[AV]Characterizing Shale Plays—The Importance of Recognizing What You Don't Know*

Brad Berg[1]

Search and Discovery Article #110197 (2015)**
Posted August 10, 2015

*Adapted from presentation at the AAPG DPA Playmaker Forum 2.0, "DPA: Resources for Explorers," January 23, 2014, Houston, Texas

[1]Anadarko Petroleum Corporation, Houston, Texas (brad.berg@anadarko.com)

Abstract

Shale plays typically exhibit much more uncertainty in individual well performance than conventional reservoirs. Understanding this uncertainty is particularly critical during the exploration drilling program when one has relatively few wells on which to base decisions. A systematic approach to understanding and managing this uncertainty can be used to address key questions during the early phases of a drilling program, including "how many wells do I need to drill before I have confidence in the results?" and "does the well performance I've seen to date provide the encouragement needed to keep drilling?" To answer these questions, one must quantify the uncertainty surrounding individual well results. Key elements of this evaluation process include:

1. Identifying analogs that can provide insights into the level of well performance uncertainty to expect;
2. Stochastically modeling the potential range of well results from the testing program;
3. Deciding what level of risk is acceptable to the decision-makers; and
4. Planning and executing a testing program that incorporates these elements.

The primary take-away from this presentation is that it is critical to recognize, and properly characterize, uncertainty in shale well production performance when planning an exploration drilling program in shale plays. Without such an approach, the commercial potential of a play may not be adequately characterized, leaving the decision-makers without the information needed to determine the path forward. Understanding the uncertainty in well performance, and planning for it, will lead to more efficient exploration activity, and better informed decision-making.

CHARACTERIZING SHALE PLAYS
The Importance of Recognizing What You Don't Know

AAPG DPA Playmaker Forum 2.0, "DPA: Resources for Explorers," January 23, 2014, Houston, Texas

Also

SPE 2013-2014 Distinguished Lecturer Series

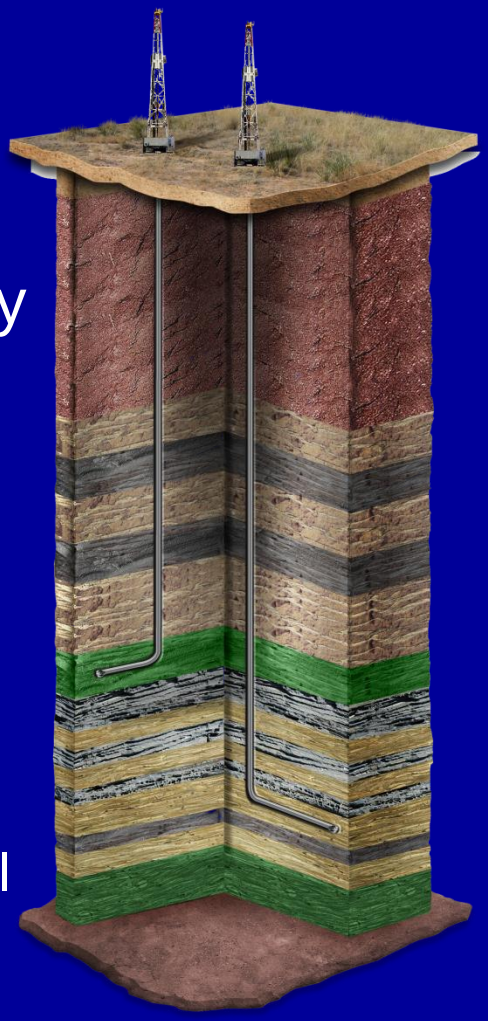
Brad Berg

SPE International

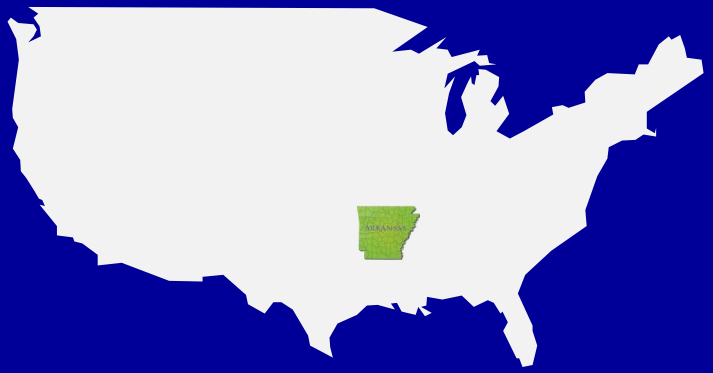
Anadarko Petroleum Corporation

The Character of Shale Plays

- We haven't been studying them very long
  - Most attention has been in the last 5 years
- Reservoir characteristics are difficult to quantify
  - Low matrix porosity & permeability
  - Presence of fractures is critical
  - Horizontal drilling and hydraulic fracturing required
  - Effective drainage area is hard to define
  - Recovery efficiencies poorly understood
- Measuring productivity
  - Geologic information alone is a poor predictor of well performance
  - Success is judged on well production
  - **With well production comes a lot of uncertainty**



Fayetteville Shale Play

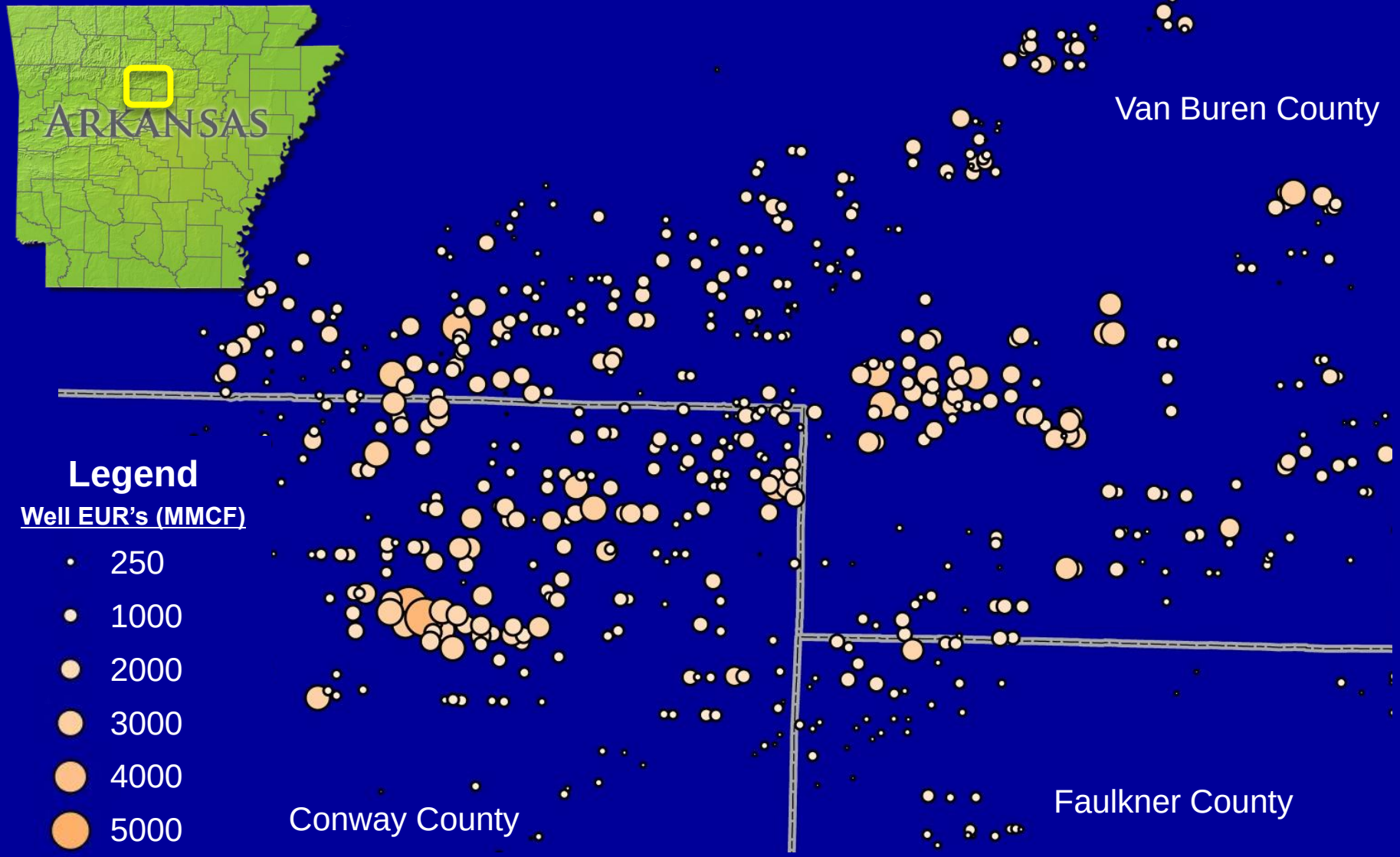


- One of the oldest shale targets, drilling began in 2004
- Mississippian-age shale at 1500- to 6500-foot depth
- Over 4000 wells drilled
- Examined 933 wells with extended production history
- Production forecasts ‘normalized’ to same completed horizontal length

