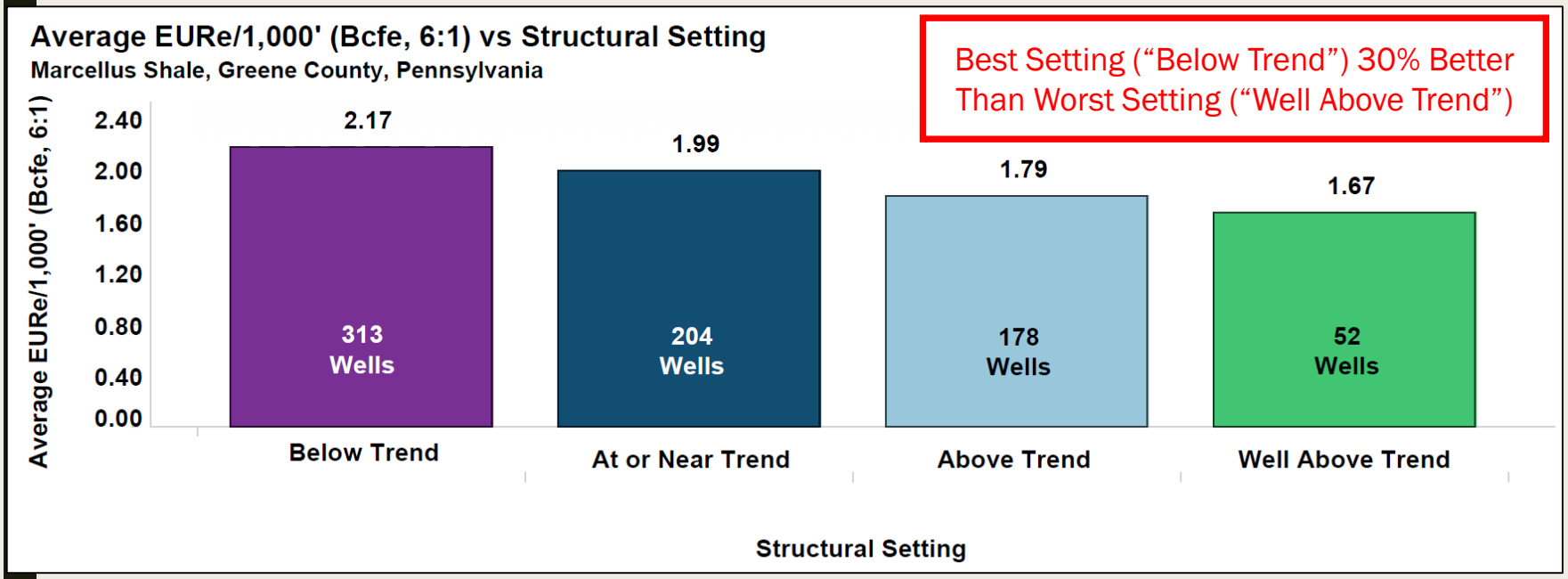

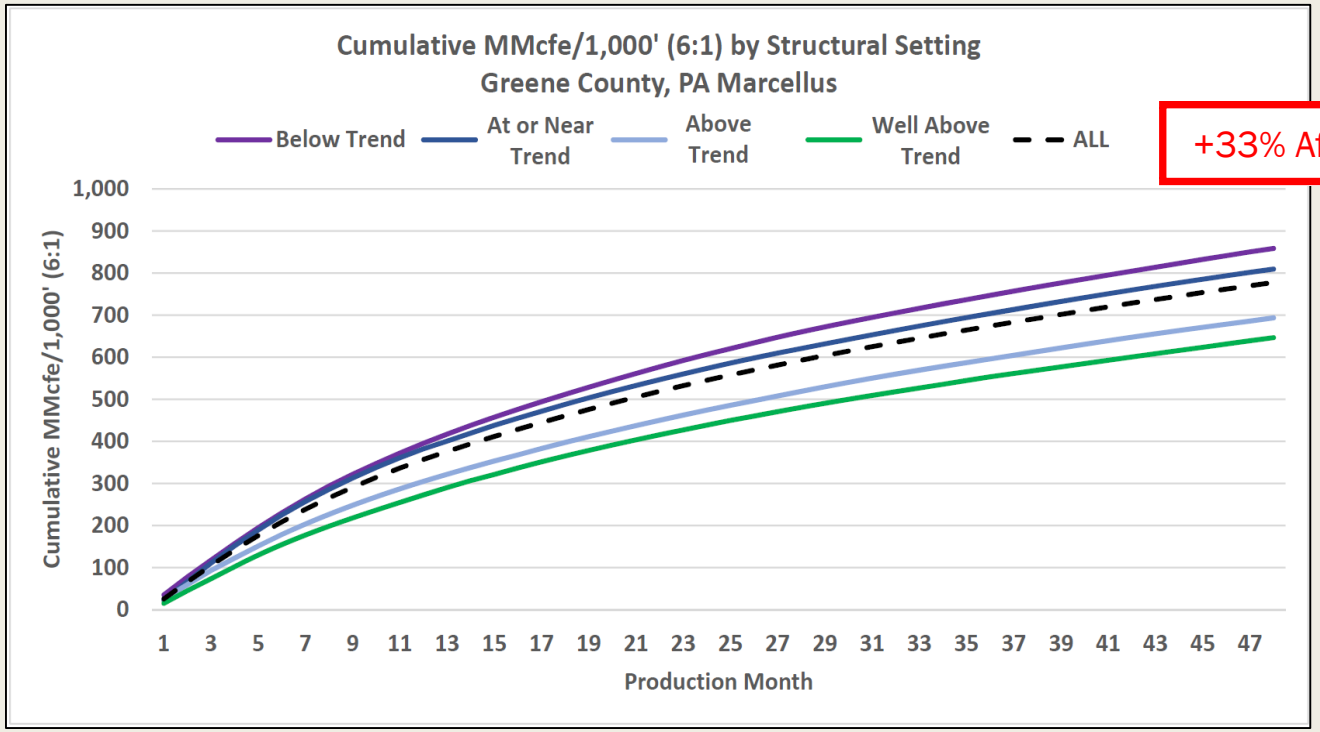

Source of Well Data: James Knobloch Petroleum Consultants Appalachian Well Database

Performance vs. Structural Setting

Greene County Marcellus Shale Observations

- The “Below Trend” setting has the highest average EUR/1,000 ft
- The “Well Above Trend” setting has the lowest average EUR/1,000’ ft
- The average EUR/1,000’ *decreases* with each progressively *shallower* structural setting
- The difference between the best and worst settings is 30%

Comparing/Contrasting Observations in Utica-PP and Marcellus Shale

- Both show that performance is worse in highest structural settings
- The difference in average performance between best and worst setting is greater in the Utica-PP (95%) versus the Marcellus (30%)

Possible Explanations for Differences in Utica-PP and Marcellus Shale Observations

- Water depth for Utica-PP ranges from 30 to 300 ft (**low oxygen**)
- Water depth for Marcellus Shale greater than 350 ft (dominantly **anoxic**)
- Therefore, decomposition of organics due to wave action, sunlight, oxygen, etc. not likely an issue in Marcellus
- Theory: this implies that differences in organics accumulation and preservation may be a function of the actual topography on which the organics came to rest (flat, sloping, etc.) and that organics slumped to lowest point
- Another issue effecting well performance: geosteering with gamma ray is much easier in Marcellus compared to Utica-PP, so out-of-zone percentage not expected to be as much of an issue in Marcellus

Practical Application of These Observations

- It is often difficult or impossible to account for the differences in performance (per 1,000 ft) between groups of horizontal wells in the same formation
- The differences are often attributed to: hydrocarbons-in-place, reservoir pressure, thermal maturity, target zone selection, geosteering (in-zone percentage), completion design, and other factors
- ALL OF THESE can have an effect on performance
- The work presented here allows one to “normalize” a data set by structural setting in order to make other correlations more meaningful

Practical Application of These Observations (continued)

- For example:
  - *If you are going to correlate performance vs. proppant loading (lbs/ft) for a group of wells, you may want to normalize by structural setting first so you are not studying 'apples and oranges'*
    - Or else, you may ascribe certain performance trends to proppant loading, when they are really a function of structural setting, or a combination of both

Future Work

- Compare Marcellus Shale TOCs in different structural settings to see if trend follows EURe/1,000’ vs structural setting (as in Utica-PP)