How Not to Squander Billions on Your Next Unconventional Venture*

Creties Jenkins[1] and Mark McLane[1]

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[1]Rose and Associates LLP, Houston, Texas (cretiesjenkins@roseassoc.com)

Abstract

Over the past decade, hundreds of unconventional oil and gas projects have failed to deliver the value promised to shareholders. While most of the companies involved in these failures would like you to believe they were unforeseen and caused by external factors, a great many occurred because of the way opportunities have been appraised and developed. Two of the most common mistakes have been focusing on production attainment instead of value creation, and incorrectly thinking that enough was understood about a given reservoir to push ahead with development.

To mitigate these errors, unconventional opportunities need to be evaluated in a series of stages. In each stage, we need to (1) identify the key uncertainties and risks, (2) collect the data needed to quantify these, and (3) generate a probabilistic assessment of potential outcomes and their associated value. A key aspect in this evaluation is not only using rock and fluid data to identify the area with the greatest potential, but also drilling enough wells to understand the production variance and whether the average well will be commercial. This includes quantifying the range of average well performance and the likelihood of achieving some minimum rate.

Multiple tools are needed for this work, including aggregation (i.e. trumpet) plots, confidence curves, and sequential aggregation plots, which can all be derived from Monte Carlo simulation modeling. Key outputs from such models include a project expected value and a chance of success associated with each project stage. Most importantly, the model can be modified to help ensure that if the project fails, it does so in the early stages so that capital losses are minimized.

This process requires discipline, including maintaining consistent drilling and completion practices so variations in reservoir quality can be understood in the early stages of the project. To help ensure a disciplined approach is followed, it is important to implement an assurance process consisting of (1) clear guidelines and workflows, (2) peer reviews and assists, and (3) periodic performance lookbacks. The time to do this is now, so we can live within our cash flow and return more value to investors.

How Not to Squander Billions on Your Next Unconventional Venture

Creties Jenkins & Mark McLane
Rose and Associates, LLP

2020 AAPG Pacific Section Convention
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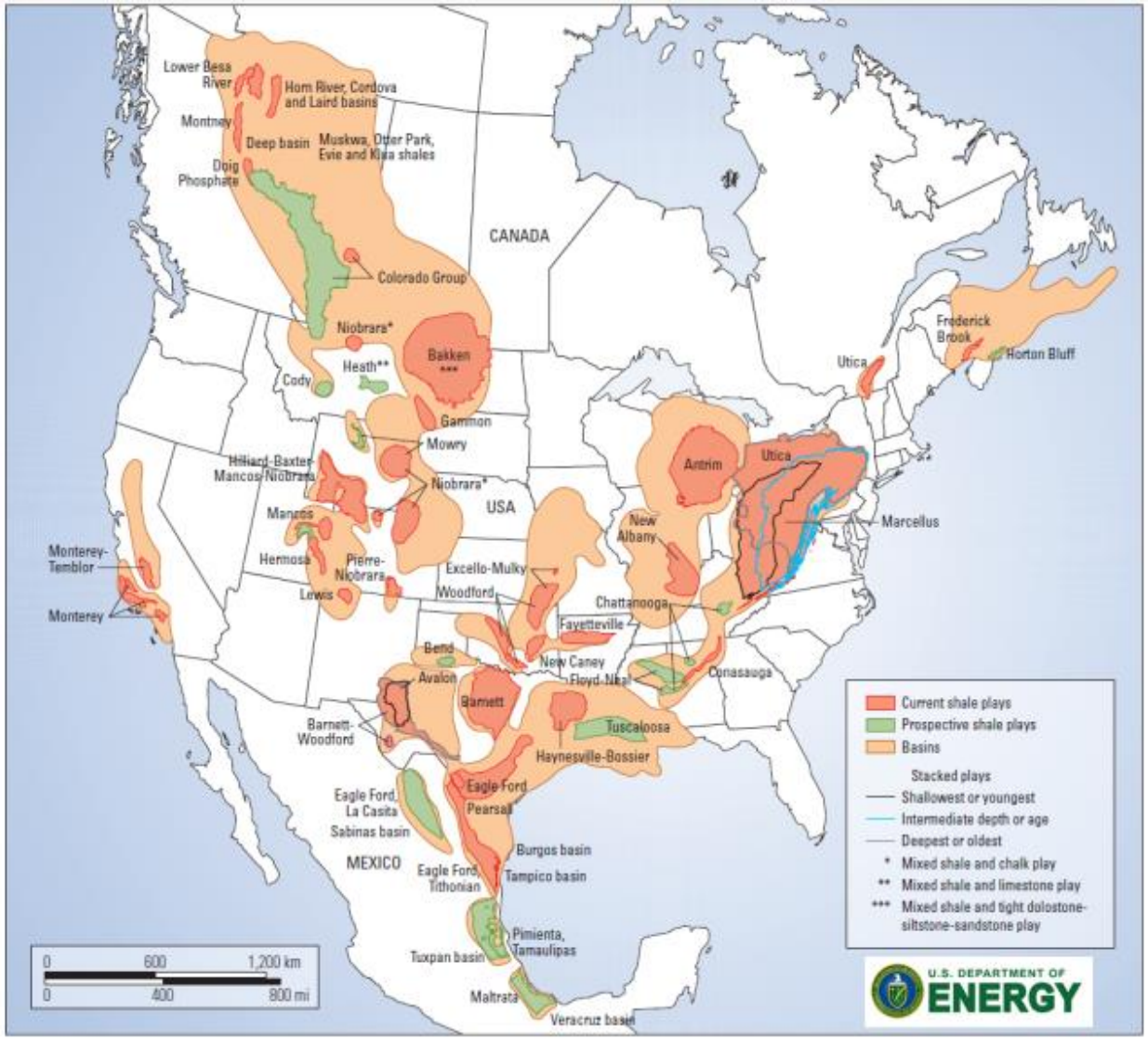
Do We Squander Billions?

