Geologic Components of Shale Production*

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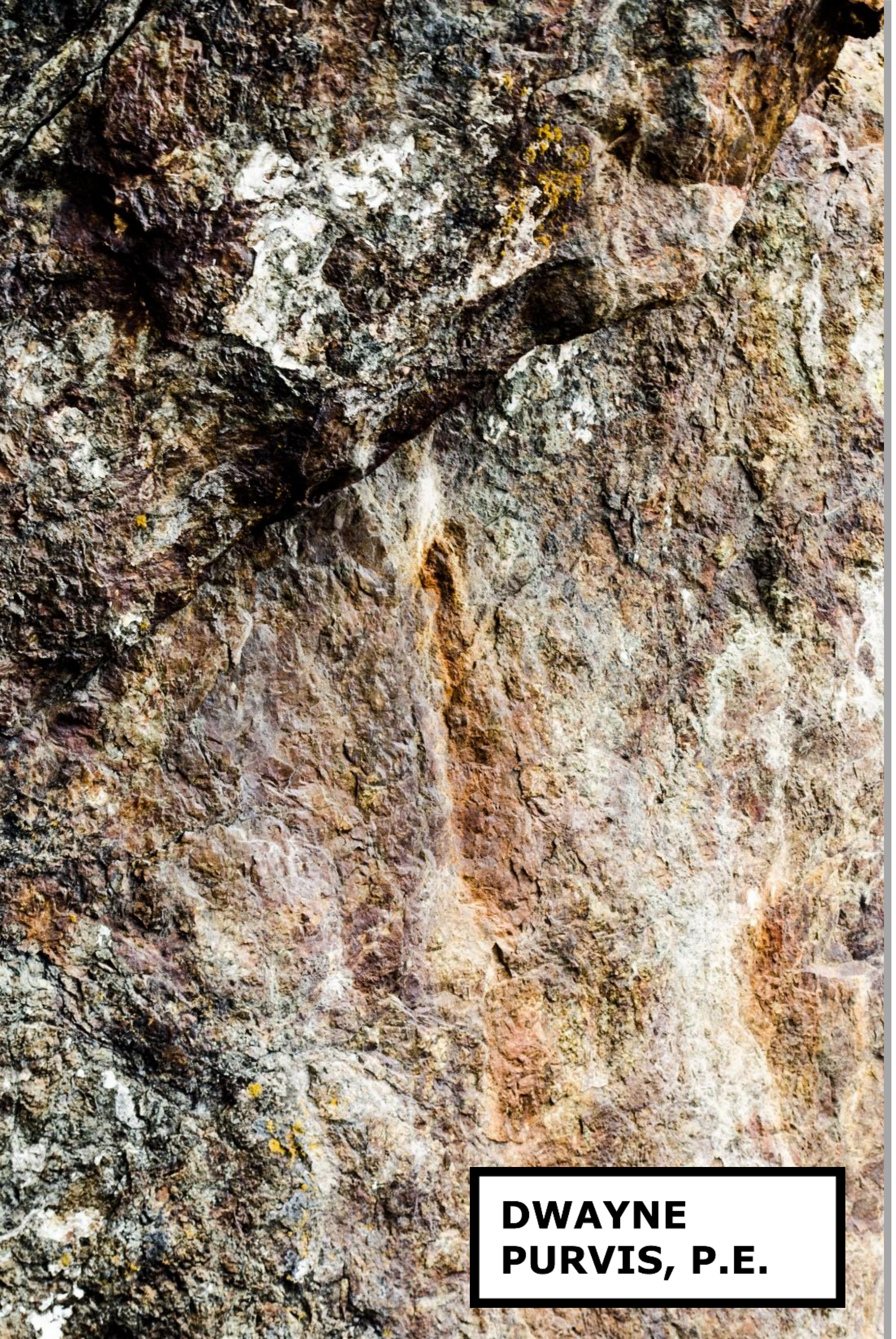
Abstract

Industry and investors recognized from the beginning that the traditional components of a field — reservoir, trap and charge — did not apply to shale production since the target formation provided all three. While it is mostly true that there are no dry holes in shale production, there is wide range of productivity, and many areas are unprofitable for geologic reasons. After years of delineation and experimentation we can now offer a model for what geologic components are necessary for profitable production:

1. Reservoir – sufficient thickness of a rock matrix able to contain and flow fluids
2. Geomechanics – the ability to create and to sustain a complex fracture network within the reservoir
3. Fluids – initial pressure and fluid type able to maintain a driving force

Unlike defined accumulations for which the criteria are binary (present/absent), the components are mostly gradational. That is, quality exists on a spectrum, and better quality in one dimension compensates for worse in different dimension. There are, however, deal-killers which cannot be overcome by other dimensions.



