Discussion – SPEE Monograph 3

"Guidelines For The Practical Evaluation of Undeveloped Reserves in Resource Plays"

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Genesis of the Resource Play Committee

In 2008, the Society of Petroleum Evaluation Engineers recognized few, if any, guidelines existed to assist evaluators with determining reserves and resources for "Resource Play" hydrocarbon reservoirs. Consequently, the SPEE Board formed a committee to prepare such guidelines.   Starting in 2009, our Resource Play Committee began a dialogue on issues associated with these types of oil and gas reservoirs.

SPEE

SOCIETY OF PETROLEUM EVALUATION ENGINEERS

Resource Plays Committee Participants

Robin Bertram – Calgary
Gary Gonzenbach – Austin
Jim Gouveia – Calgary
Brent Hale – Dallas
Russell Hall – Midland
Paul Lupardus – OKC
Paul McDonald – Dallas
Nathan Meehan – Houston
Bill Vail – Houston
Marshall Watson - Midland

Monograph 3 – "Guidelines For The Practical Evaluation of Undeveloped Reserves in Resource Plays"

Table of Contents

Chapter 1 – What is a Resource Play?
Typical Resource Play Reservoirs

- Shale Gas
- Coalbed Methane
- Tight Gas Reservoirs
- Basin Centered Gas Systems
- Certain Tight Oil Reservoirs

# Resource Play - Tier 1 Criteria

- Exhibits a <u>repeatable</u> statistical distribution of EURs

- Offset well performance is not a reliable indicator of PUD performance

- Contains continuous hydrocarbon systems that are regional in extent

- Hydrocarbons are not held in place by hydrodynamics
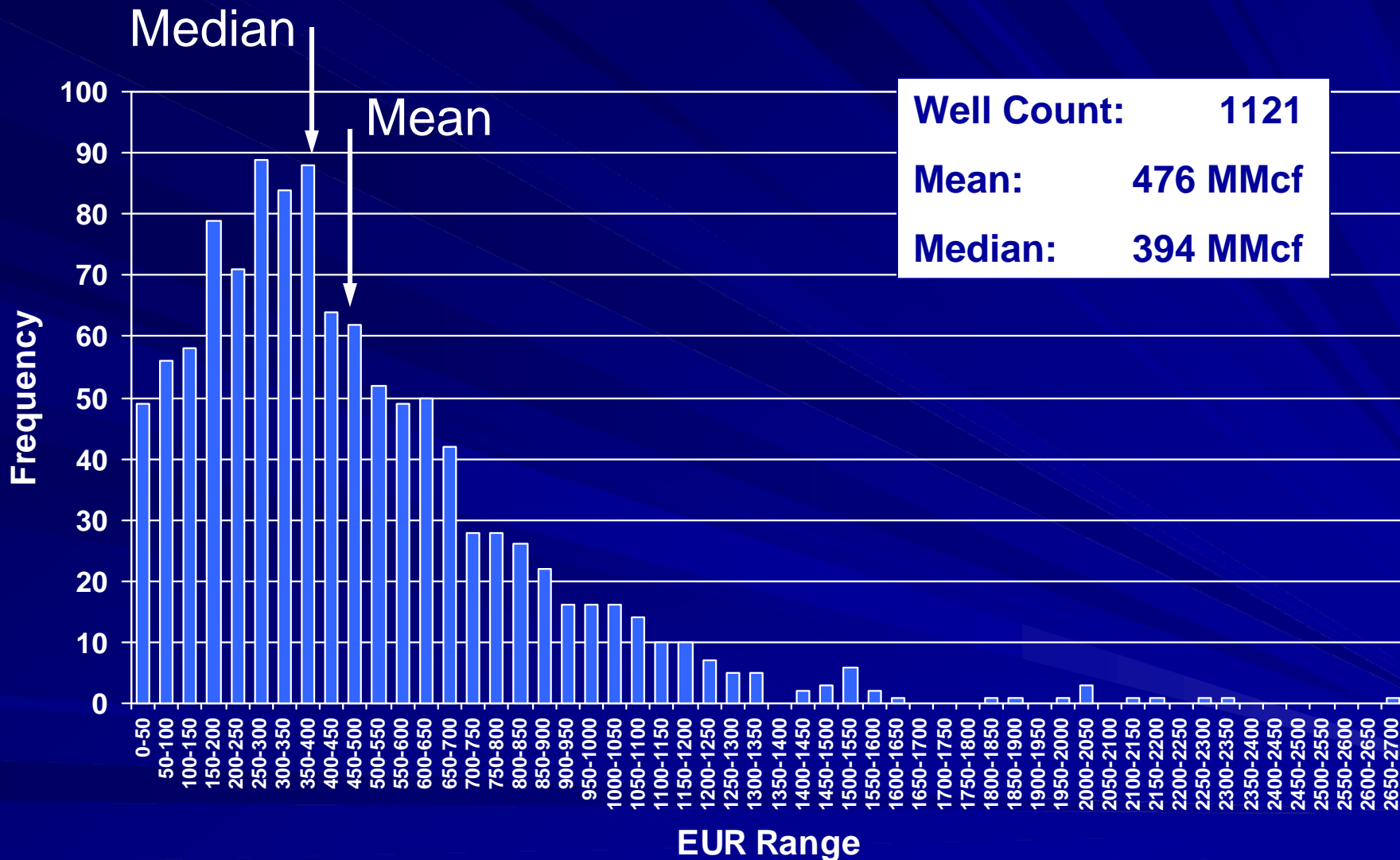
Resource Play - Tier 2 Criteria