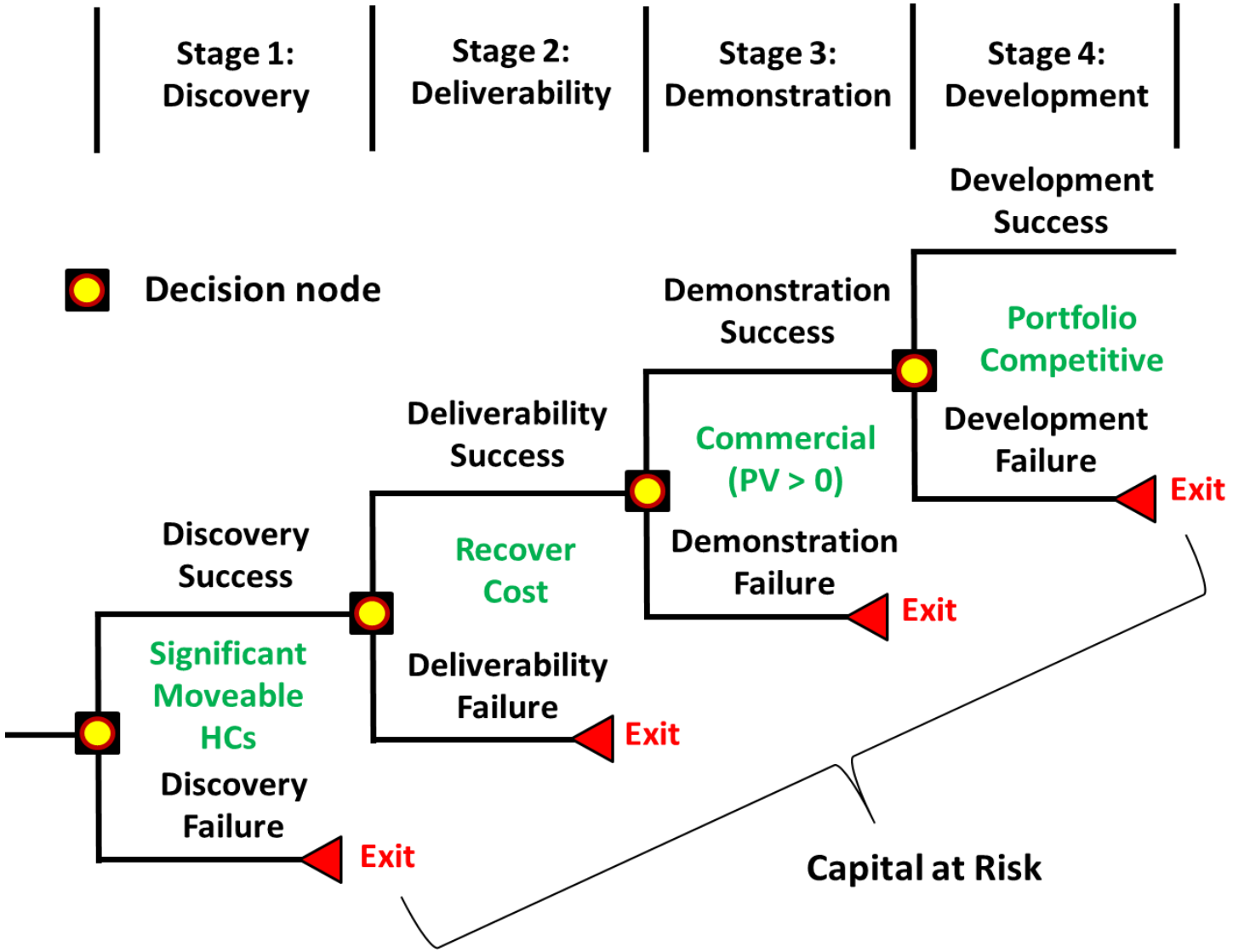
- 29 companies in a Wall Street Journal analysis spent $112 billion more in cash than they generated from operations in the last 10 years
  - Thousands of locations are yielding less than owners projected to investors
- The production forecasts made by many of these companies are dangerous because they are based on a small sample of wells
  - There is profound variability in the performance of wells because of the complexity of shale basins
- This is occurring against a backdrop of 215 North American oil and gas companies filing for bankruptcy from 2015-2020
  - With nearly $130 billion in aggregate debt

Map of N. American Shale Plays



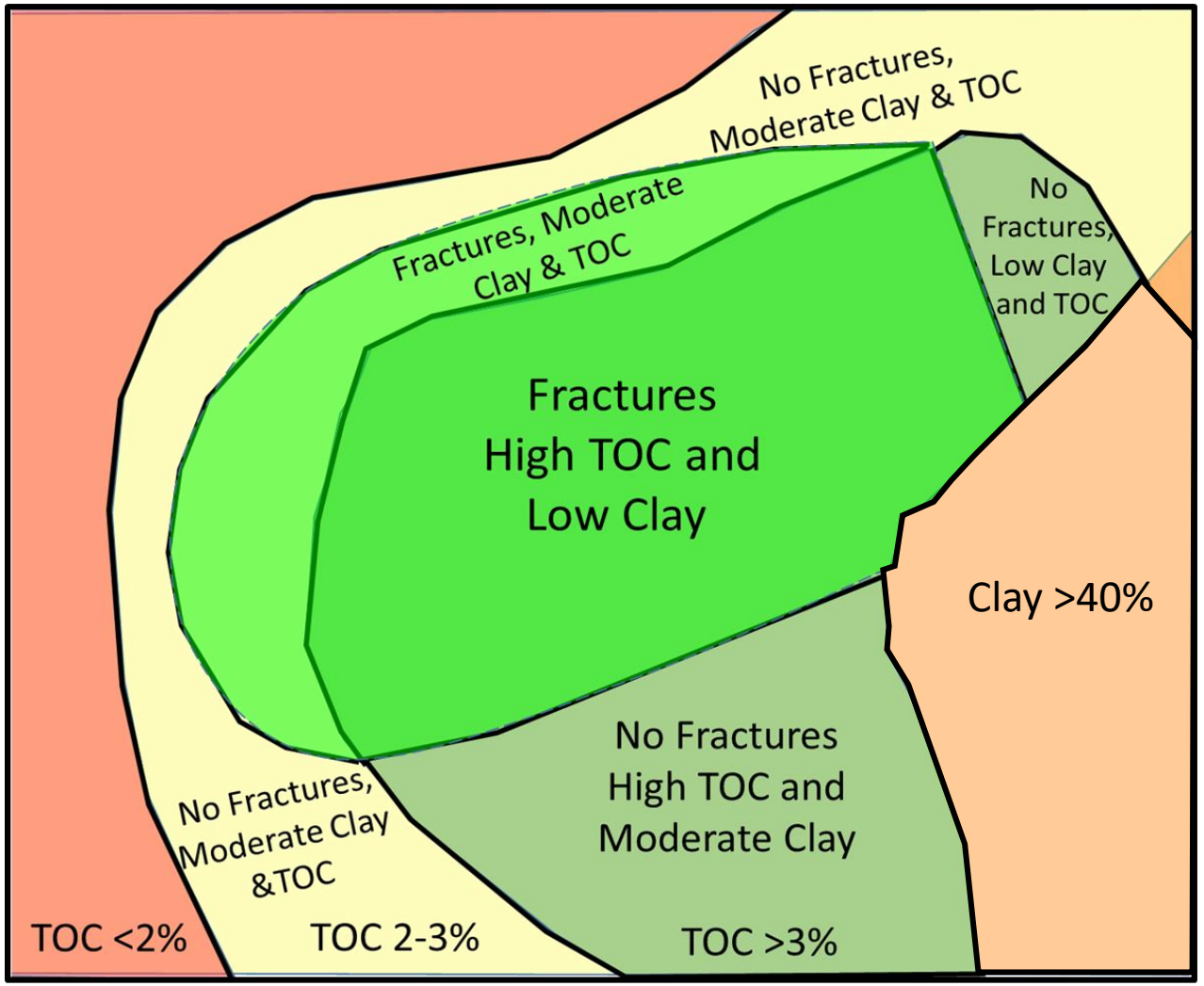
- What percentage of targeted shales have been commercialized?
- What percentage of an average basin is underlain by commercially recoverable hydrocarbons?
- Small commercial areas emphasize the critical need to be in the RIGHT area of the RIGHT basin
- If you're not in a commercially viable area, you need to know this quickly to minimize the capital spent