Geologic Components of Shale Production

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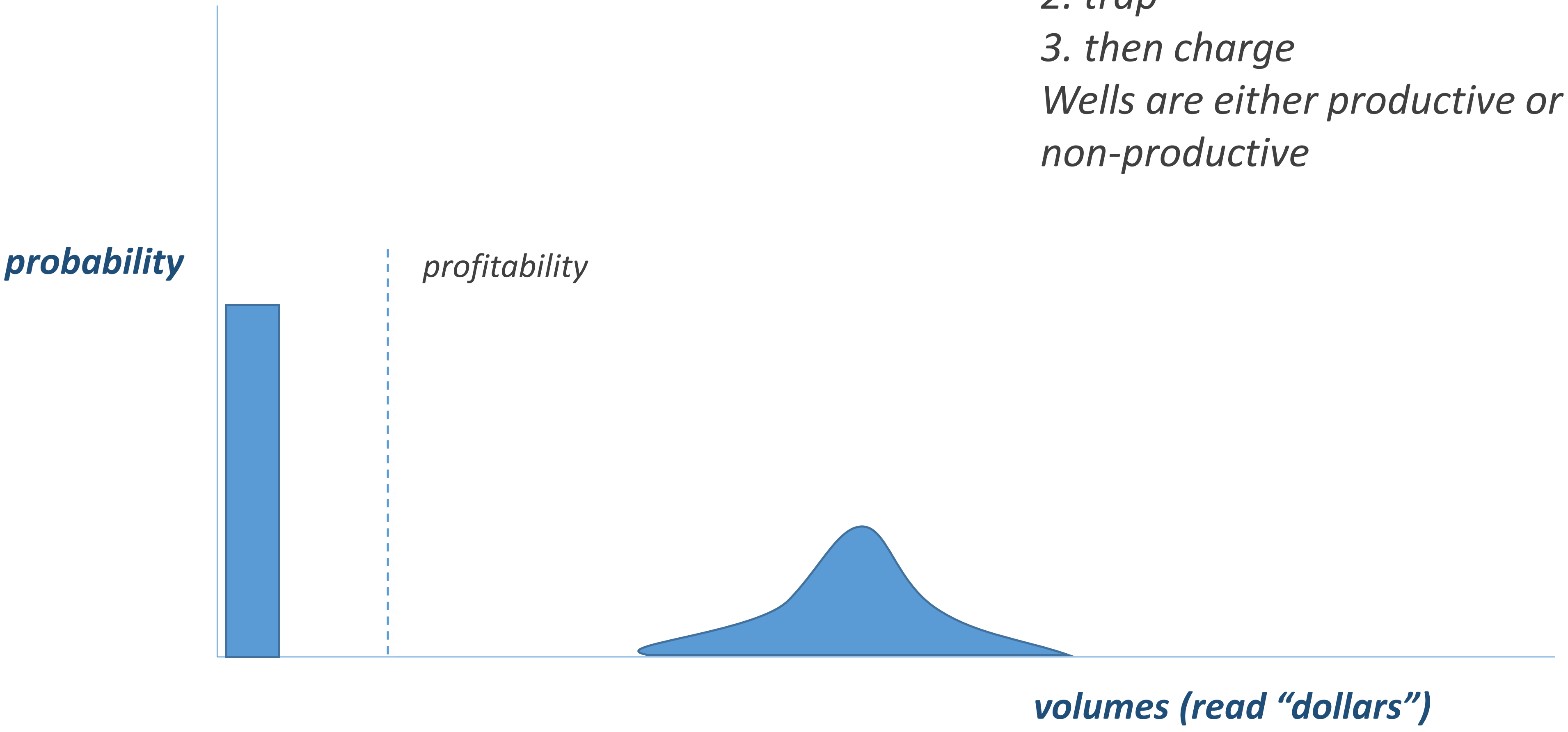
Defined accumulations yield binary results