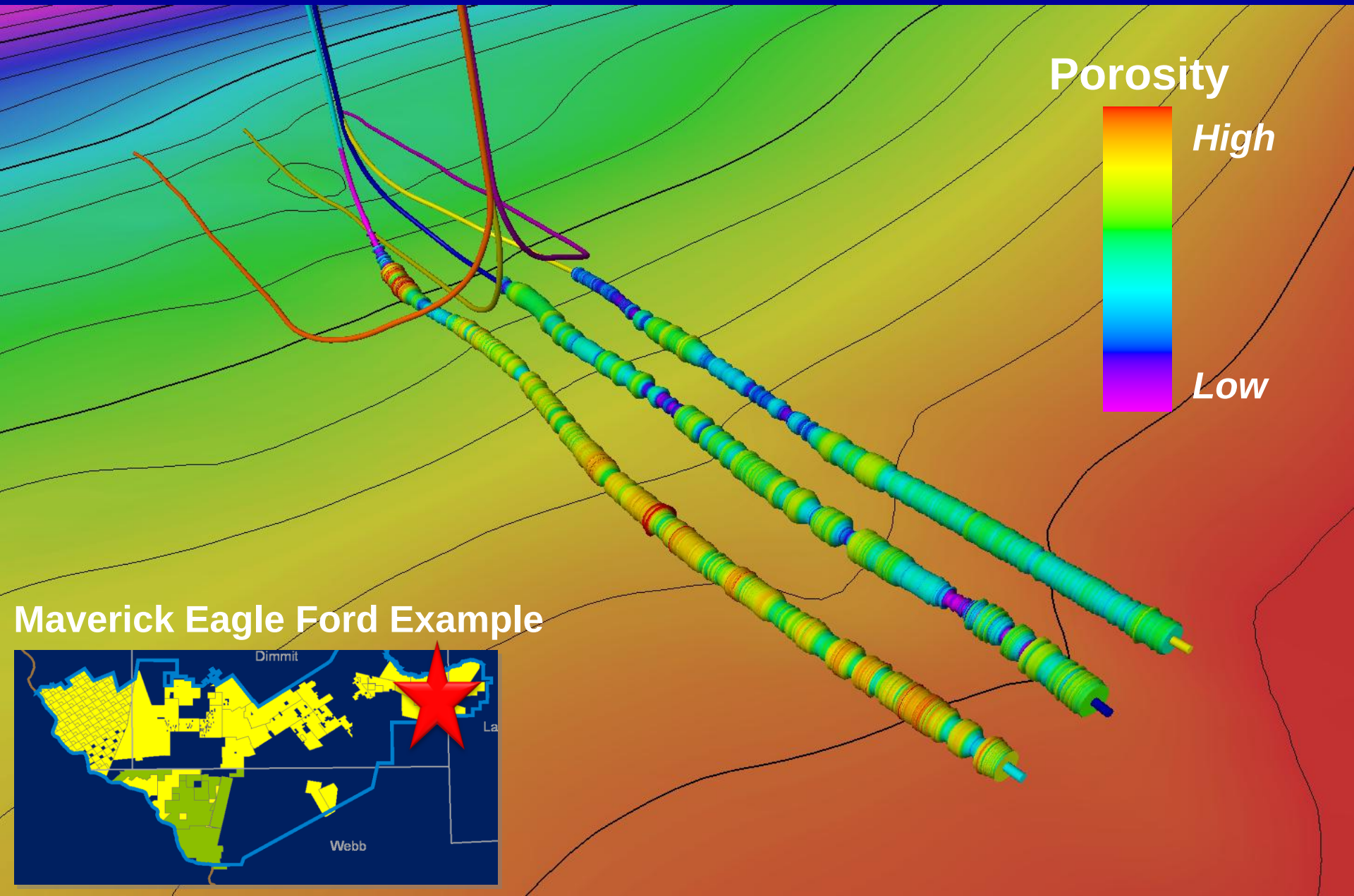
Challenges to Predicting Reservoir Performance

Fayetteville Shale Play

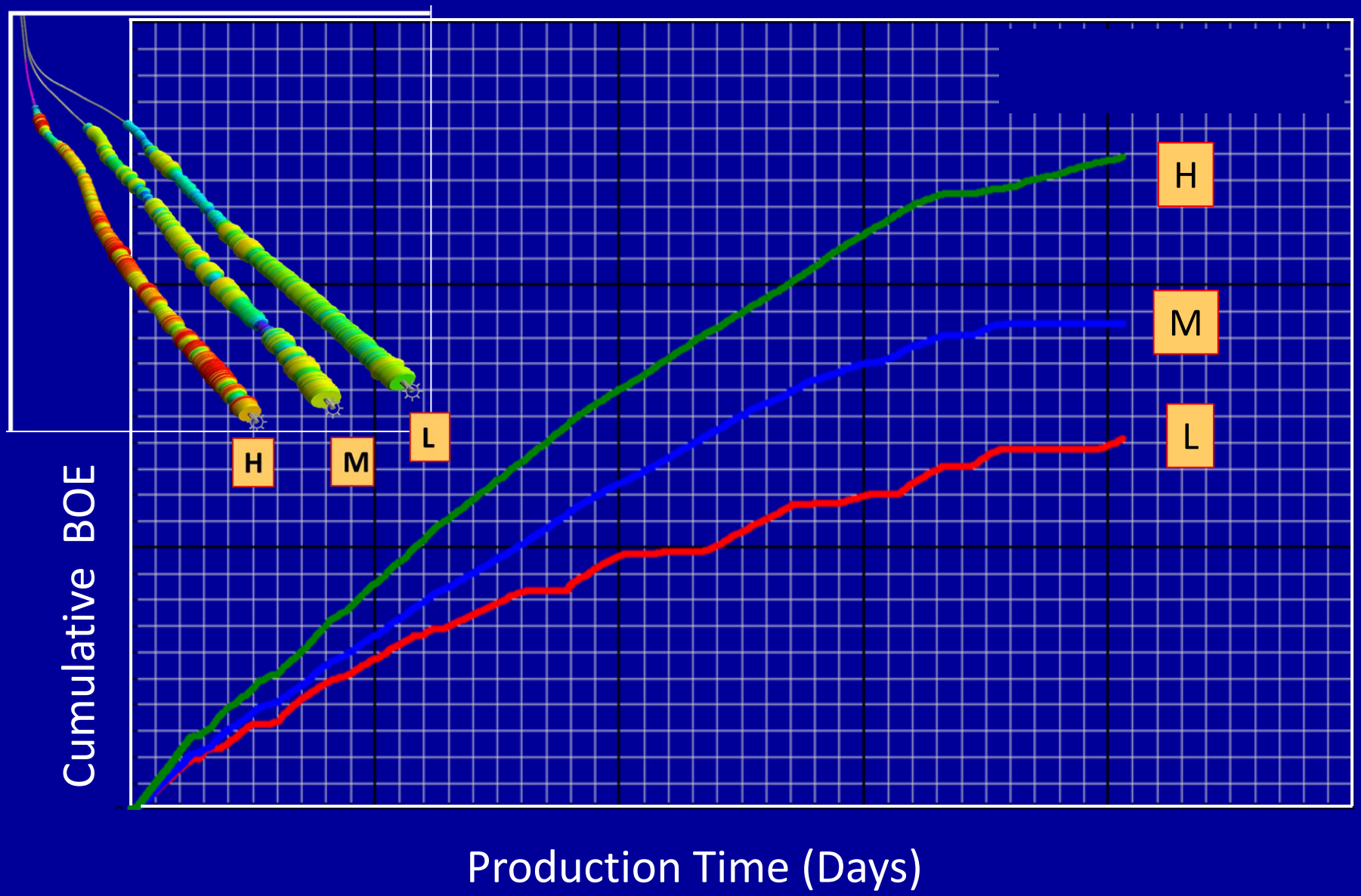
Well EUR's normalized to 3200' average lateral length