- Requires Extensive Stimulation to Produce
- Produces Little In-situ Water
- Does Not Exhibit an Obvious Seal or Trap
- Low Matrix Permeability (< 0.1 mD)

ALL VIRGINIA WELLS --- CBM WELLS HIGHLIGHTED IN GREEN
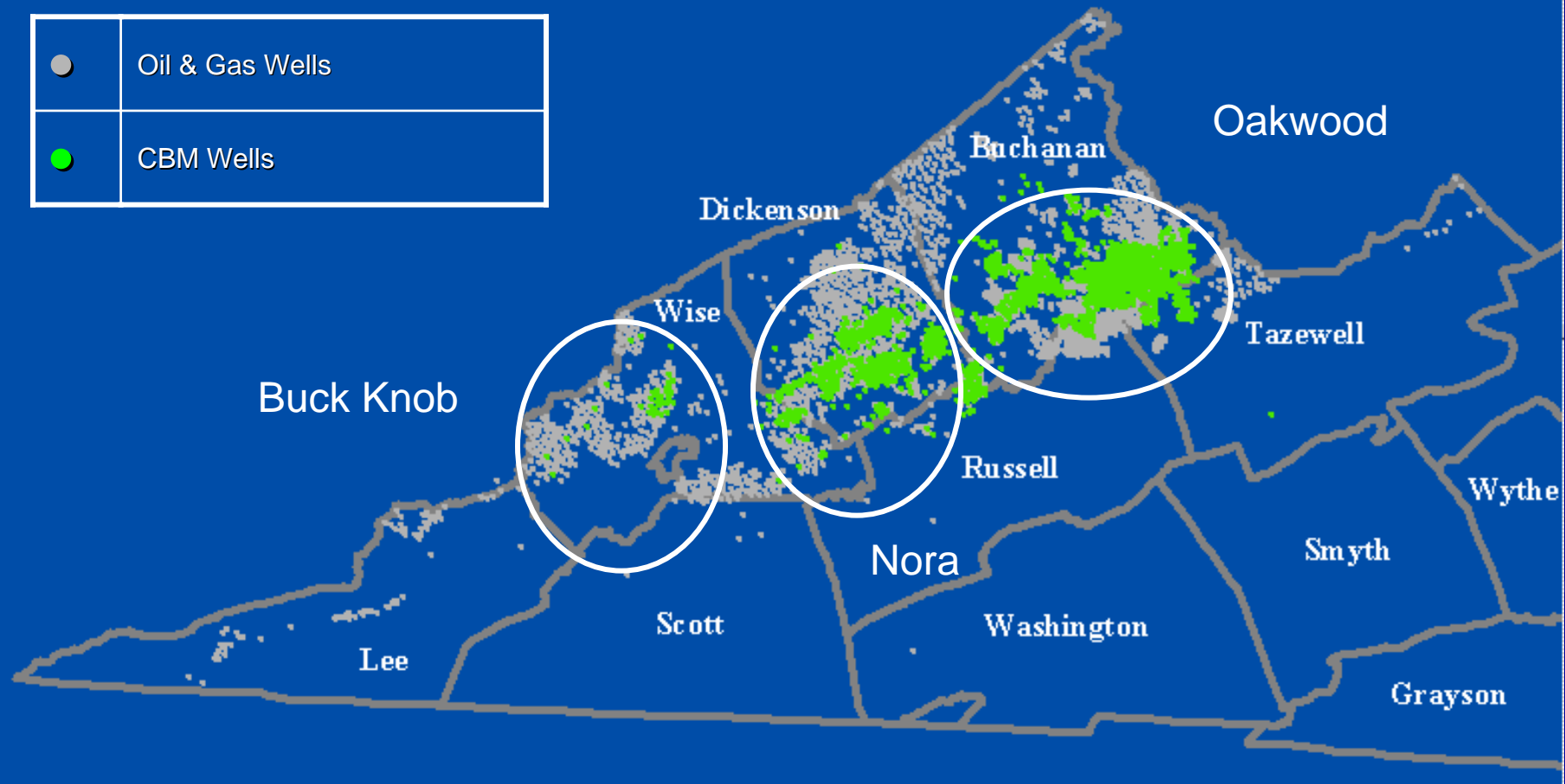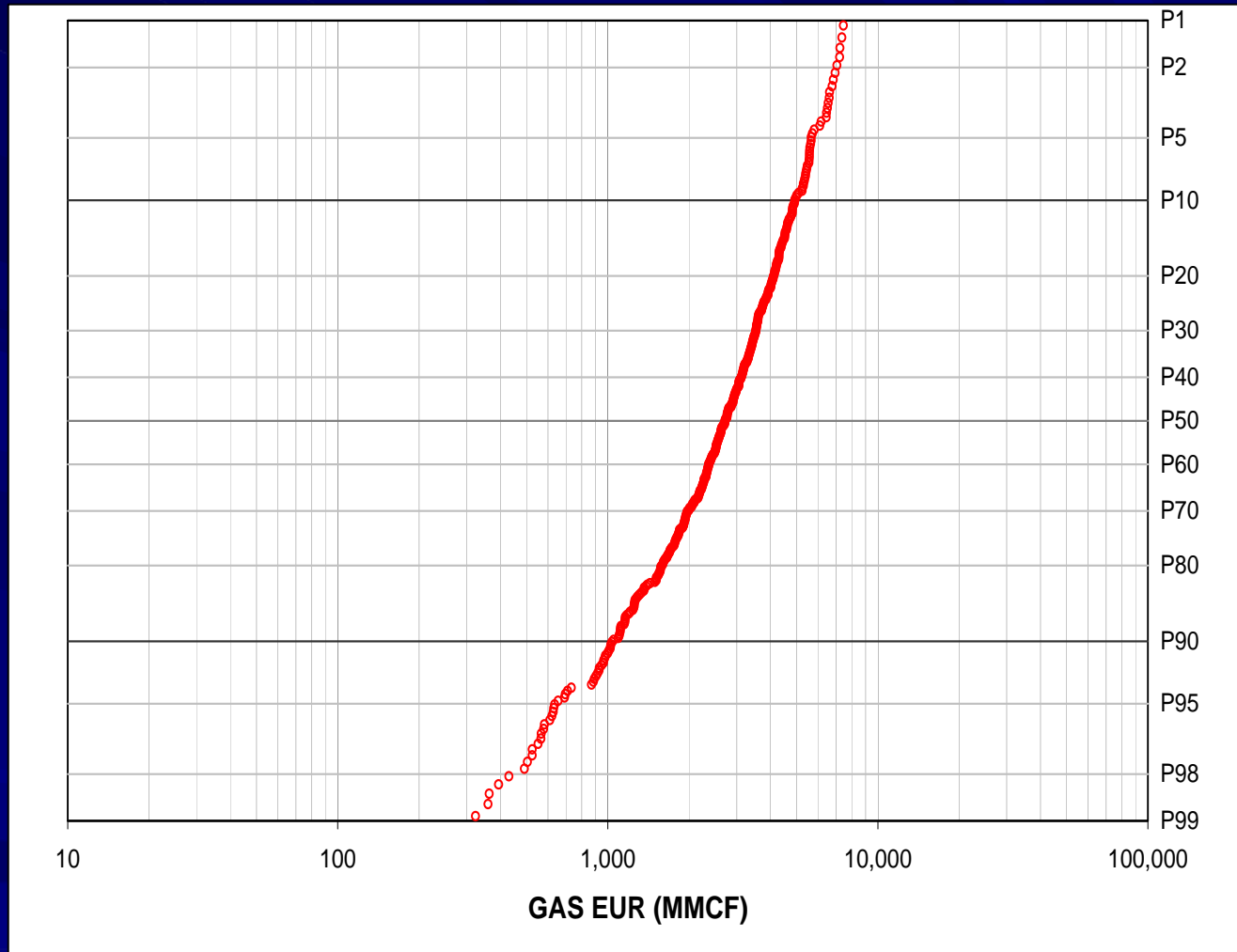
Distribution of EUR results
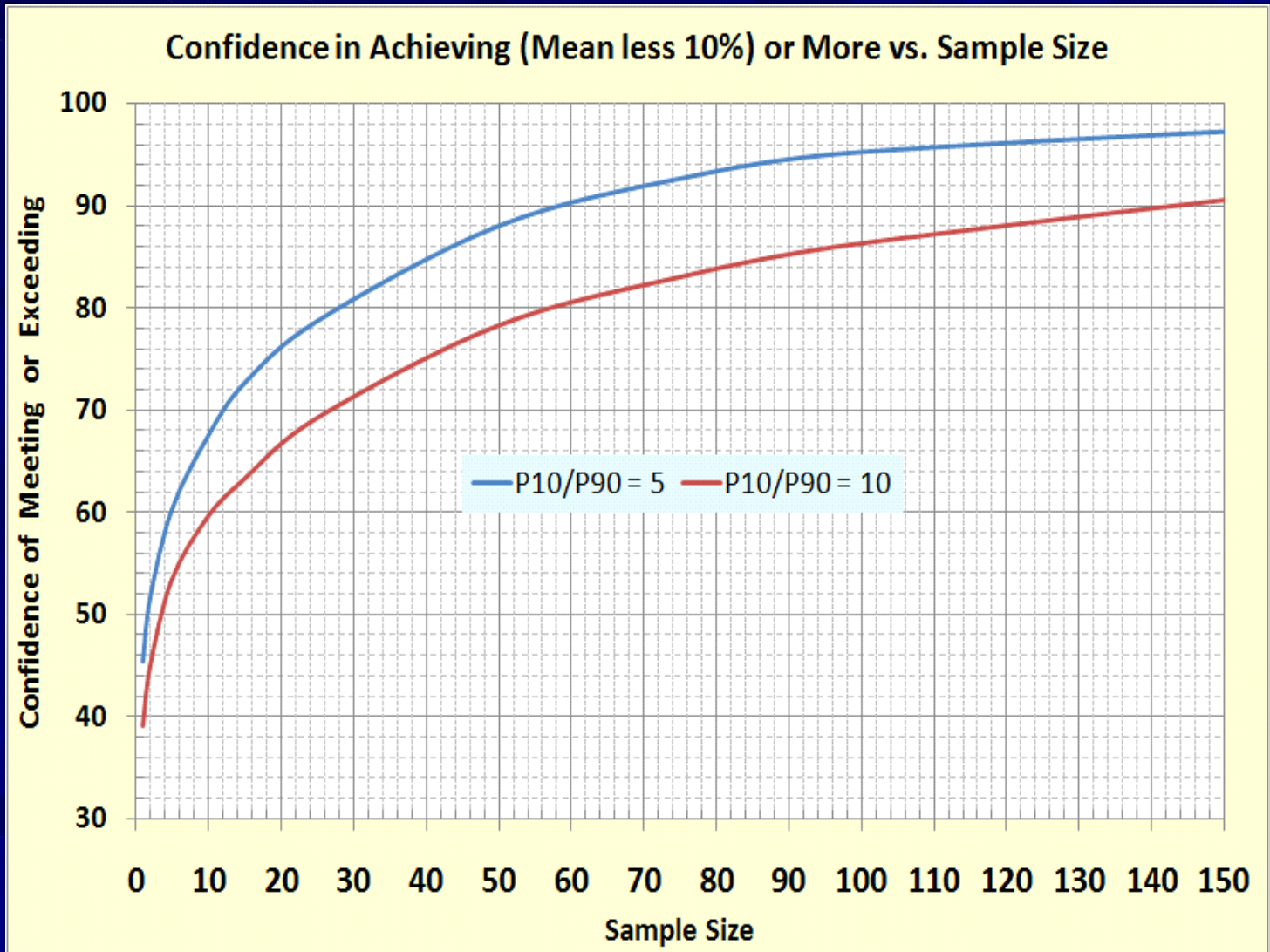
Chapter 2 - Statistics