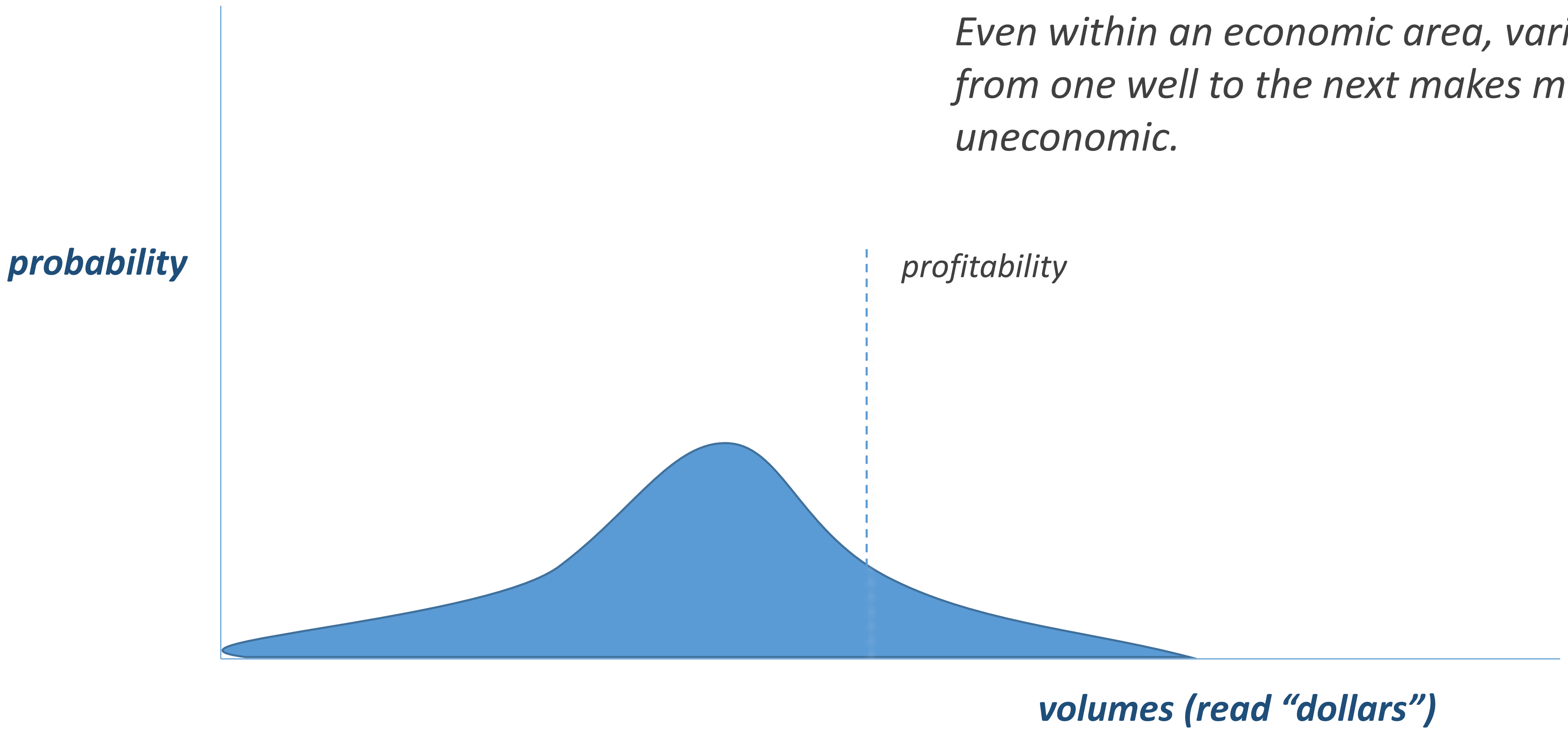
Yes or no criteria:
1. reservoir
2. trap
3. then charge
Wells are either productive or non-productive



Continuous accumulations yield continuous results

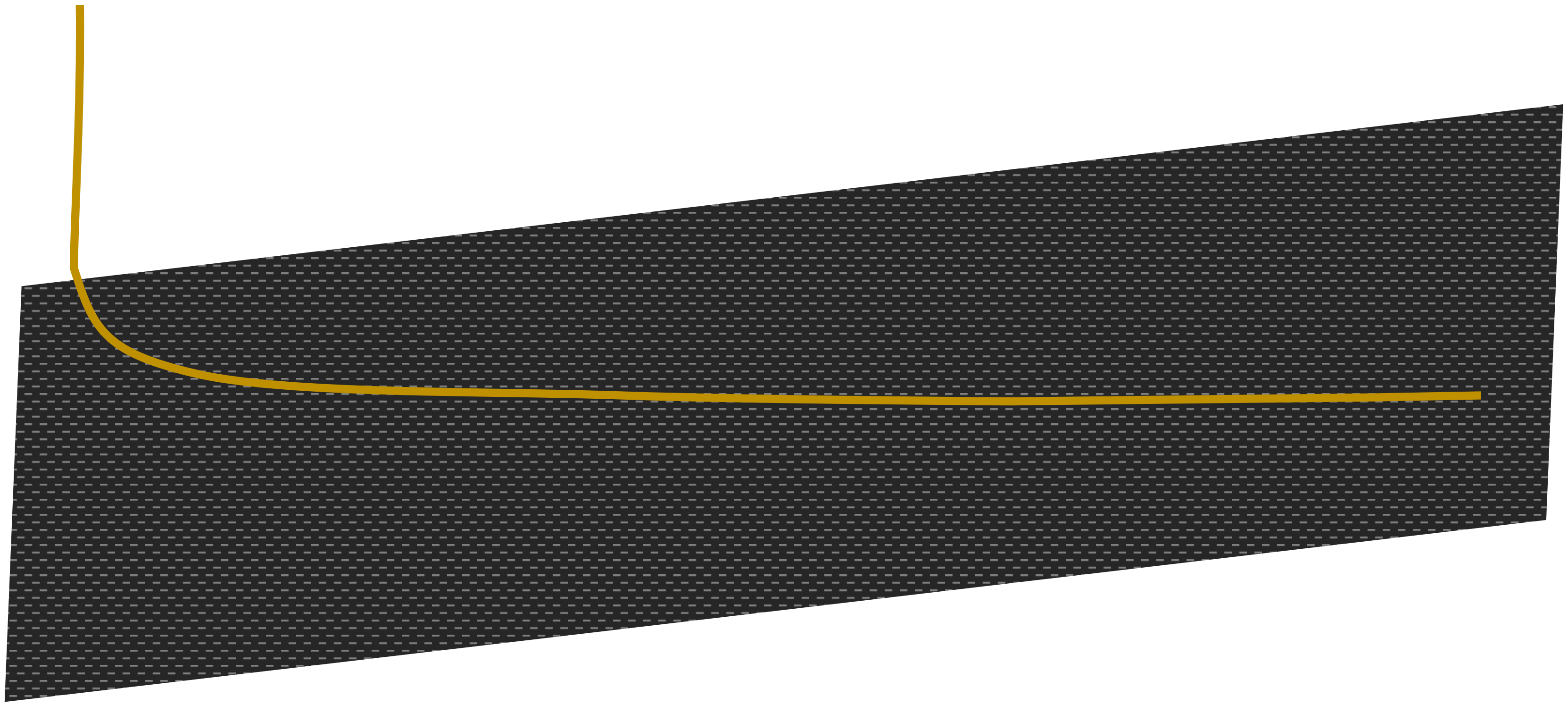
Volumes are rarely zero, but large (or even most) areas of a shale are uneconomic.