Challenges to Predicting Reservoir Performance



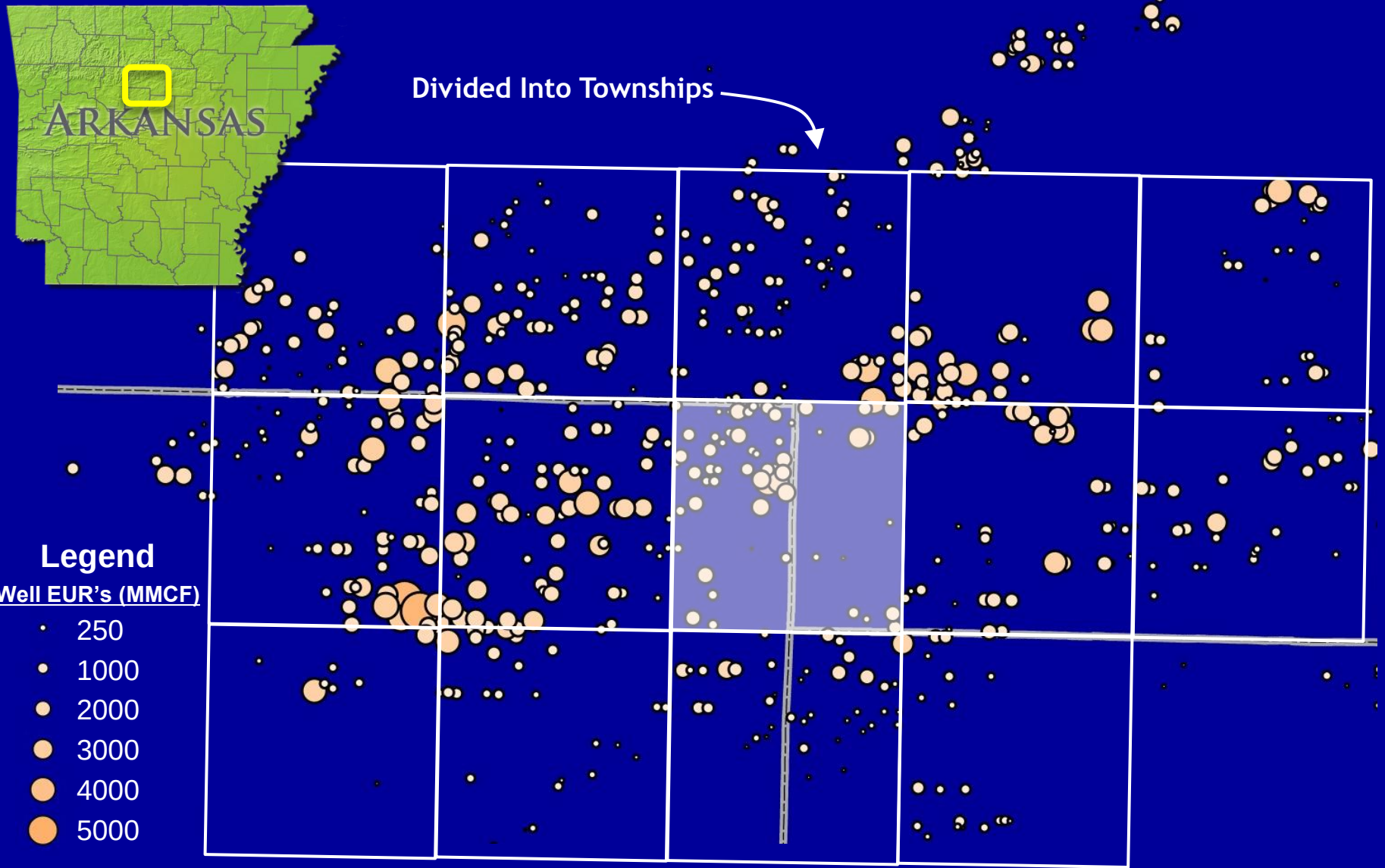
Challenges to Predicting Reservoir Performance



Challenges to Predicting Reservoir Performance

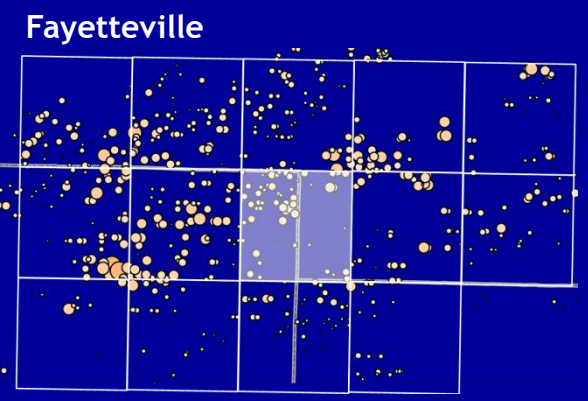
Fayetteville Shale Play

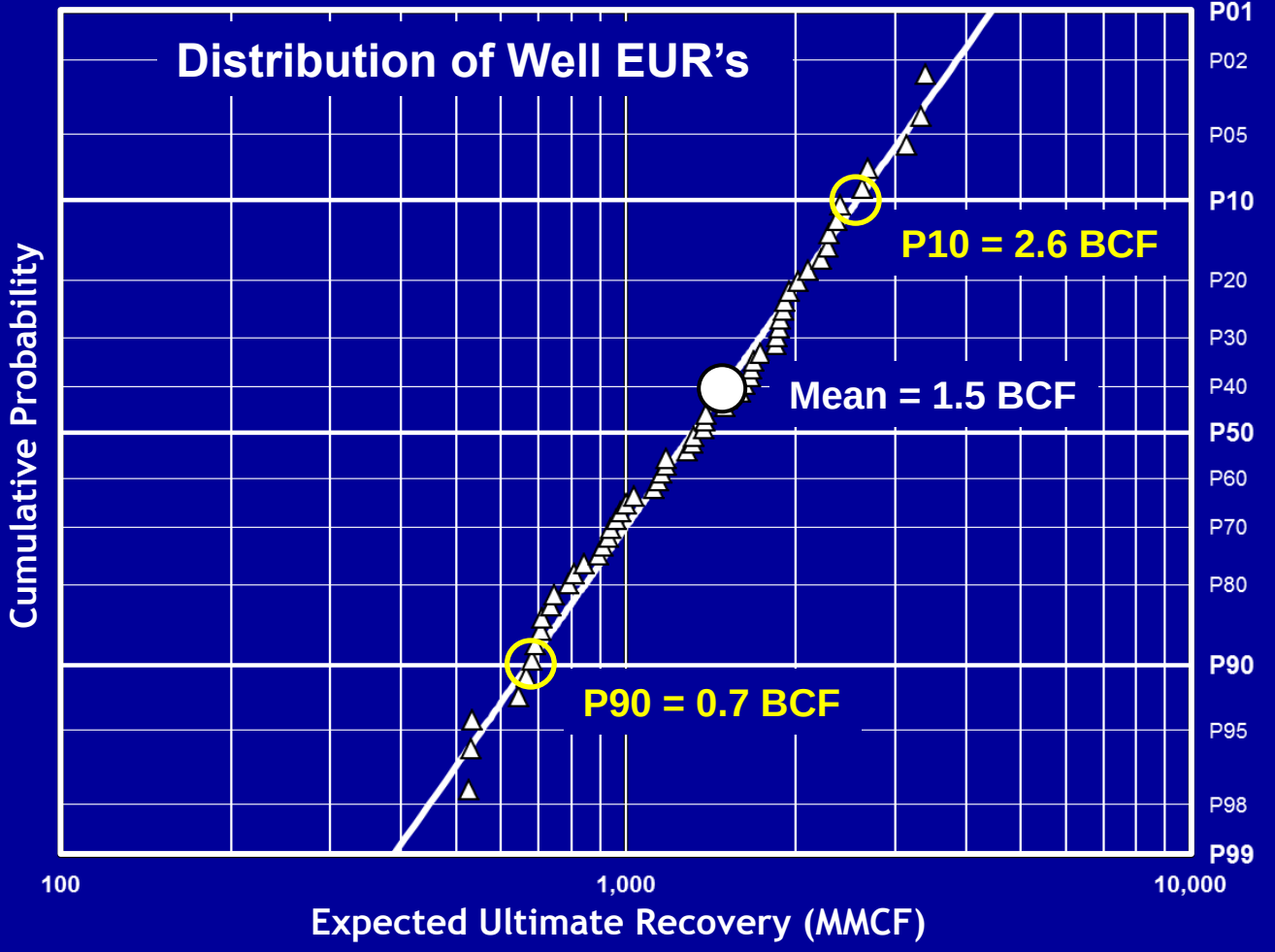
Well EUR's normalized to 3200' average lateral length



Measuring Uncertainty in Well Performance

- The uncertainty range, or variance, of the distribution is measured as P10/P90 ratio.