- Chapter Highlights
  - Importance & Relevance of Lognormal Distributions
  - Use of P10/P90 ratios as a measure of uncertainty for Lognormal Distributions
  - Recommendations for Minimum Sample Size
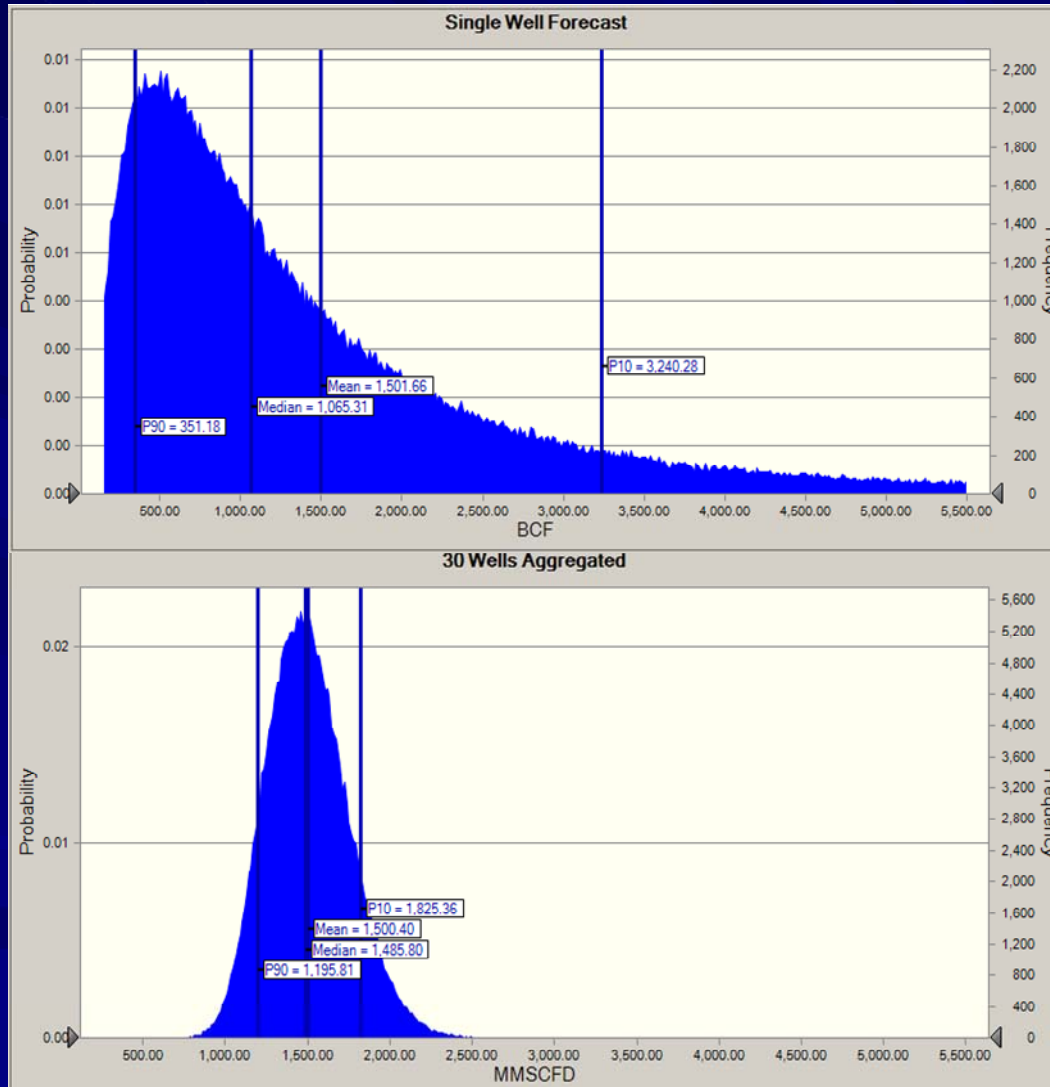 - Aggregation