Even within an economic area, variability from one well to the next makes many wells uneconomic.



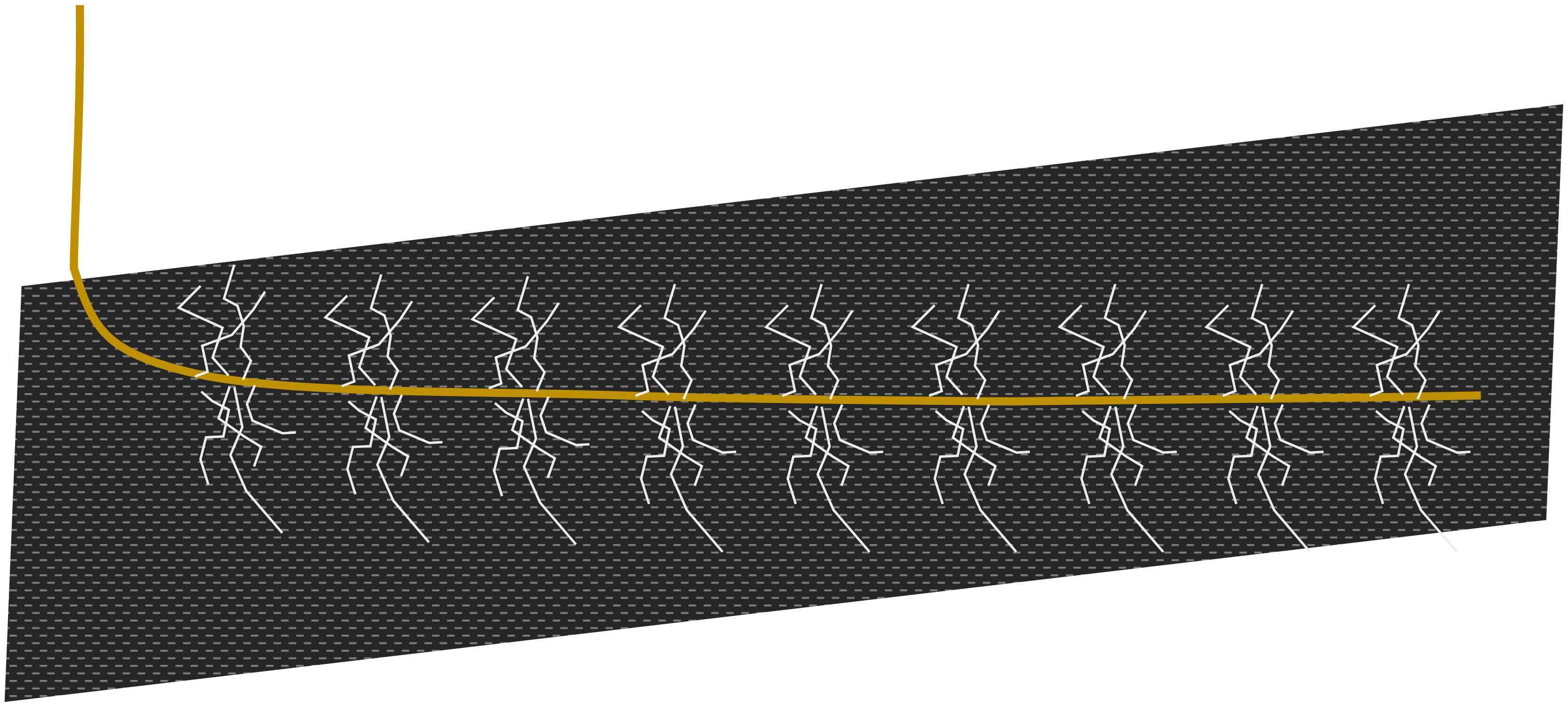
First geologic components for shale production