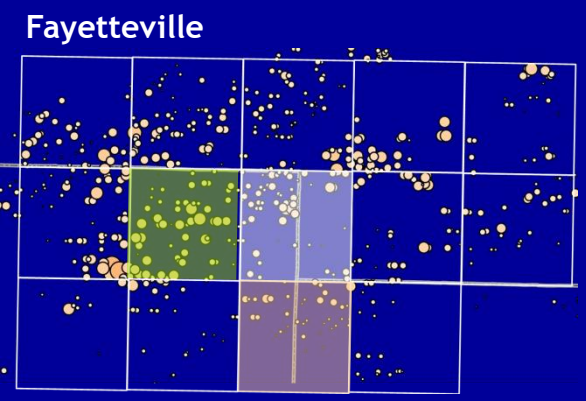


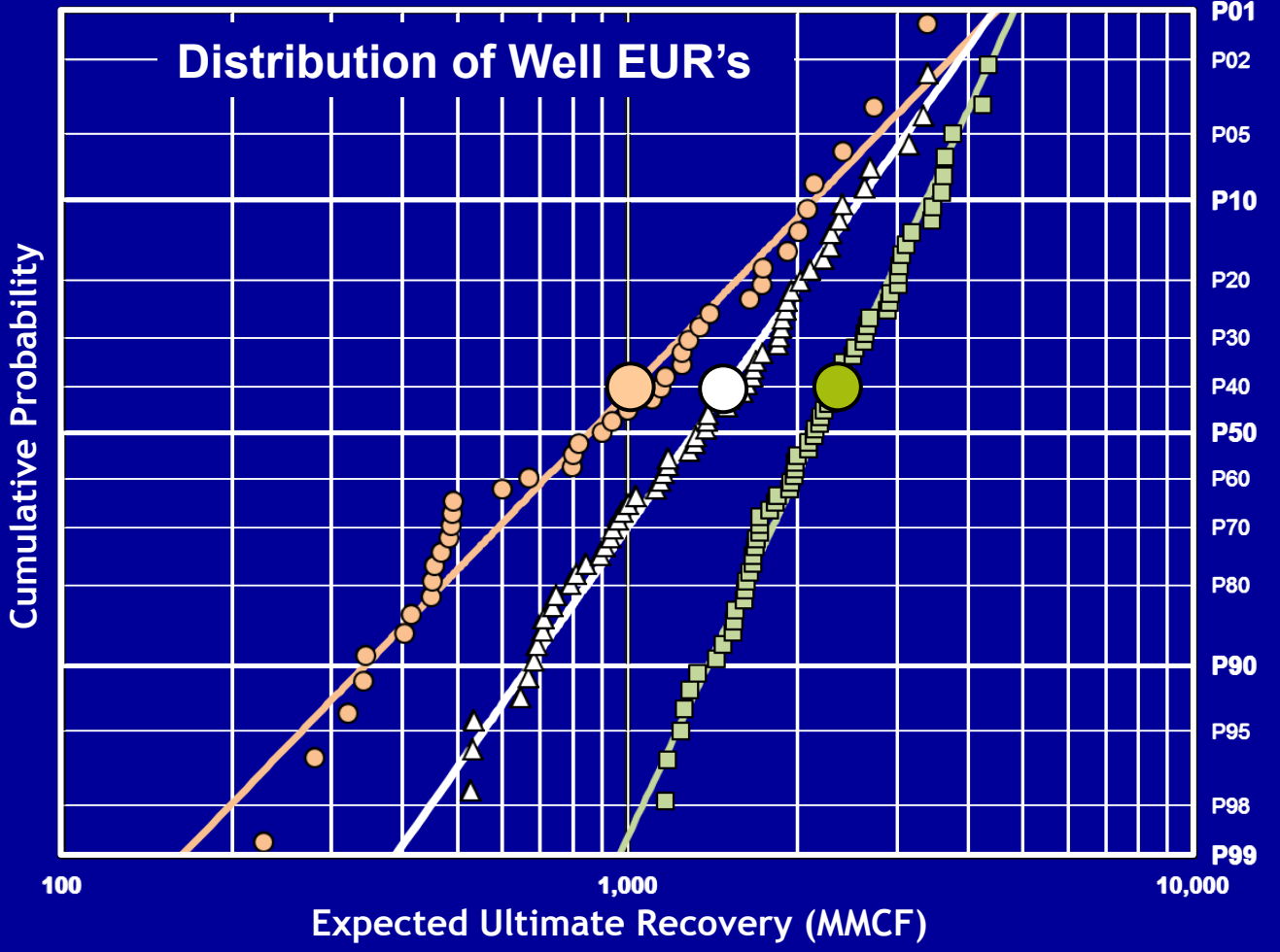


P10/P90 = 2.6 / 0.7 = 3.7

Measuring Uncertainty in Well Performance

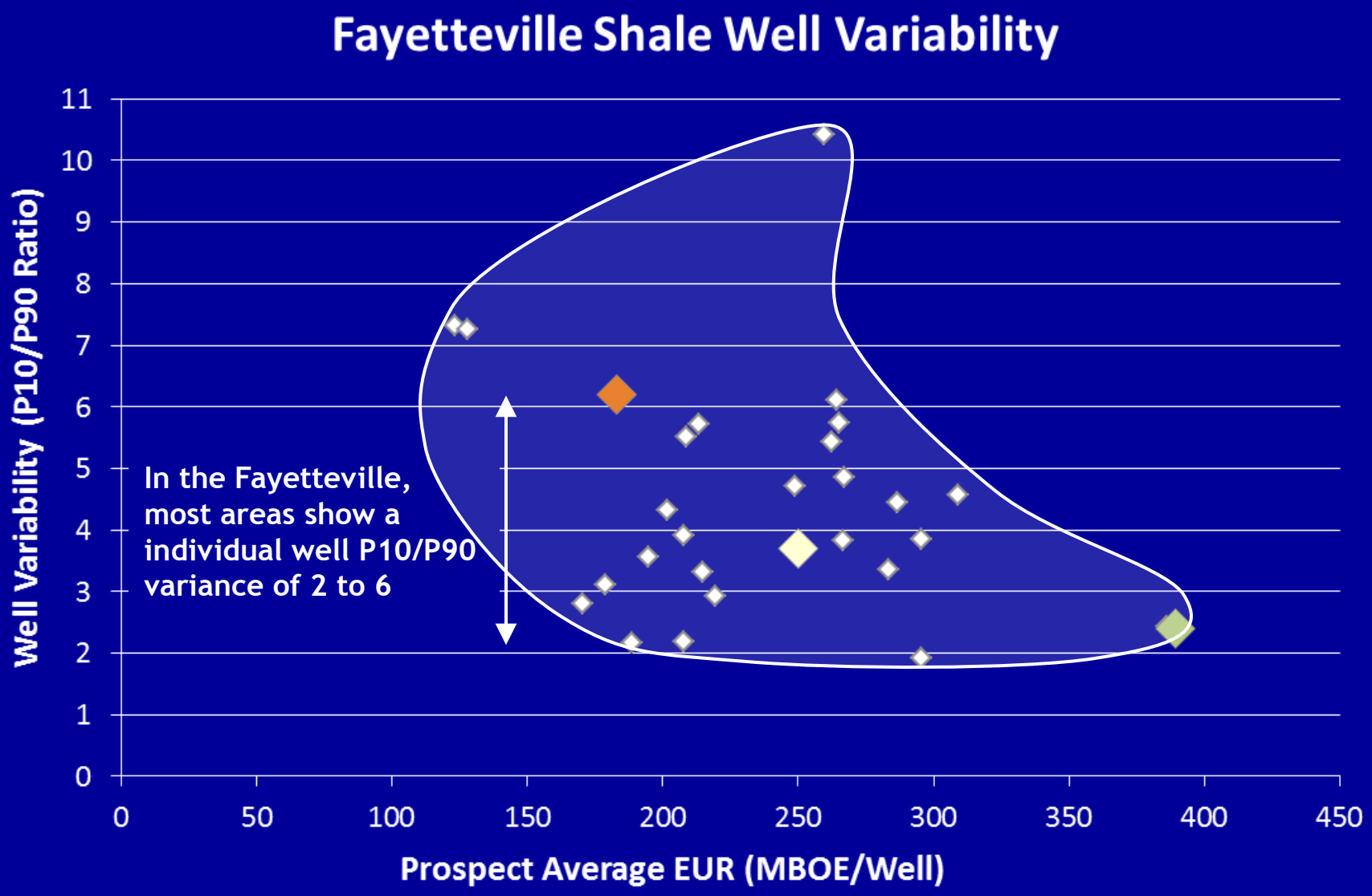