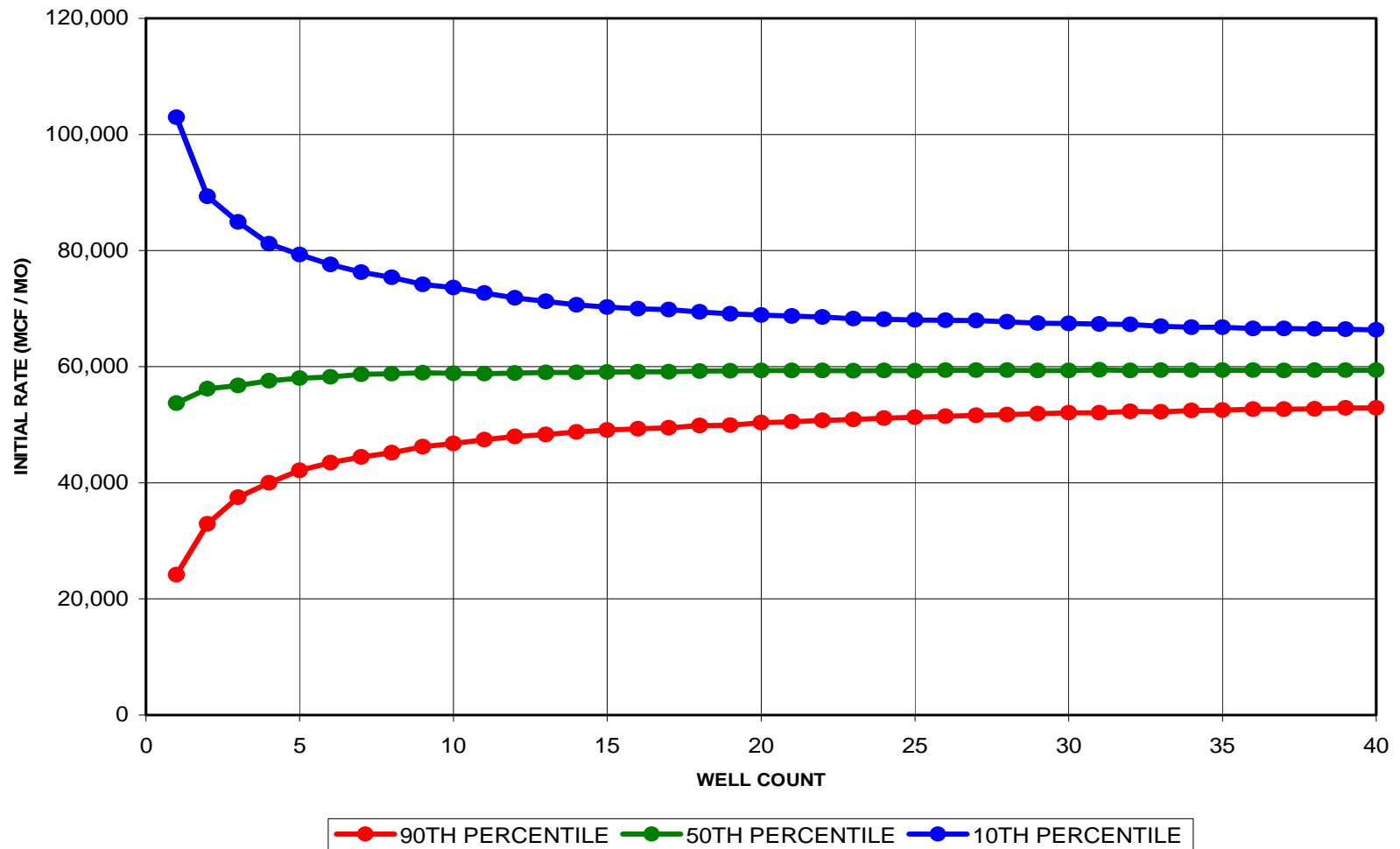# Use of P10/P90 ratios

Plotting EURs using a probit scale

Minimum Sample Size

Confidence in Achieving (Mean less 10%) or More vs. Sample Size

Aggregation

More Wells leads to tighter spread between P10 and P90

Chapter 3 – What Constitutes a Proved Location in a Resource Play?