1. Reservoir – sufficient thickness with ability to contain and to flow fluids



Second geologic component for shale production

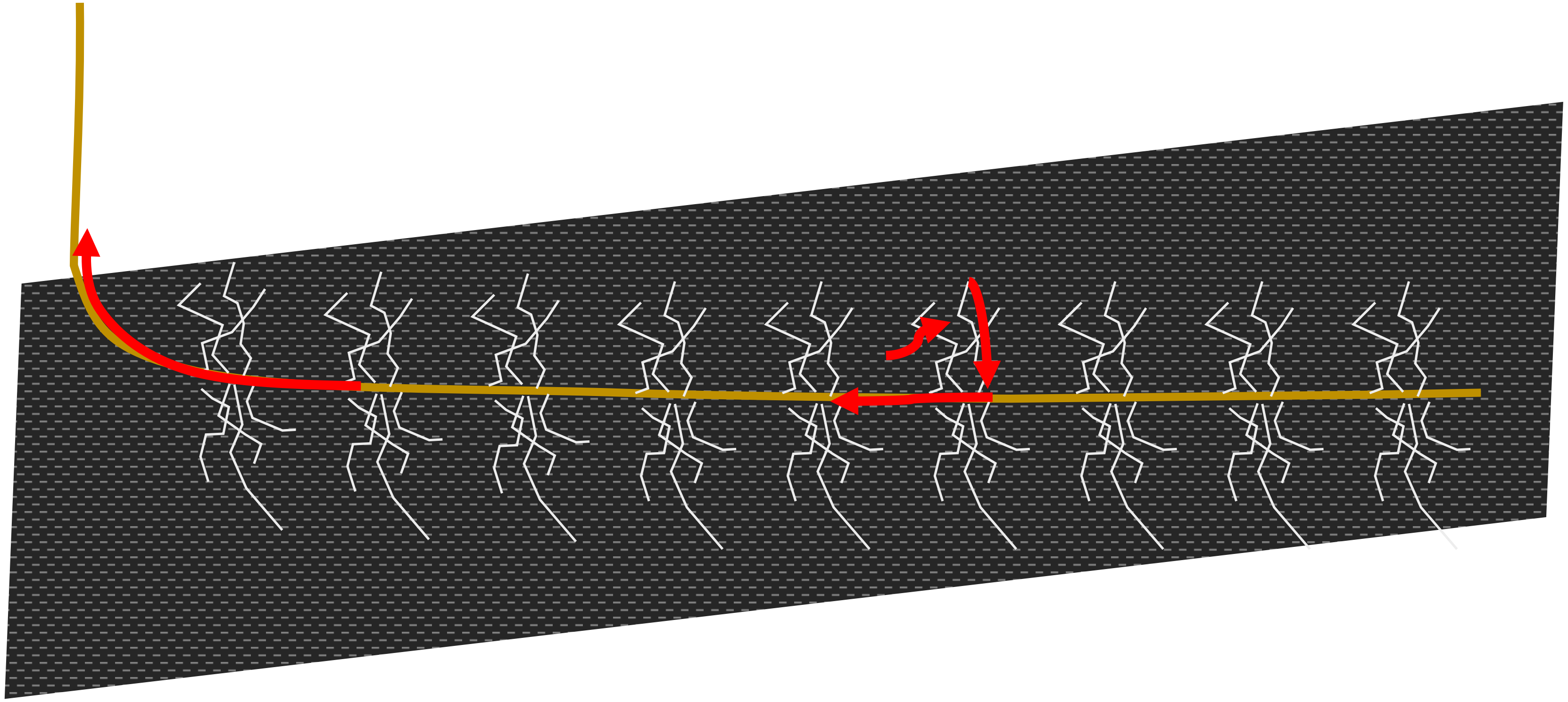
1. Reservoir
2. Geomechanics– ability to create and sustain complex hydraulic fracture system within/throughout zone



Third geologic component for shale production

1. Reservoir
2. Geomechanics
3. Fluids – pressure and fluid able to maintain driving force

(no RIPs)



In addition, recovery depends more heavily upon the drilling, completion and operations practice than in higher quality rocks.

Haphazard list of considerations. . .

e.g.

clay content

porosity

brittleness

frac barriers

stress contrast

TOC content

TOC maturity

. . .fit within one or more headlines

	clay content	porosity	brittleness	frac barriers	TOC content	TOC maturity
1. Reservoir	✓	✓			✓	✓
2. Geomechanics	✓		✓	✓		
3. Fluids						✓

more modes of failure

some trade-offs between criteria

Continuous variation obscures patterns

Defined accumulations

discrete criteria give binary feedback from drilling

so. . .

best fields drilled early

best locations within each field drilled early

diminishing results through development

Continuous accumulations

ambiguous feedback

- stochastic variation within a common geologic area
- uncertainty in reserves estimation