The Staged Approach



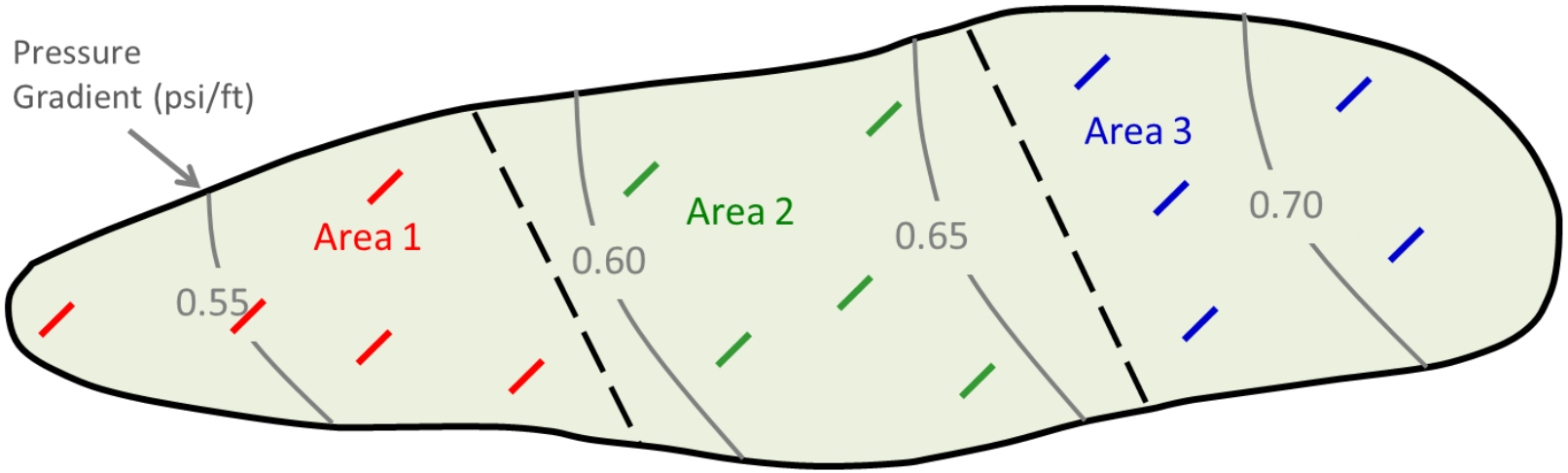
- Decision to invest more capital or exit the project must be made at each node
- Success is based on attaining pre-determined thresholds
- Why do companies find it so difficult to rigorously implement this decision tree?
- Pressure to act quickly, create favorable outlooks, minimize pre-development time and cost, and keep rigs busy

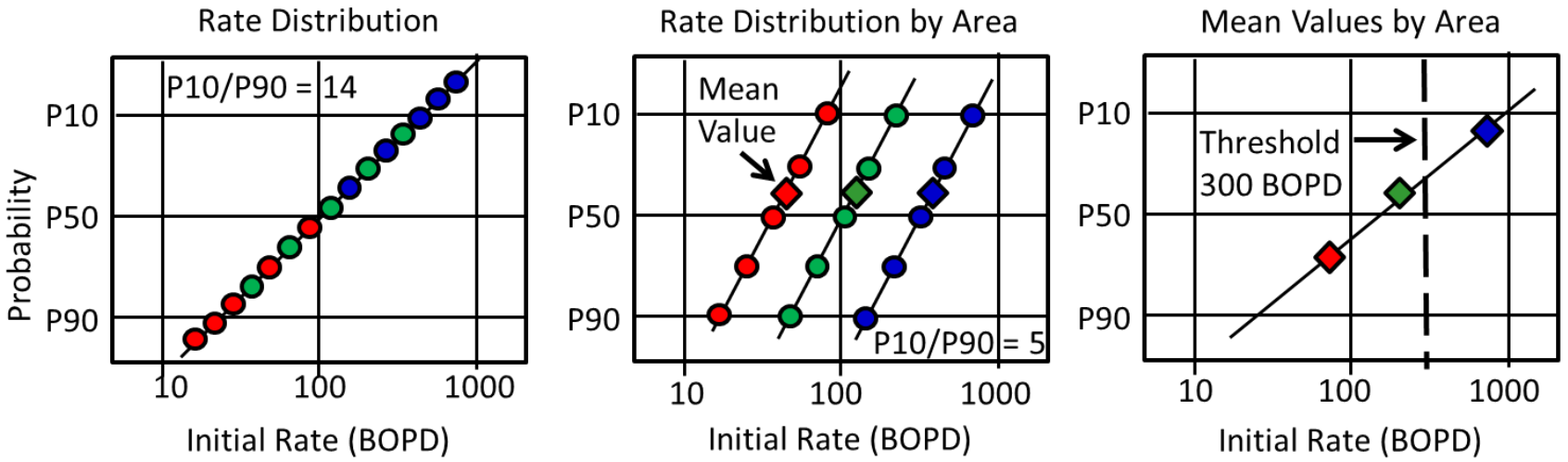
Discovery Stage



- Identify basins with working petroleum systems and associated fairways
- Build and overlay volumetric and producibility play maps
- Estimate play chance and prospective resources
- Divide into screening, discovery well, and delineation sub-stages