- How many offset locations can be classified as proved?

- Monograph 3 makes the case that statistical methods can be applied as "reliable technology" for quantifying future development drilling.

Chapter 3 – Analogous Wells

- Analogous Wells Have Similar:
  - Geology
  - Completion Procedure
  - Lateral Length
  - Spacing
  - Interference
  - Wellbore Orientation

Making the Transition to a Statistical Analysis

Well Counts for Various Stages of Development

	PHASE OF RESOURCE PLAY DEVELOPMENT			
	Early	Intermediate	Statistical	Mature
RATIO OF ANALOGOUS PRODUCING WELLS TO RECOMMENDED SAMPLE SIZE	< 1	1 to 4	> 3	Very Large
P_{10}/P_{90} <4, APPROXIMATE WELL COUNT	< 50	100	150	> 500
P_{10}/P_{90} 4 TO 10, APPROXIMATE WELL COUNT	< 50-200	100-400	150-600	> 1000
P_{10}/P_{90} 10 TO 30, APPROXIMATE WELL COUNT	< 200-700	200-1400	600-2100	> 4500

How Many Locations Can Be Identified as Proved?

PUD counts at Various Stages

|	PHASE OF RESOURCE PLAY DEVELOPMENT			
	Early	**Intermediate**	**Statistical**	**Mature**
RECOMMENDED NUMBER OF PUD OFFSETS PER PRODUCING WELL (VERTICAL WELLS)	4	8	Statistical	Statistical
RECOMMENDED NUMBER OF PUD OFFSETS PER PRODUCING WELL (HORIZONTAL WELLS)	2-4	4-8	Statistical	Statistical

Determining "Proved" Area From Well Data

- Monograph 3 recommends using the **Expanding Concentric Radii** method

- This method compares ever increasing areas of potential reservoir around "Anchor" wells to the EUR distribution of the "Anchors"

- If the EUR statistical distribution for each area is comparable, then each area is an extension of the resource play, and areas bound by the concentric circles should be Proved reserves
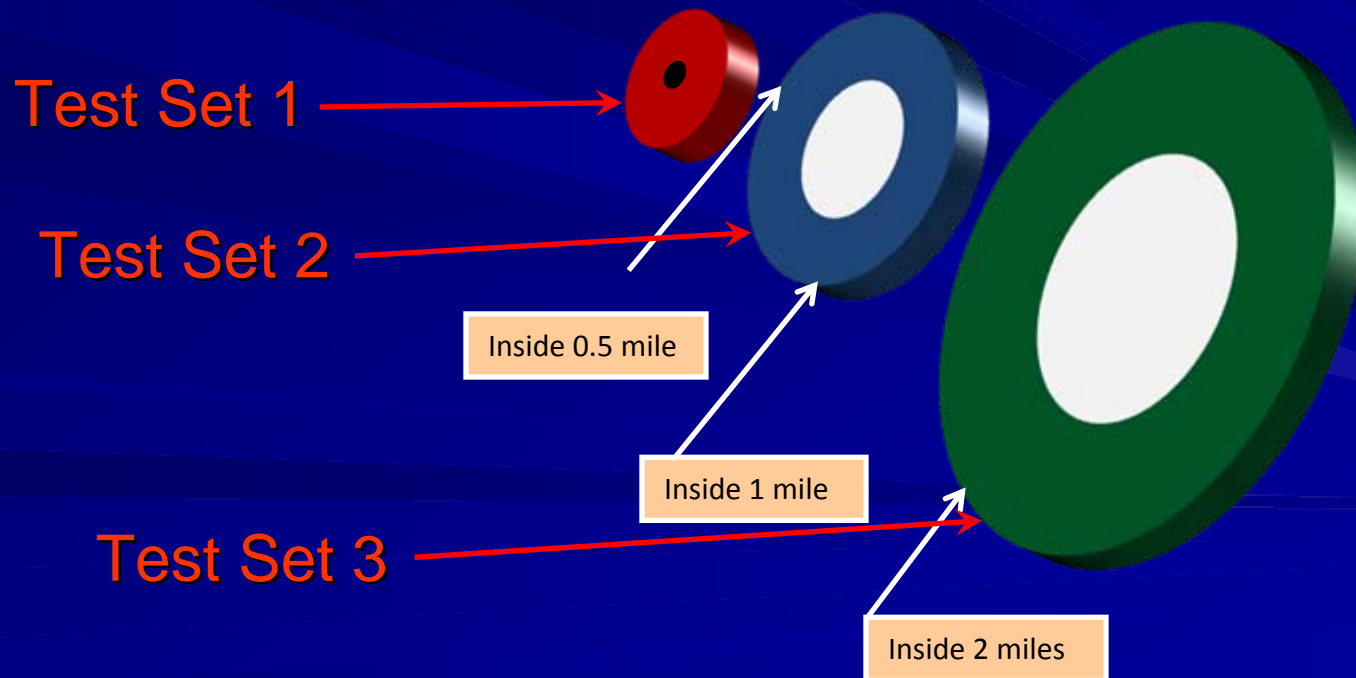
Expanding Concentric Radii Method