requires many more wells to delineate areas and ranges of recoveries

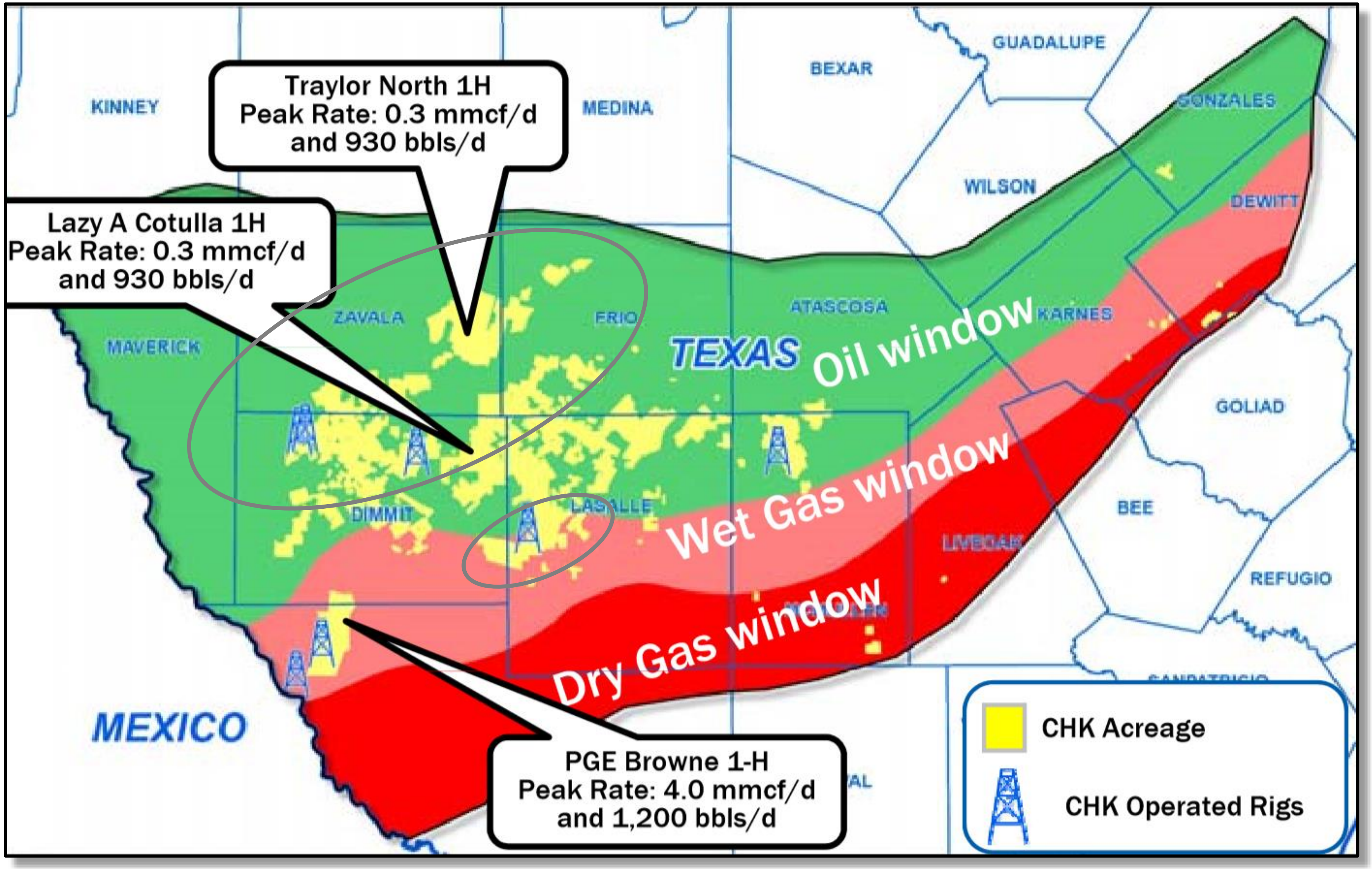
so. . .