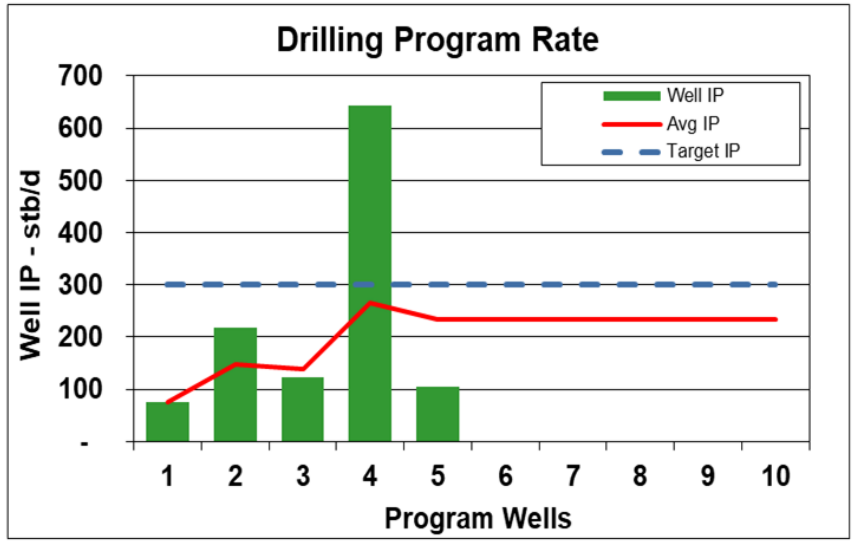
Deliverability Stage

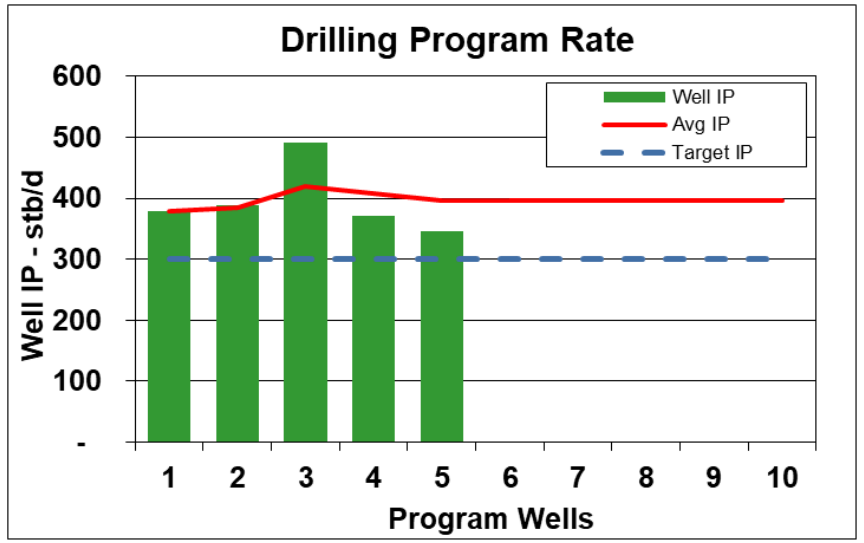


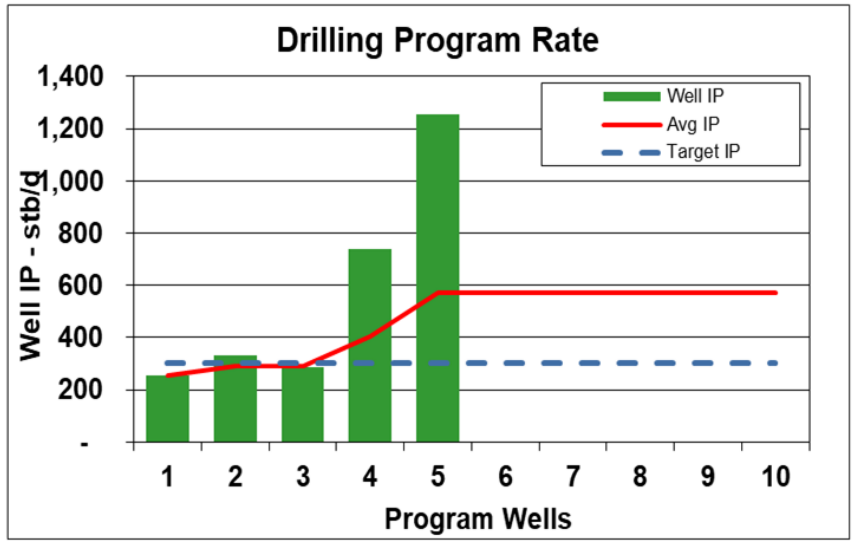


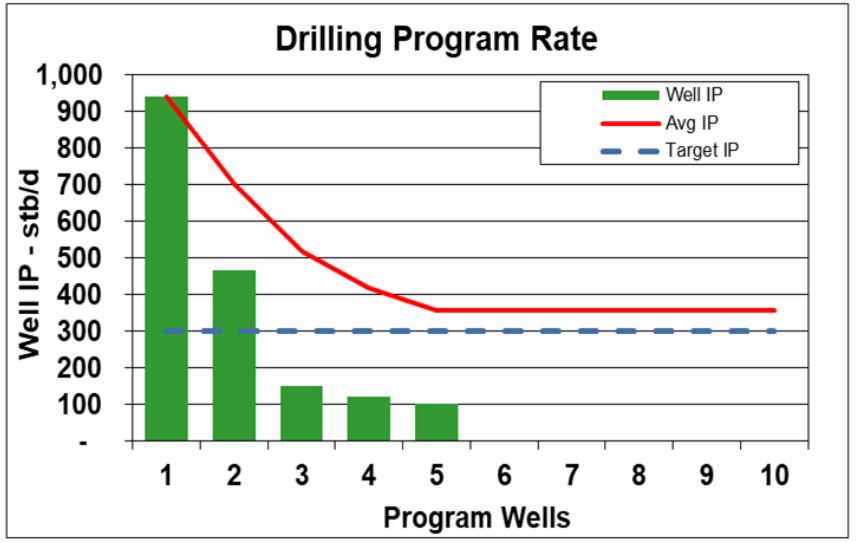
- Average well needs to exceed some initial rate threshold
- Similar drilling, completion and production practices should be used
- High P10:P90 ratios indicate the area should be divided into smaller geologic domains