■ First, create a statistical distribution for wells located in the center of the concentric circles, the "Anchor" wells
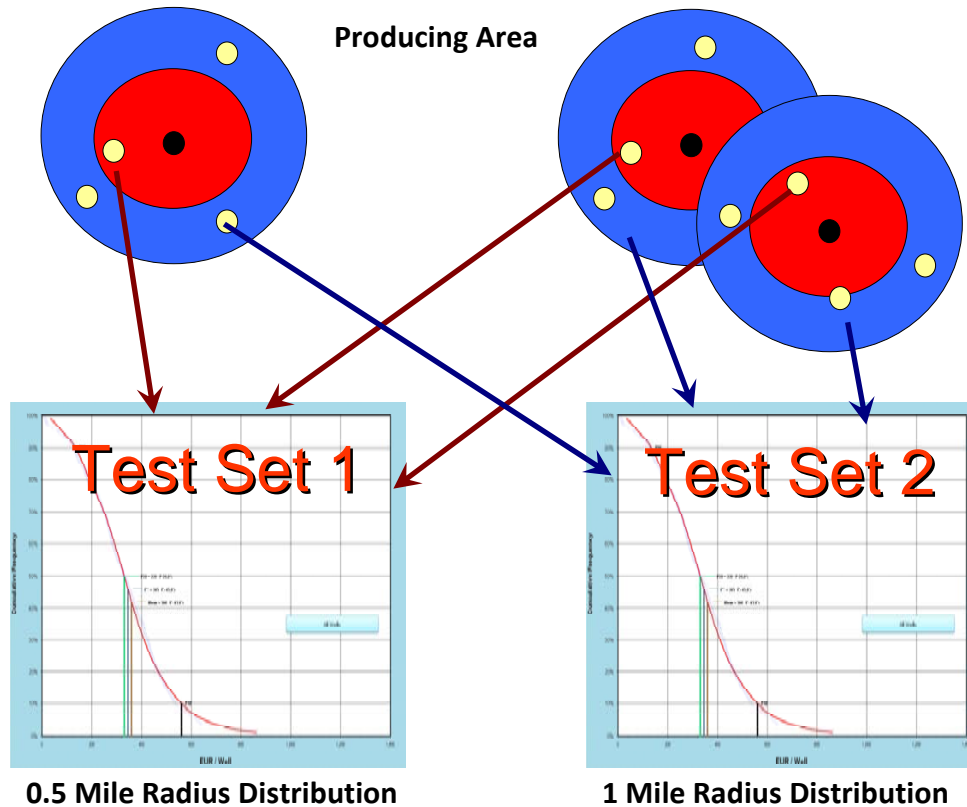
Anchor Well Located In
First Circle (Closest Area)

Inside 0.5 mile

Inside 1 mile

Inside 2 miles
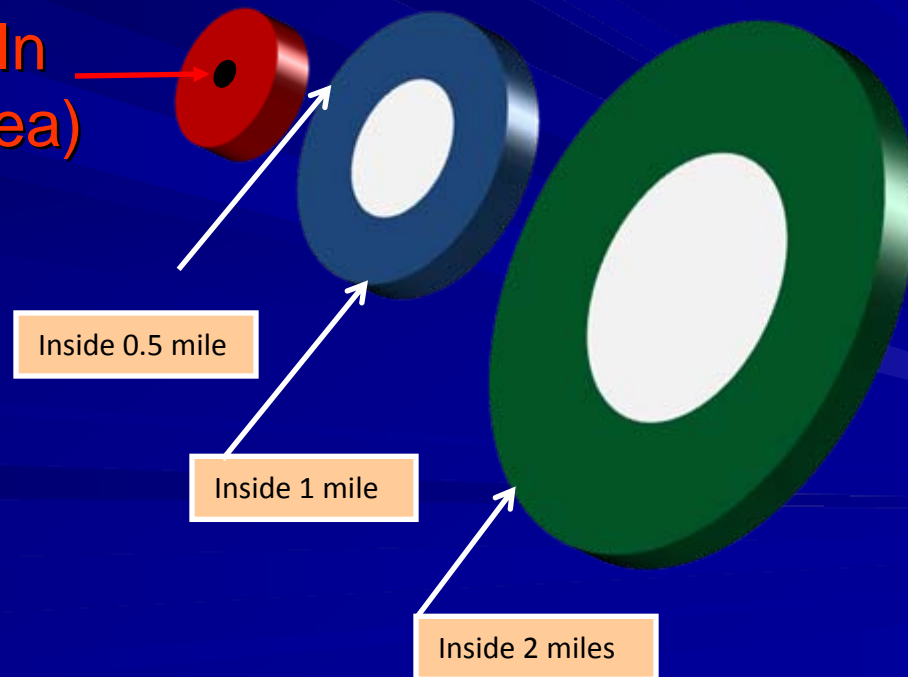
Expanding Concentric Radii Method