- Average well performance by area



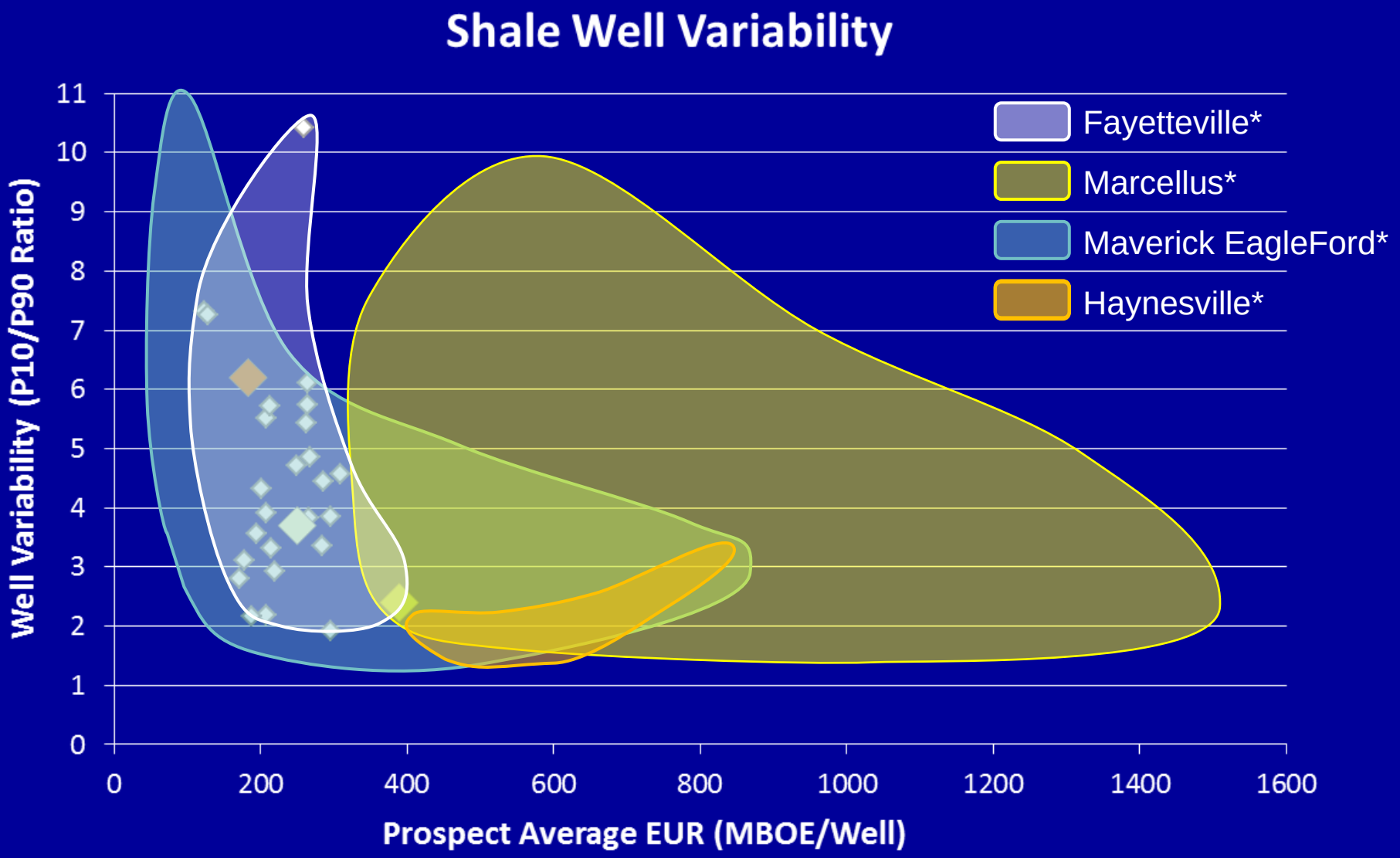


Mean = 1.1 BCF, P10/P90 = 6.2
Mean = 1.5 BCF, P10/P90 = 3.7
Mean = 2.3 BCF, P10/P90 = 2.4