Fooled by Randomness



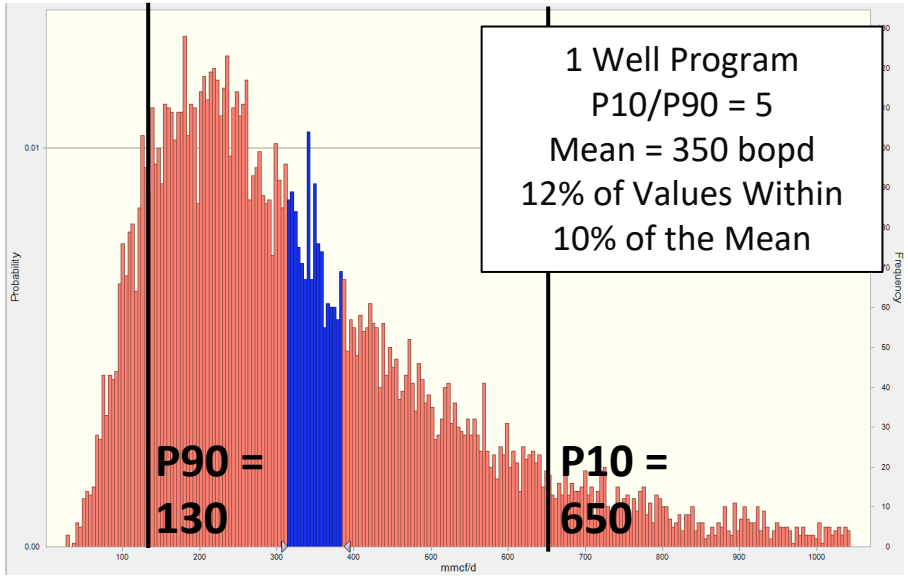


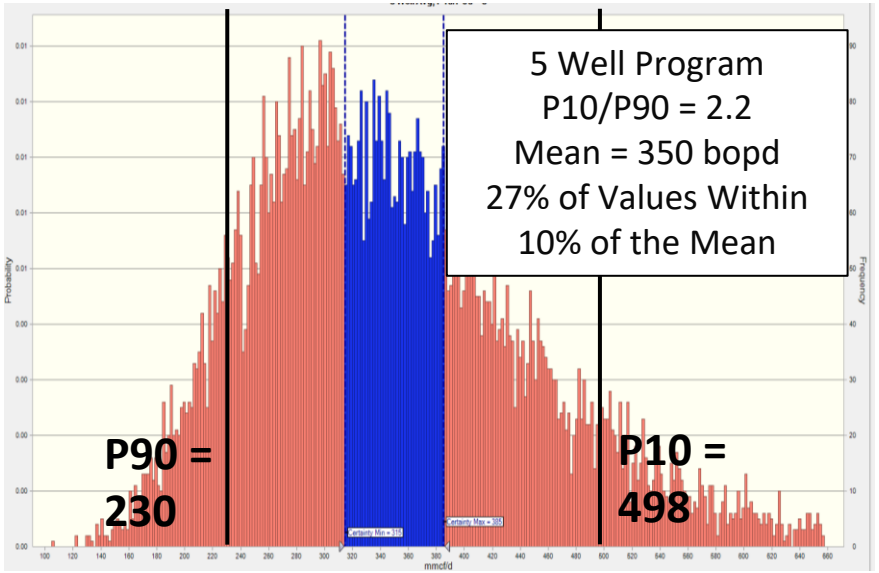


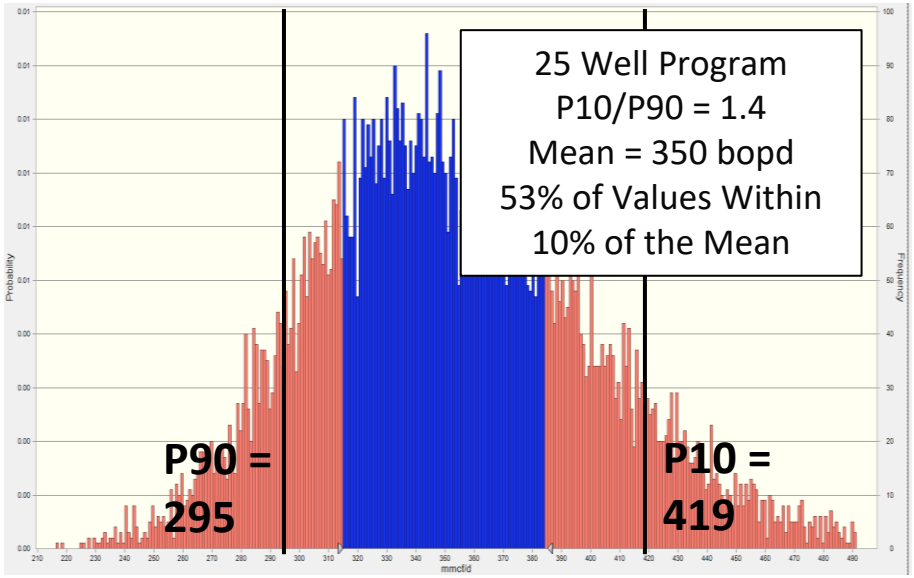


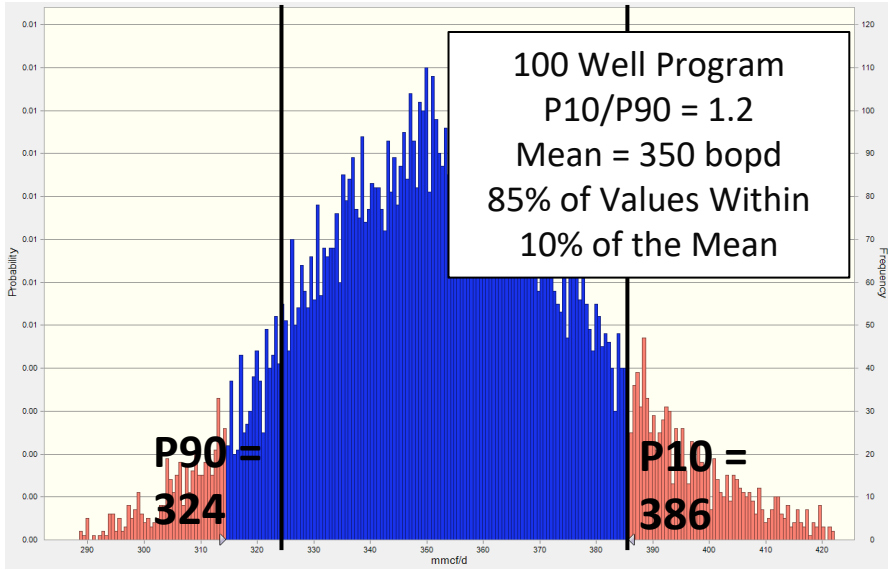
- 5-well drilling programs in a reservoir where mean = 350 BOPD and P10:P90 = 5 from analogs
- Assuming that the *average* well must exceed a threshold of 300 BOPD, can a 5-well program provide confidence of this?

Aggregation



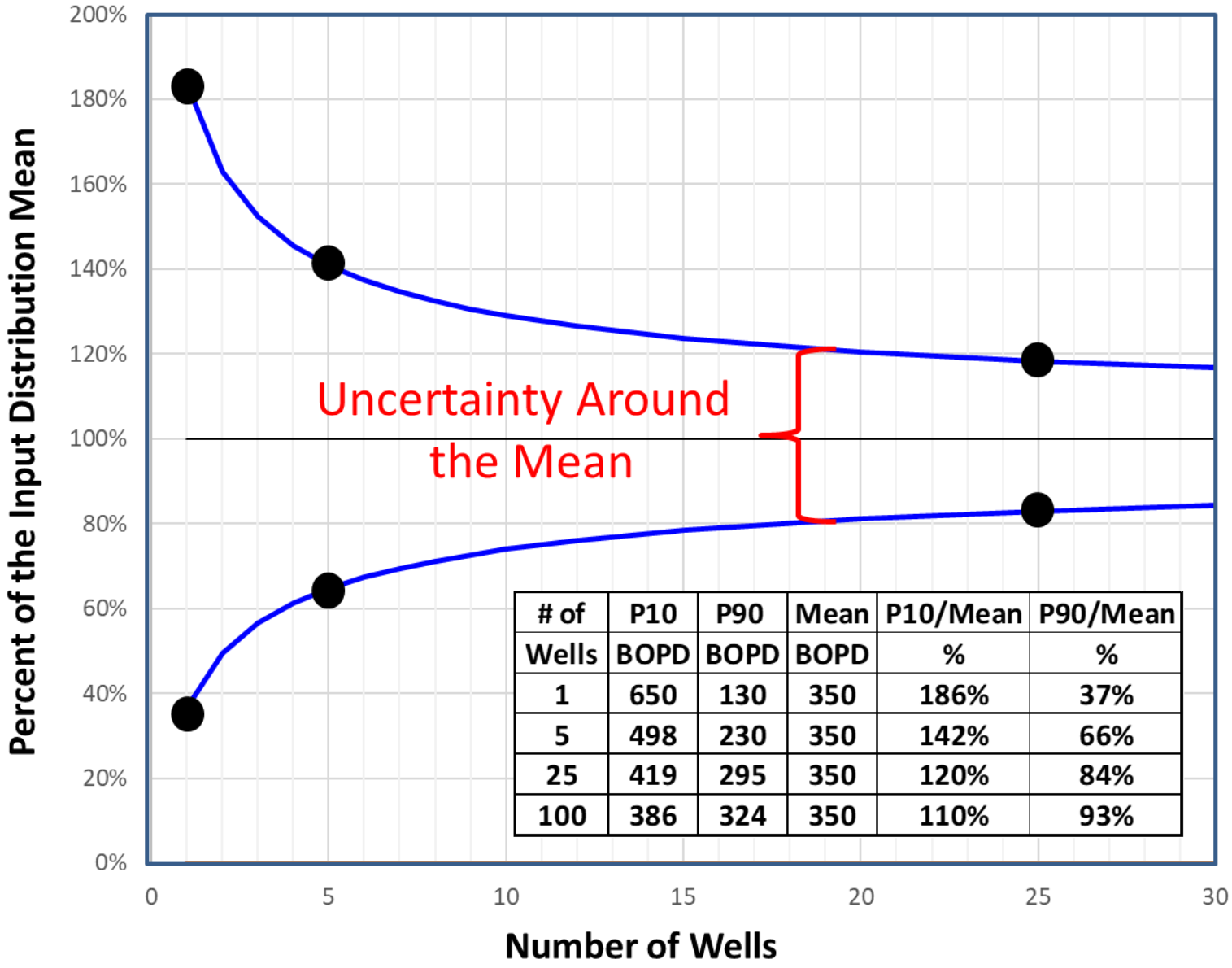






- Frequency plots show outcomes of 1, 5, 25, and 100 well programs for mean = 350 BOPD and P10:P90 = 5
- By drilling larger well programs, we reduce the uncertainty of the average outcome which is converging on the mean