slow and diffuse high-grading of acreage

- often mistaken for technology improvements

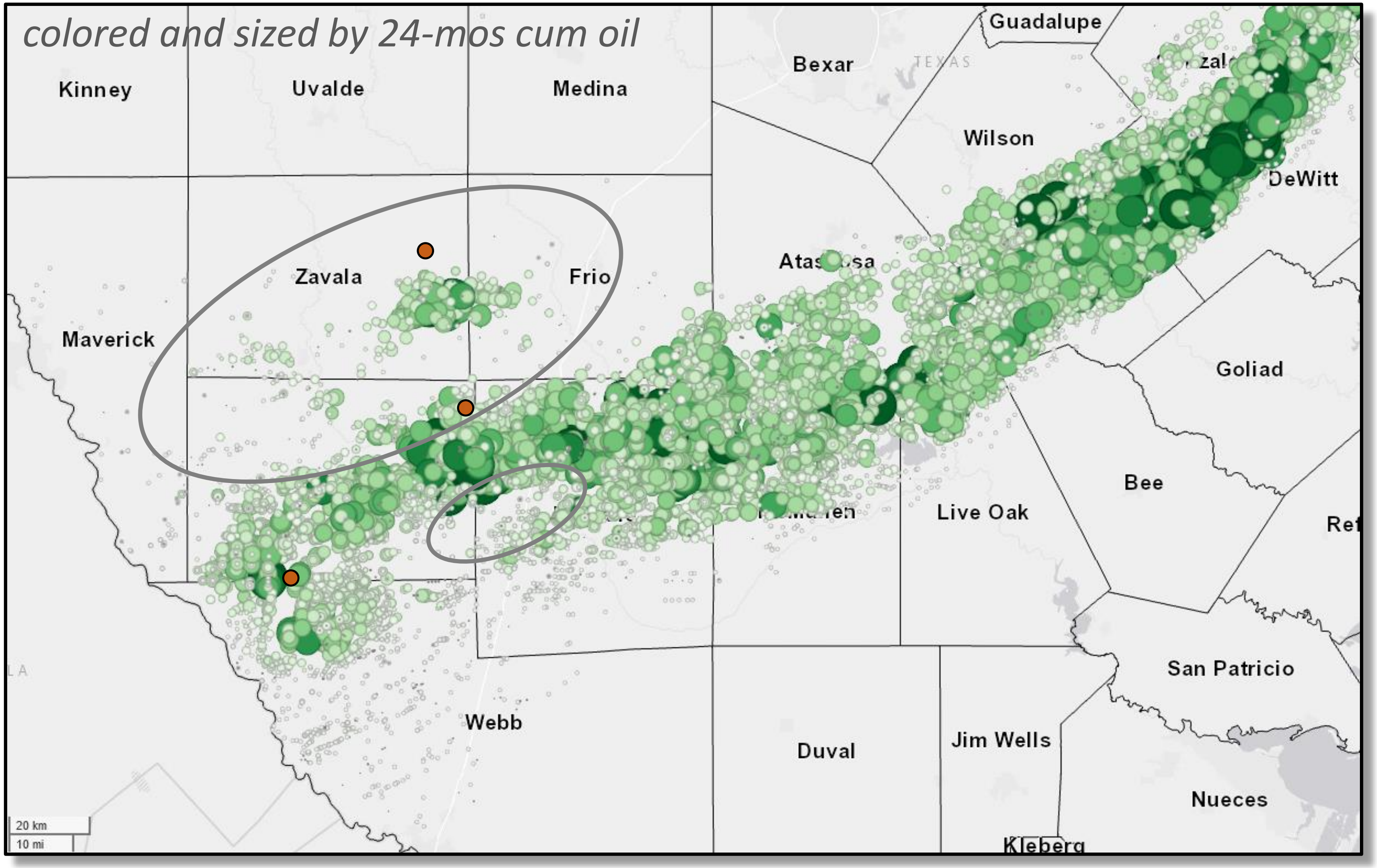
Better theory could shorten delineation and avoid more uneconomic areas

“[O]ptimal mix of permeability and thermal maturity”. . .