Well Performance Uncertainty in Shale Plays

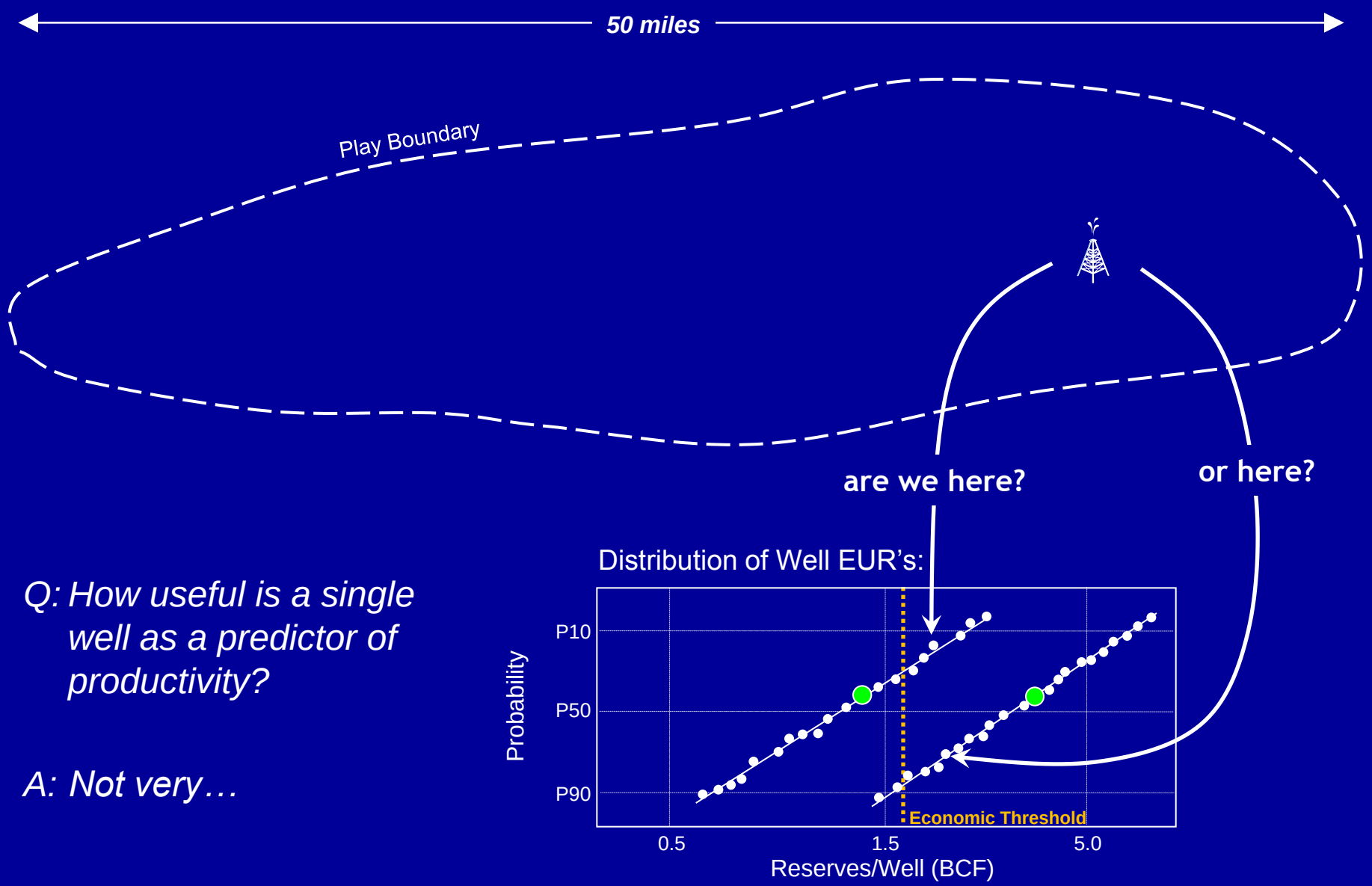


Well Performance Uncertainty in Shale Plays



** Portions of each play*

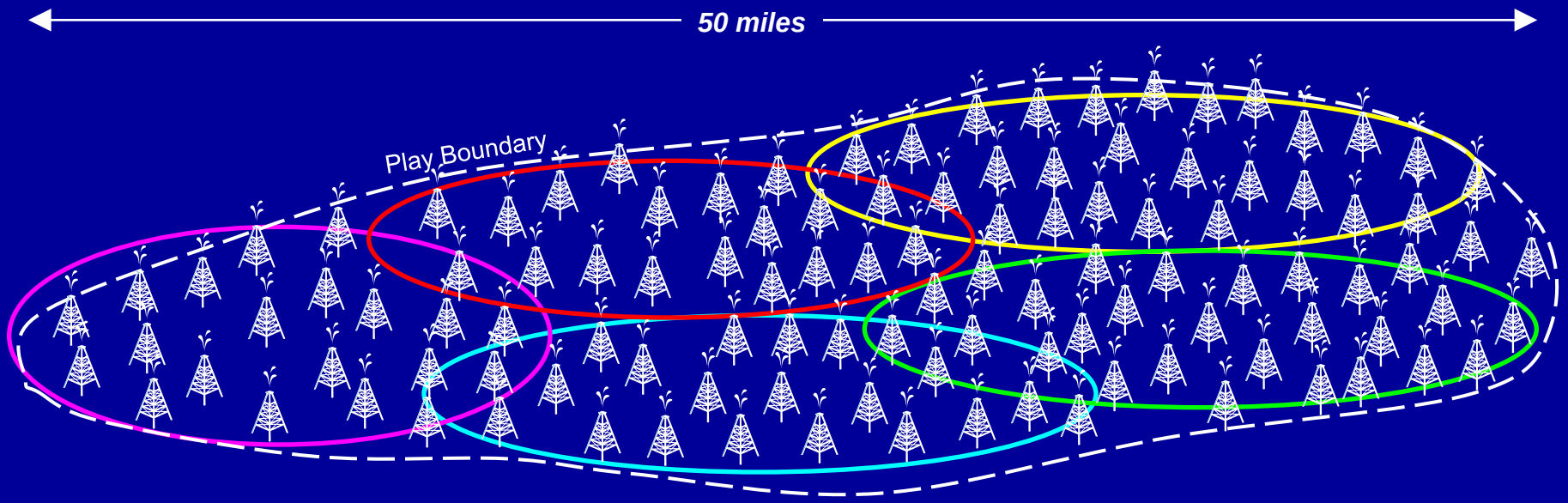
Characterizing a Shale Play

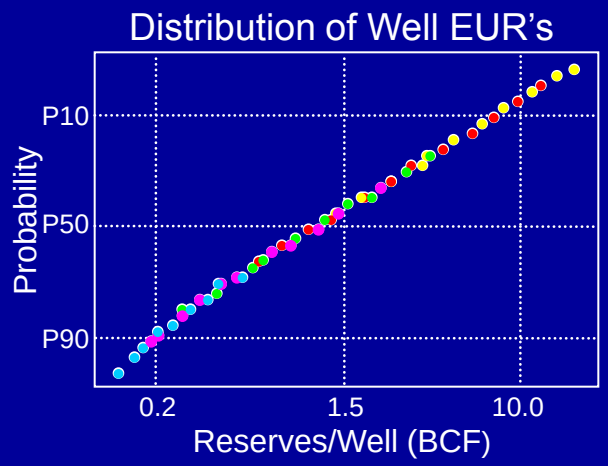


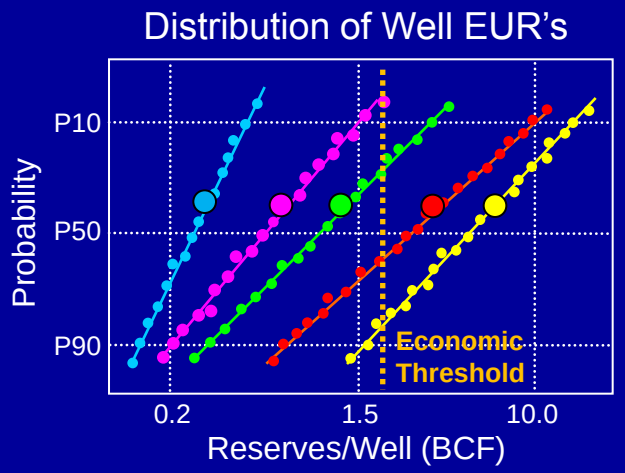
Q: How useful is a single well as a predictor of productivity?

A: Not very…

Characterizing a Shale Play





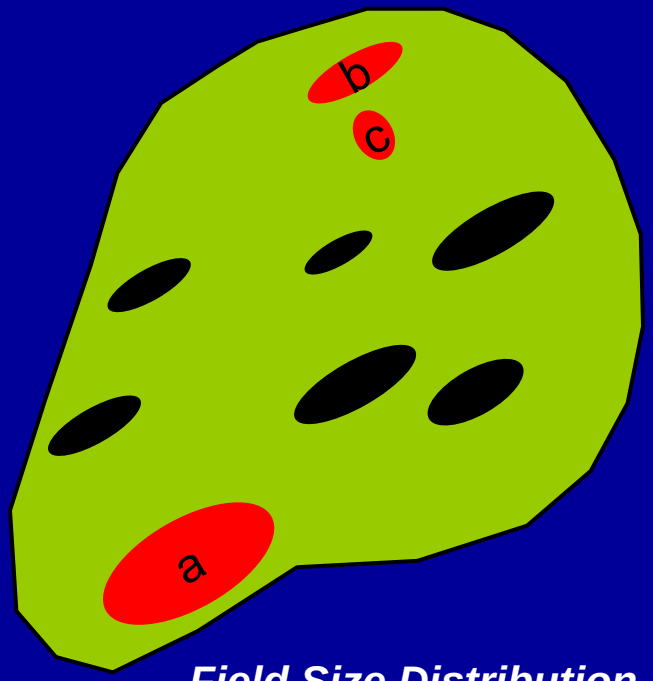


Planning an Exploration Program

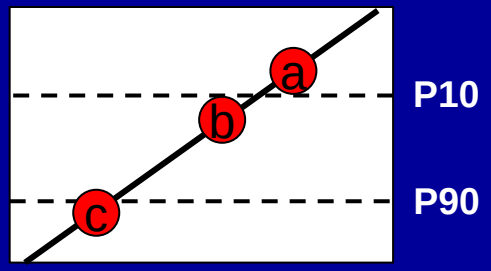
- What defines a prospect area?
- How many wells should I drill in each prospect area?
- What defines the "encouragement" needed to continue drilling?

What Defines a Prospect Area?