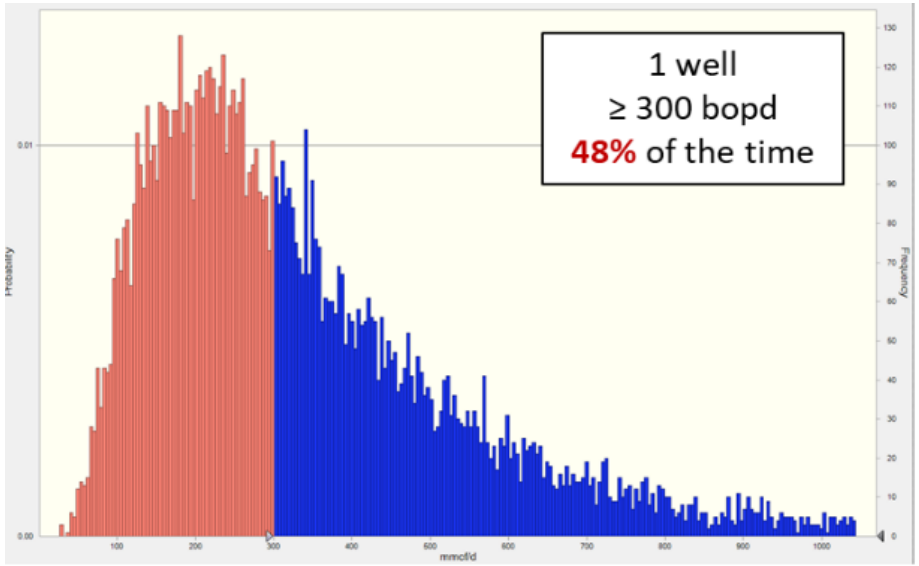
Trumpet Plot

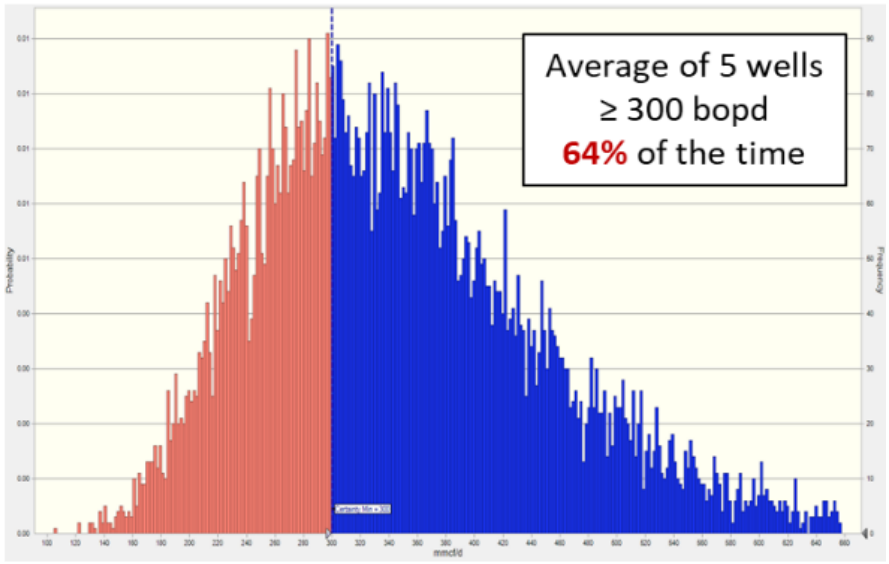


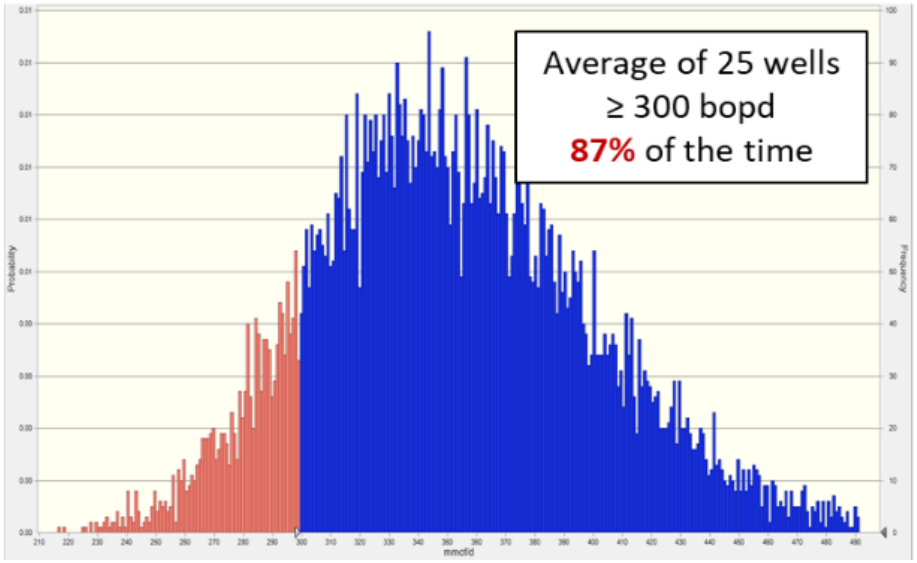
# of Wells	P10 BOPD	P90 BOPD	Mean BOPD	P10/Mean %	P90/Mean %
1	650	130	350	186%	37%
5	498	230	350	142%	66%
25	419	295	350	120%	84%
100	386	324	350	110%	93%

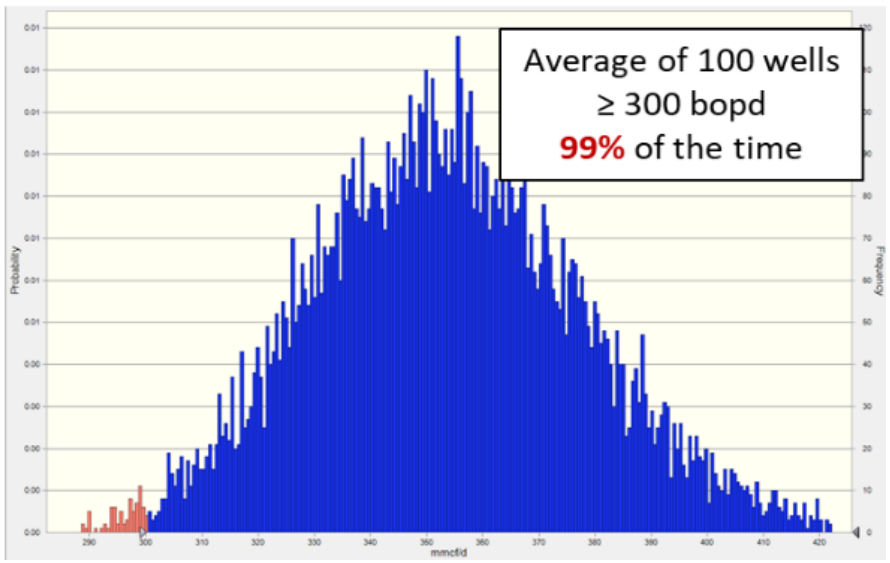
- Shows compression of the frequency plots around the mean as more wells are added
- Resulting values, expressed as percentages, create upper (P10) and lower (P90) bounds.
- The separation between these bounds is referred to as “Uncertainty Around the Mean” and is centered along the 100% confidence line.