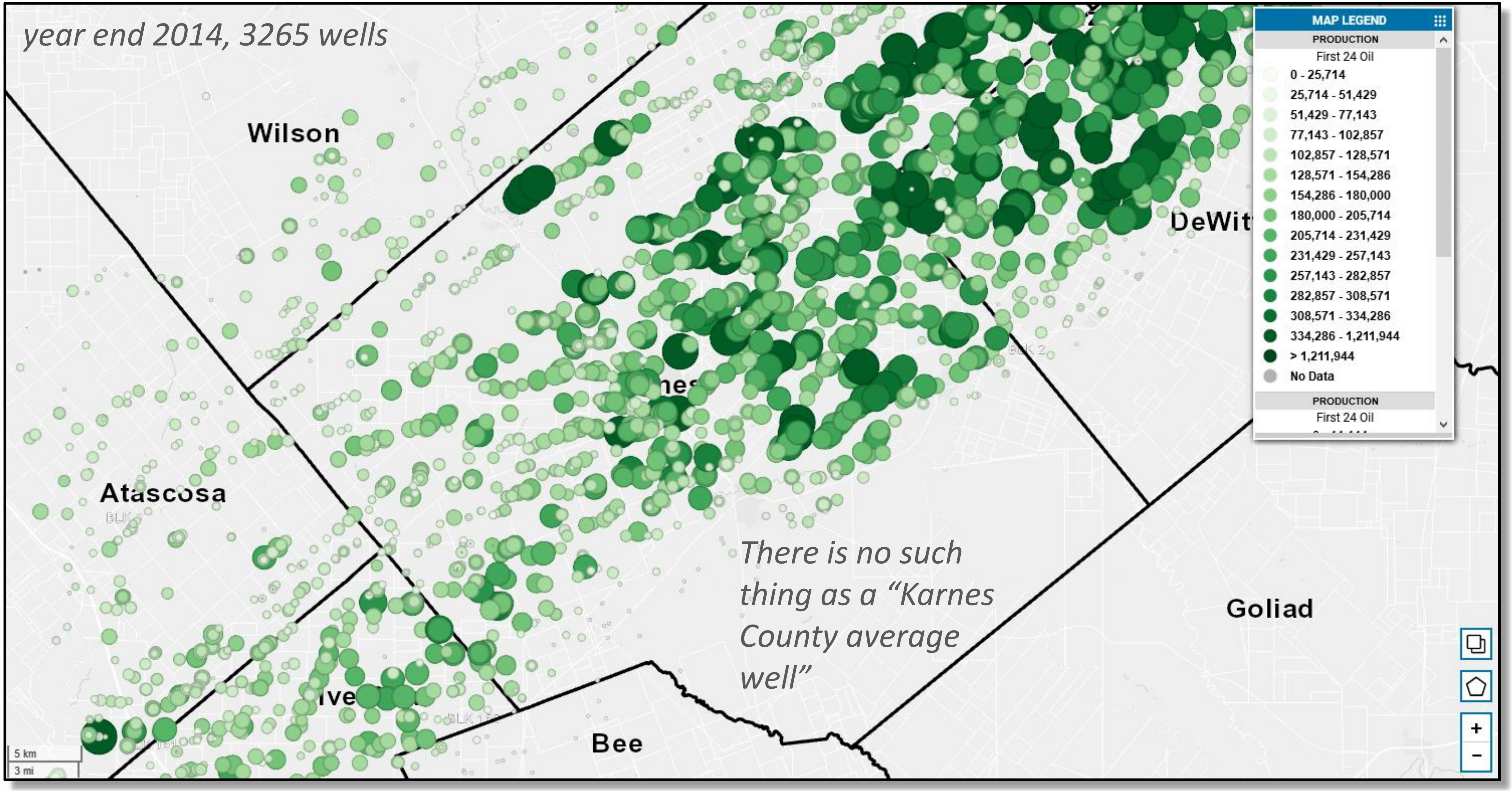


CHK investor presentation, Aug 4, 2010

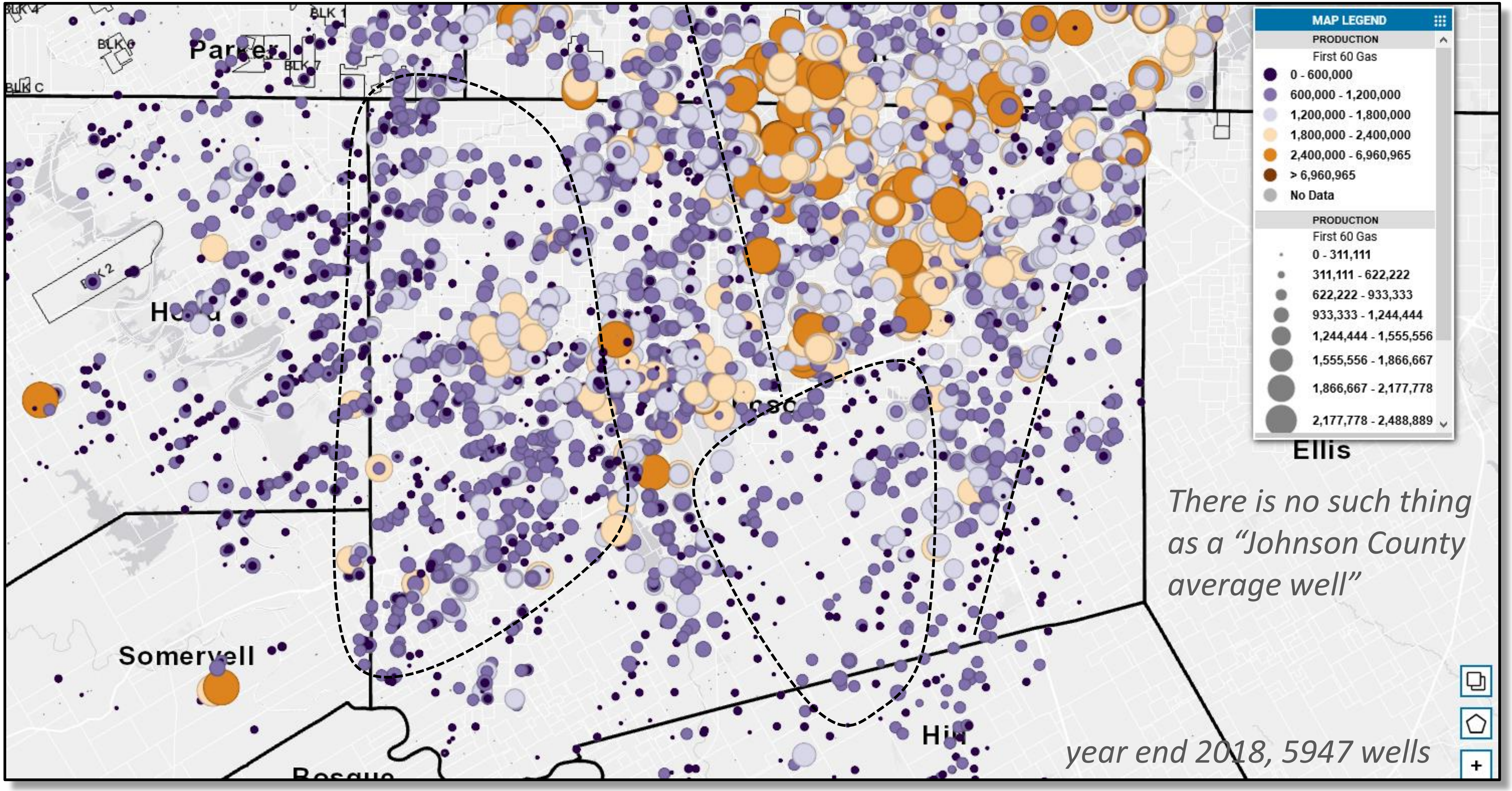
. . .turned out not to be



Patterns are clearly defined after thousands of wells



Some area boundaries could be defined in advance, others not



There is no such thing as a "Johnson County average well"

year end 2018, 5947 wells

Thank You!

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