Conventional

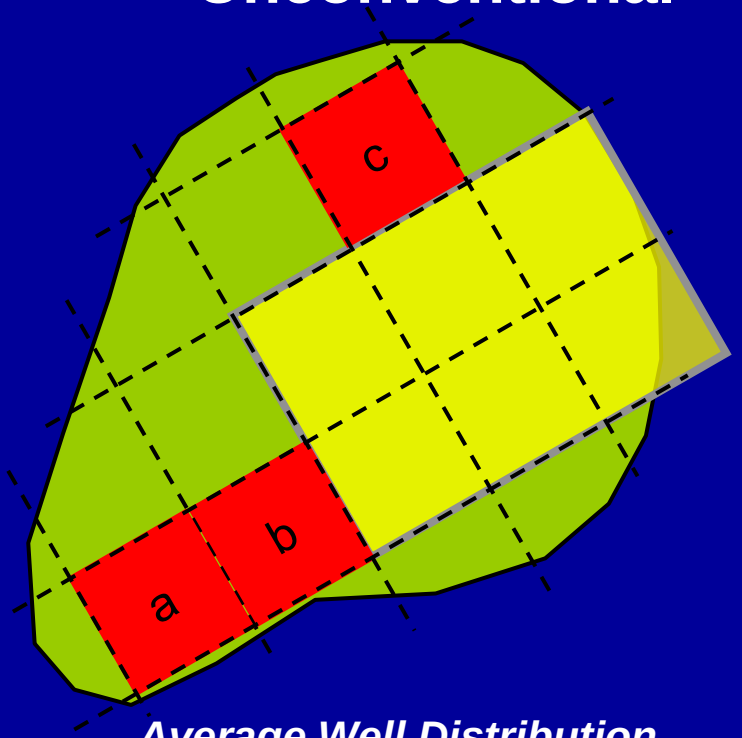


Field Size Distribution

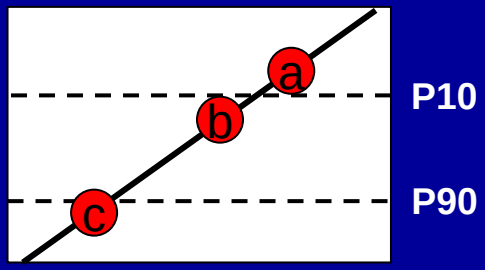


Total Reserves

Unconventional



Average Well Distribution



Reserves/Well

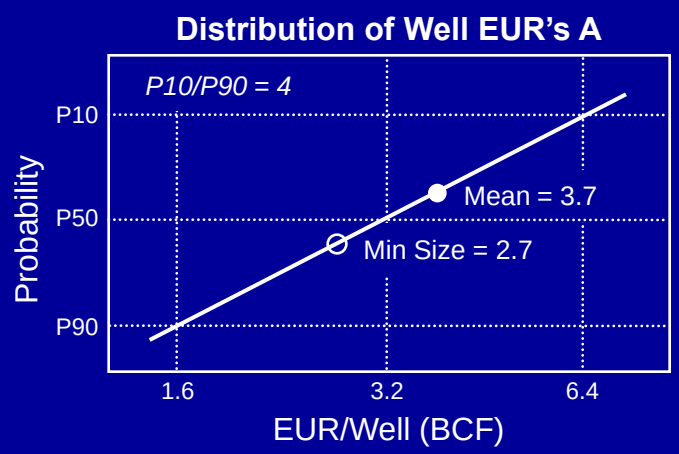
Source: Wayne Camp, Anadarko Petroleum Corporation

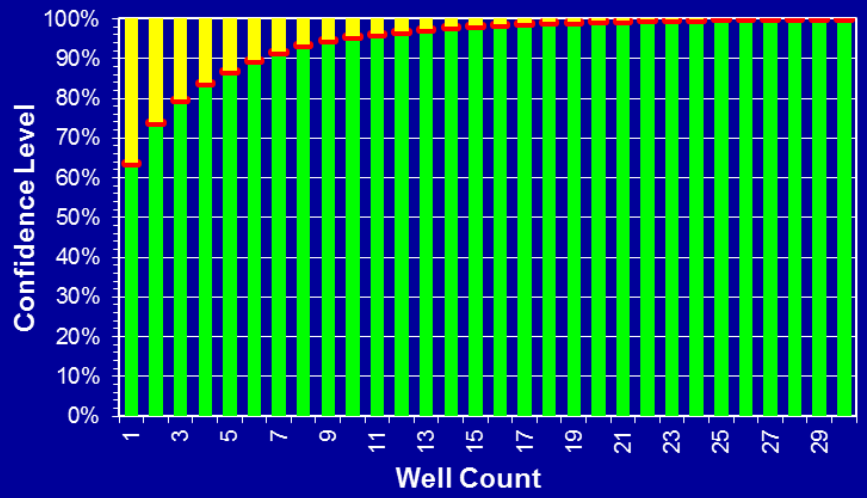
Planning an Exploration Program

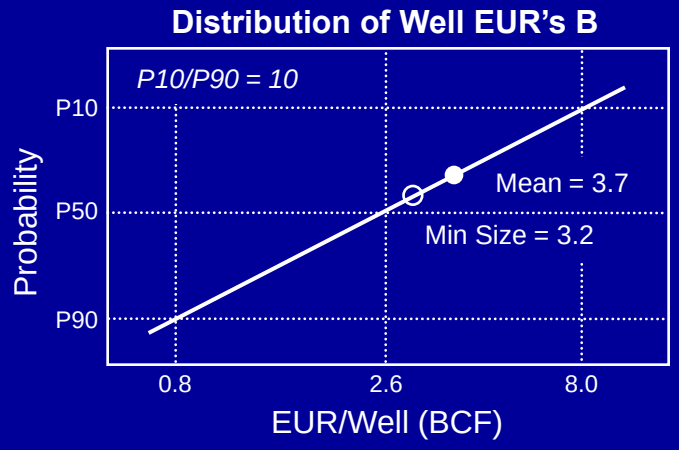
- What defines a prospect area?
- How many wells should I drill in each prospect area?
- What defines the "encouragement" needed to continue drilling?

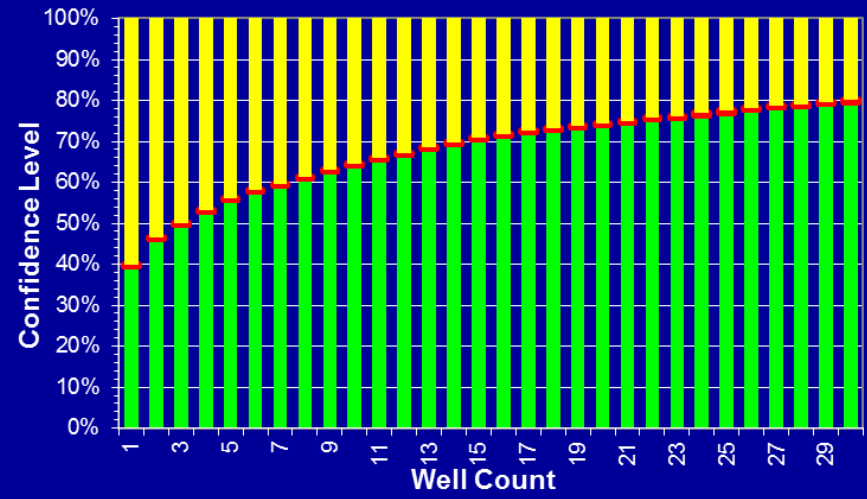
Designing An Exploration Pilot

- The number of wells needed depends primarily on:
  - Uncertainty range of the reserves distribution
  - Proximity of the minimum commercial size to the mean of the distribution









Planning an Exploration Program

- What defines a prospect area?
- How many wells should I drill in each prospect area?
- What defines the "encouragement" needed to continue drilling?

What Defines Encouragement?

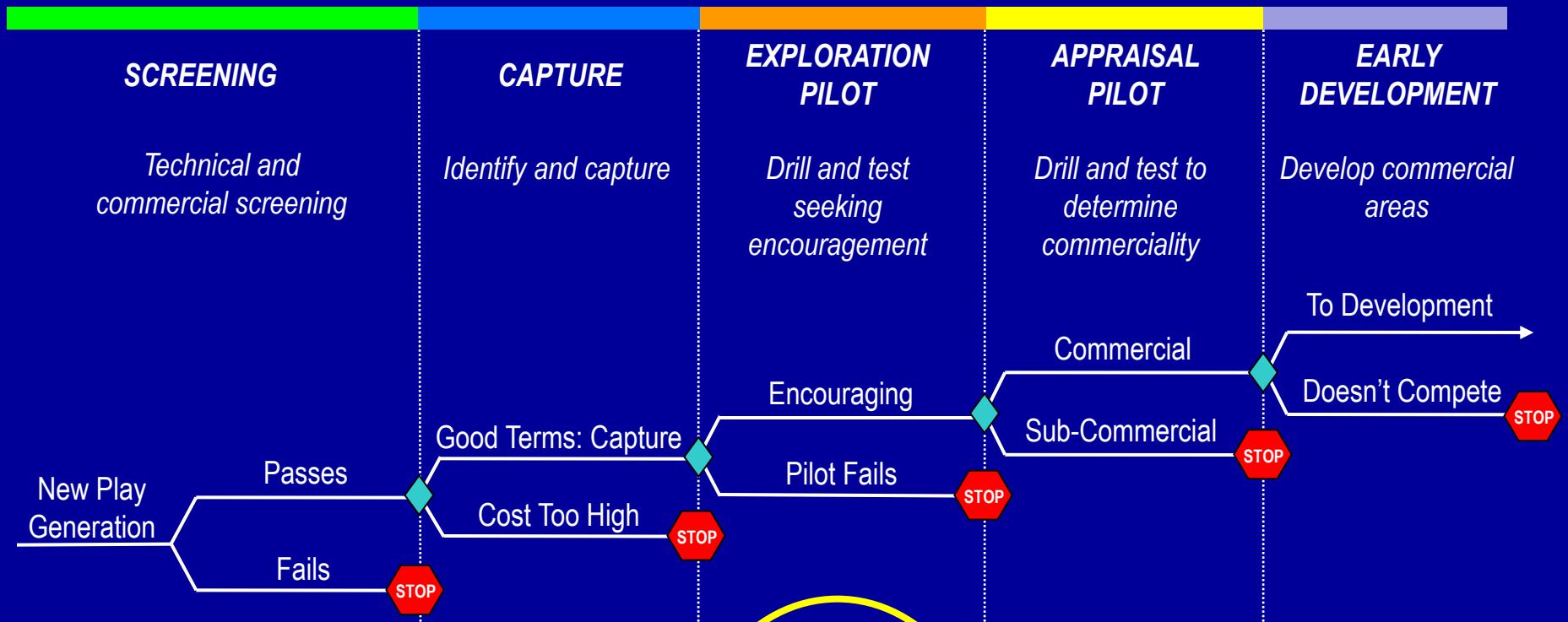
En·cour·age·ment [en-**kur**-ij-m*uh*nt]

noun

1. Available data indicates that the play has the **potential** to be economically viable.
2. A threshold that recognizes the uncertainty in the data.
3. Results that motivate you to keep drilling.