Confidence



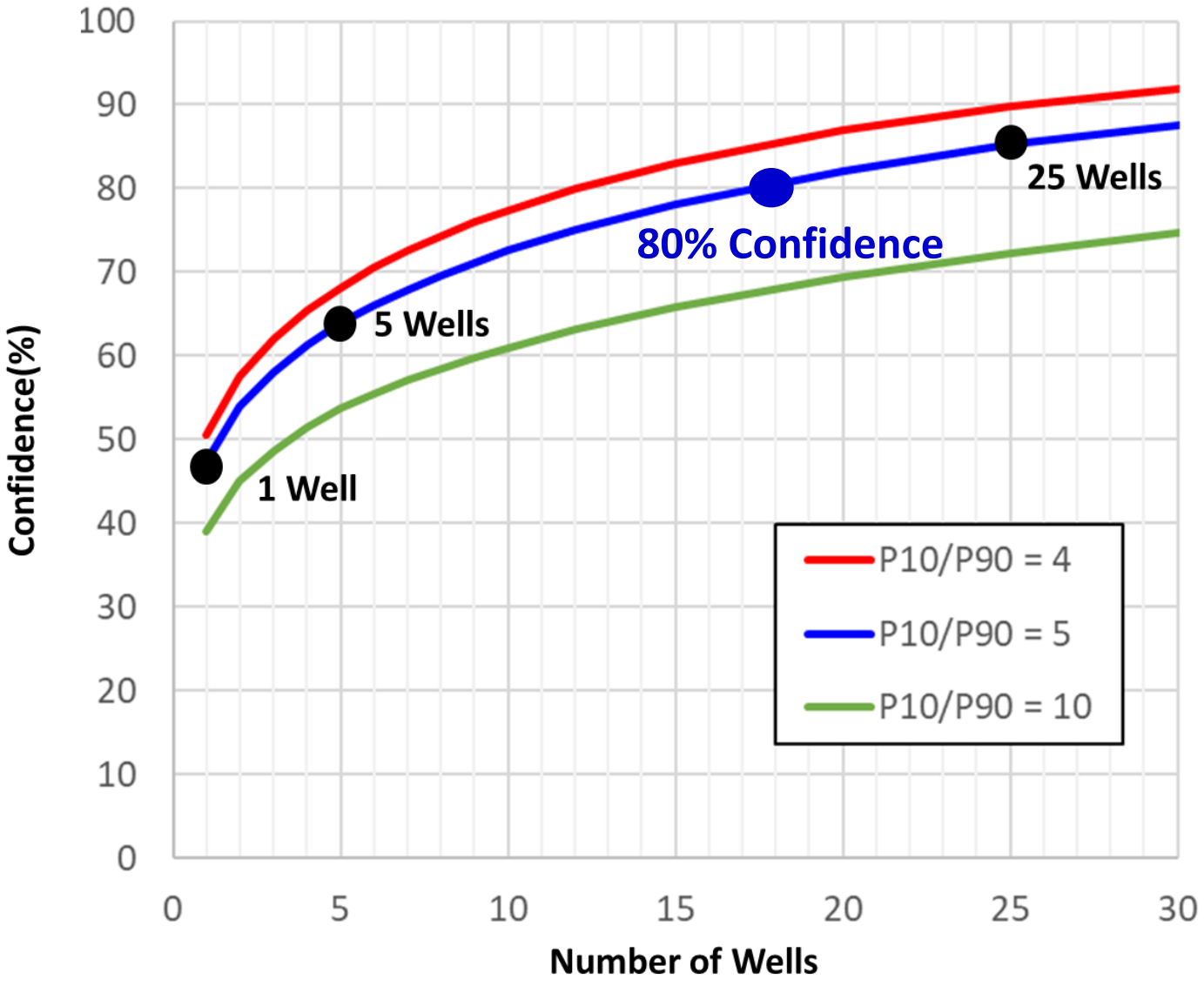






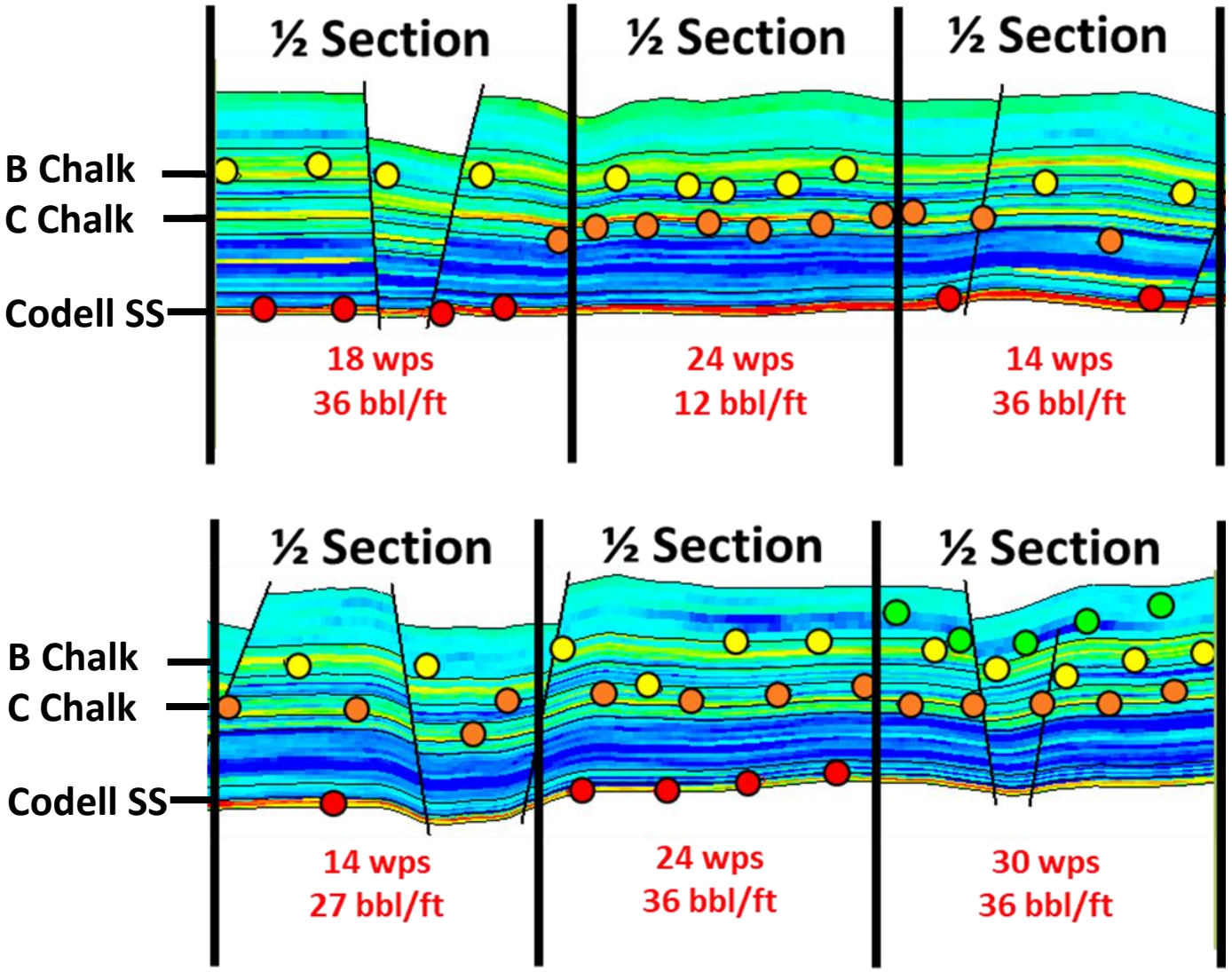
- Frequency plots can be used to estimate the chance that a well program will meet or exceed a given threshold for a given P10:P90 ratio.
- In this case, for a 5-well program, a 300 BOPD threshold and a P10:P90 ratio of 5, there is about a 1 in 3 chance you'll walk away from a commercial venture