- The less data you have, the lower your threshold should be.
- Example thresholds
  - During the exploration phase: < Breakeven
  - During the appraisal phase: Breakeven
  - During the development phase: Competitive with other opportunities

Modeling Decision Behavior



Play Description:

- 500,000 acres (~2000 km^2)
- 10 Prospect Areas
- EUR potential 1 to 6 BCF/well
- Individual Well P10/P90 = 4
- Breakeven EUR = 2.3 BCF/well
- Competitive EUR = 2.8 BCF/well

	EXPLORATION PILOT	APPRAISAL PILOT	EARLY DEVELOPMENT
Drilling Program:	• Drill 3 wells in 3 prospects (9 wells)	• Drill 5 more wells in each "good" prospect • Test additional prospects.	• Drill 12 more wells in each "good" prospect. • Test additional prospects.
Economic Hurdle:	50% of Breakeven	Breakeven	Competitive

The Impact of Decision Behavior

Anticipated Behavior

Base Case

- Drill 3 Wells in 3 Prospects
- Threshold: ½ NPV10 = 0

Stricter Behavior

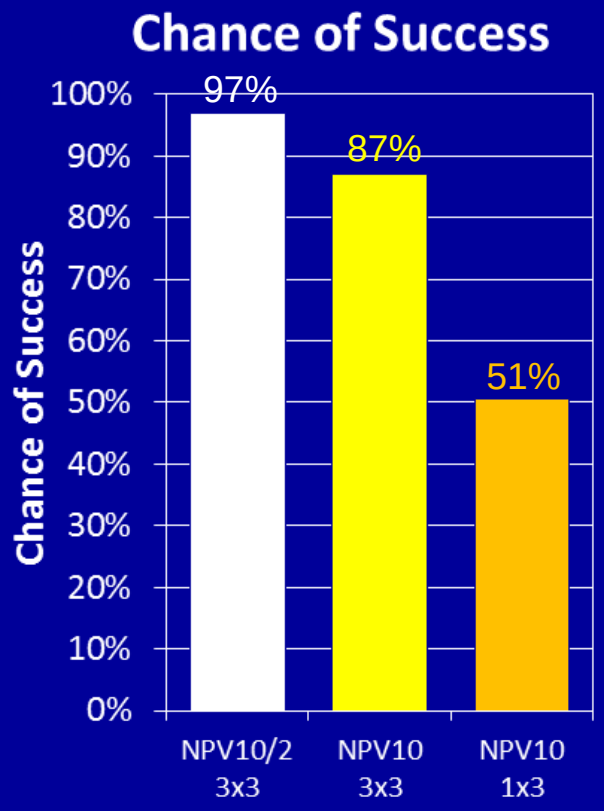
Raise threshold

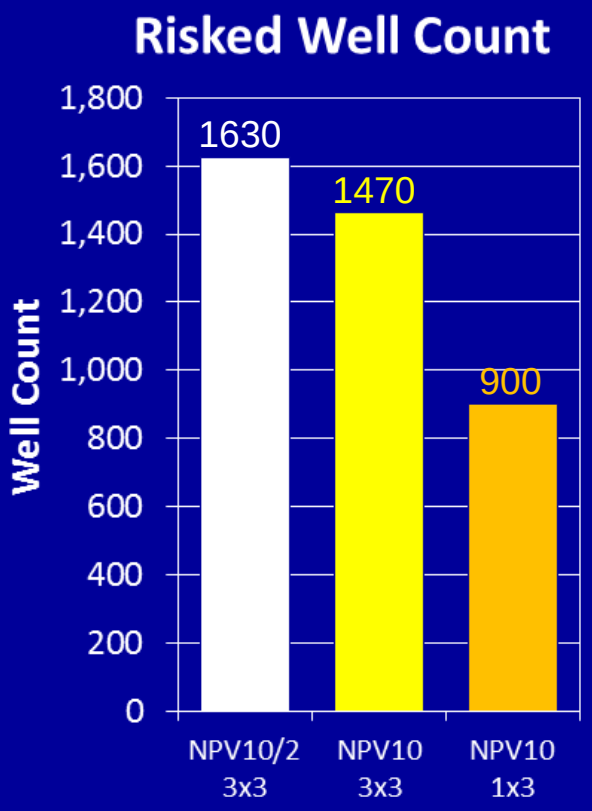
- Drill 3 wells in 3 Prospects
- Threshold: NPV10 = 0

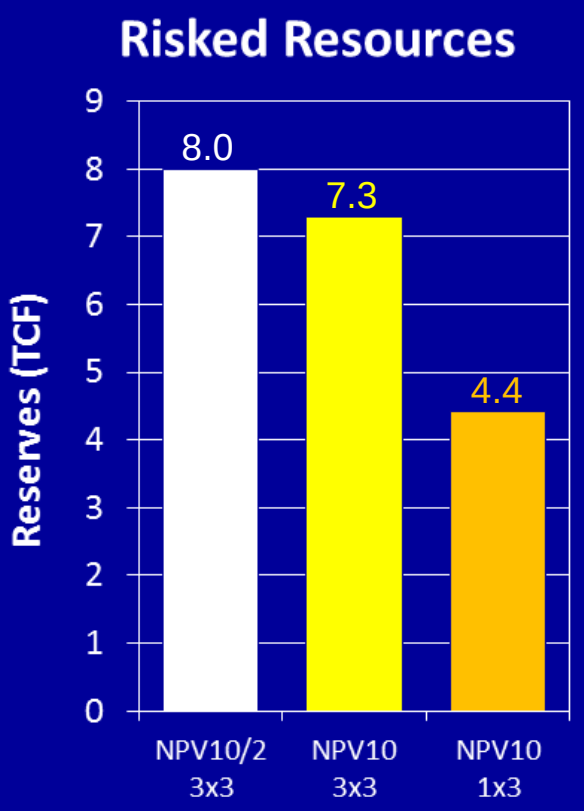
Harsh Behavior

Cut well count

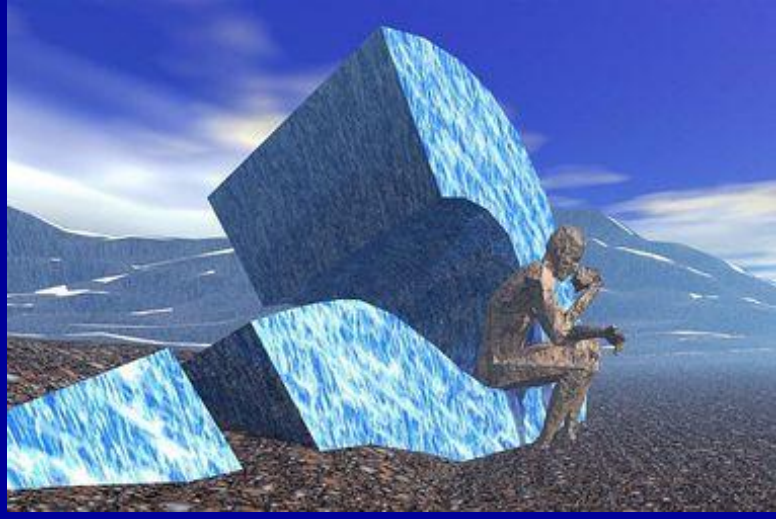
- Drill 3 wells in 1 Prospect
- Threshold: NPV10 = 0







Conclusions



- Shale play potential is measured through long term production performance.
- Wells in the same area, drilled and completed the same way, can and do perform quite differently from one another.
- Natural variance in well performance can easily fool you into making bad decisions. You can only overcome this if you drill enough wells to achieve statistical significance.
- Decision behavior can have a substantial effect on the chance of success. It's important to model how you'll actually behave.
- There are many challenges associated with evaluating shale reservoirs. Perseverance and an understanding of the uncertainties associated with these plays are needed in order to successfully explore for them.