Confidence Curves



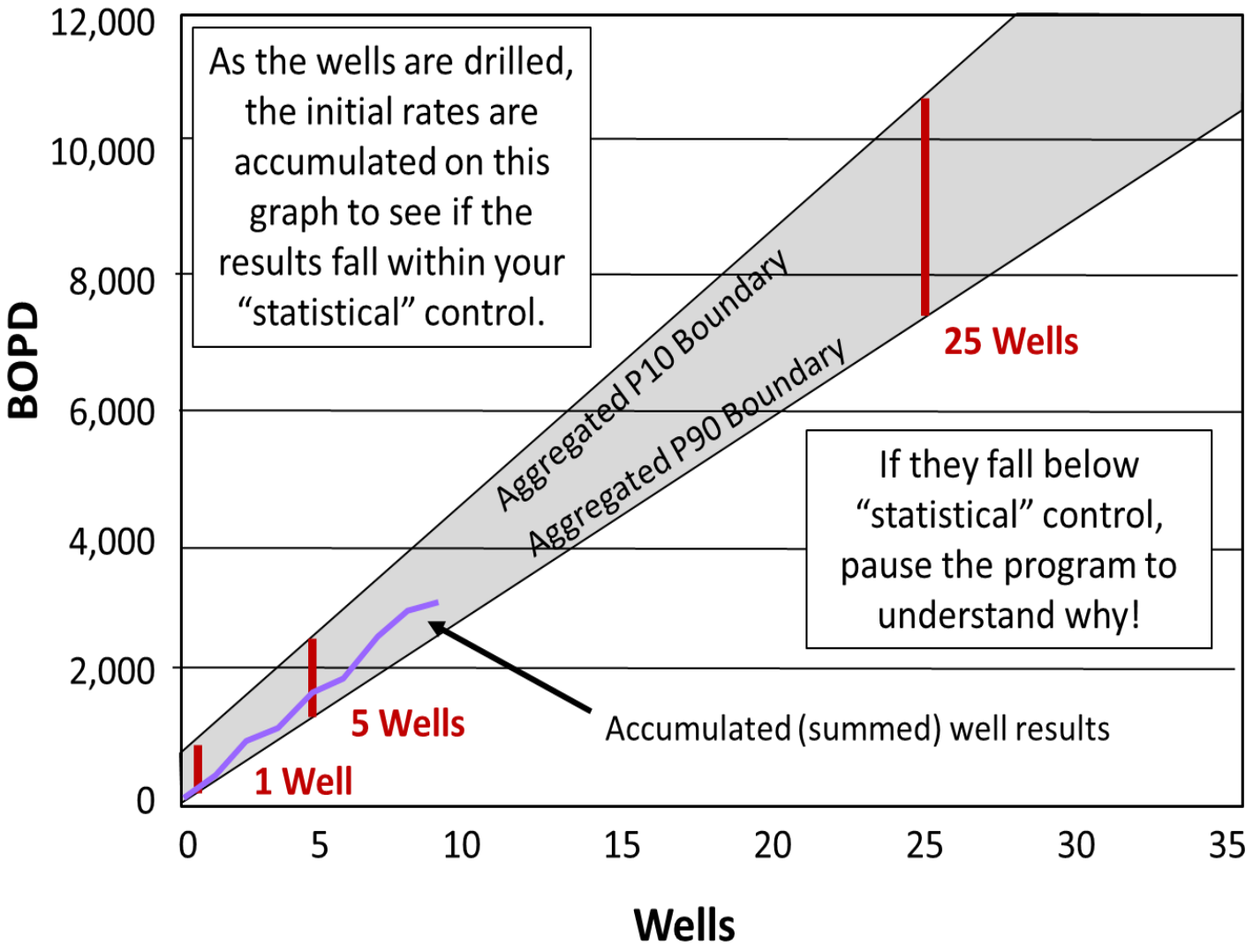
- The data from the frequency plots can be used to estimate how many wells will be needed to attain a certain level of confidence for a given P10:P90 ratio
- For a P10:P90 ratio of 5, to have an 80% confidence of reaching the threshold rate of 300 BOPD, 18 wells would have to be drilled
- The number of wells is fewer for lower P10:P90 ratios, greater for higher P10:P90 ratios

Demonstration Stage



- Optimize well spacing, validate production type curve(s), drive down costs
- Average well needs to be commercial (PV > 0)
- May be advisable to implement several of these projects
- These are important locations for diagnostic work
- A good example is the South Hudson project in DJ Basin (Anadarko Petroleum)

Development Stage



- Ensure that results from new wells meet expectations
- Key tool for this is a *sequential aggregation plot*
- Boundaries are the aggregated P90 and P10 initial rate values as a function of well program size
- Plot shows us whether we are delivering within the range of expected outcomes
- If not, we need to pause the program and understand "why"

Summary (1/2)

- Hundreds of unconventional oil and gas projects have failed to deliver the value promised to shareholders.
- Two of the most common mistakes have been focusing on production attainment instead of value creation, and incorrectly thinking that enough was understood about the reservoir to push ahead with development.
- To mitigate these errors, unconventional opportunities need to be evaluated in a series of stages. In each stage, we need to:
  - Identify the key uncertainties and risks
  - Collect the data needed to quantify these
  - Generate a probabilistic assessment of potential outcomes and their associated value.

Summary (2/2)

- A key aspect of reservoir evaluation is drilling enough wells to understand the production variance and whether the average well will be commercial.
- Multiple tools are needed for this work including aggregation, trumpet plots, confidence curves, and sequential aggregation plots, which can all be derived from Monte Carlo simulation modeling.
- This process requires discipline, including maintaining consistent drilling and completion practices so variations in reservoir quality can be understood in the early stages of the project.
- To help ensure a disciplined approach is followed, an assurance process is needed consisting of 1) clear guidelines and workflows, 2) peer reviews and assists, and 3) periodic performance lookbacks.

Acknowledgements / Thank You! / Questions?

- URTEC-198318, 2019, How Not to Squander Billions on Your Next Unconventional Venture
- Fracking's Secret Problem—Oil Wells Aren't Producing as Much as Forecast, WSJ, 2Jan19
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- Edward Dodge, North American Energy Policy Integration
- Brad Berg, 2013-14 SPE Distinguished Lecture Presentation
- Jim Gouveia, 2017-2018 SPE Distinguished Lecture Presentation
- Mark McLane and Jim Gouveia, SPE 175527
- Mike Tryggestad & Walt Dobbs, Anadarko, Unconventional Reservoir Summit, Aug. 2017
- Patrick Miller and Jim Gouveia, SPE 195811