- The second step creates subsequent statistical distributions for wells located in each concentric circle

Test Set 1

Test Set 2

Inside 0.5 mile

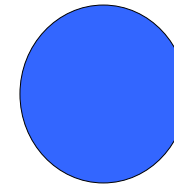Test Set 3

Inside 1 mile

Inside 2 miles

Expanding Concentric Radii Method

- Step 1 – Create one statistical distribution for "Anchor" wells
- Step 2 – Create a subsequent statistical distribution for wells positioned in Expanding Concentric Radii (Test Sets)
- Step 3 – Compare each statistical distribution from the test sets to the "Anchor" wells

Expanding Concentric Radii Method

Expanding Concentric Radii Method
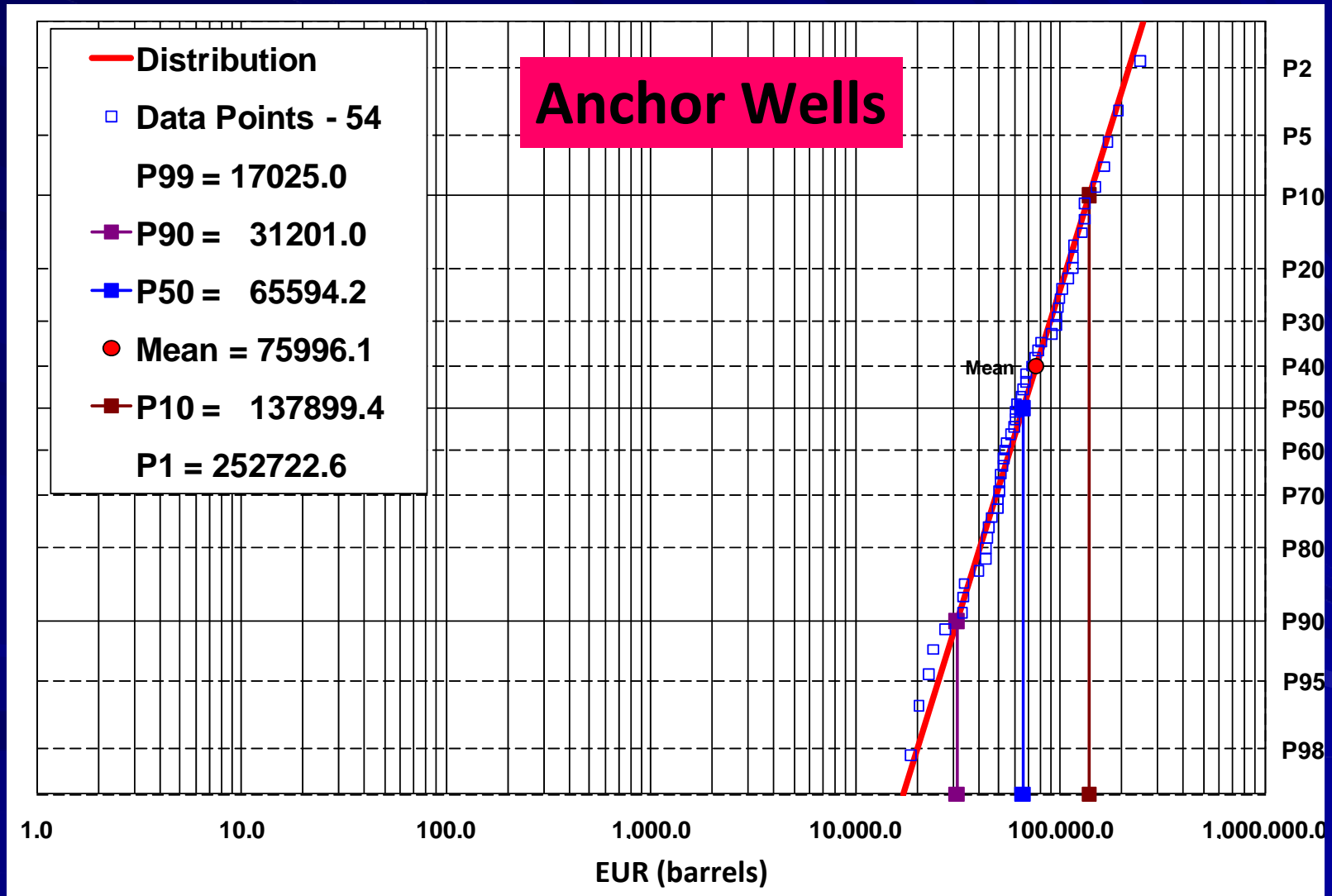
Determining "Proved" Area From Well Control

Legend

- 🔴 Anchor Set 1
- ⚫ Analogue Wells
- 🔵 Geologic Subset 1
- 🔵 Project 1
- ▦ Non Contiguous Drilling Area
- ━ LKH
- ▭ Resource Play

0   3   6   12 Miles

Clipped Polygons within Expanding Concentric Circles
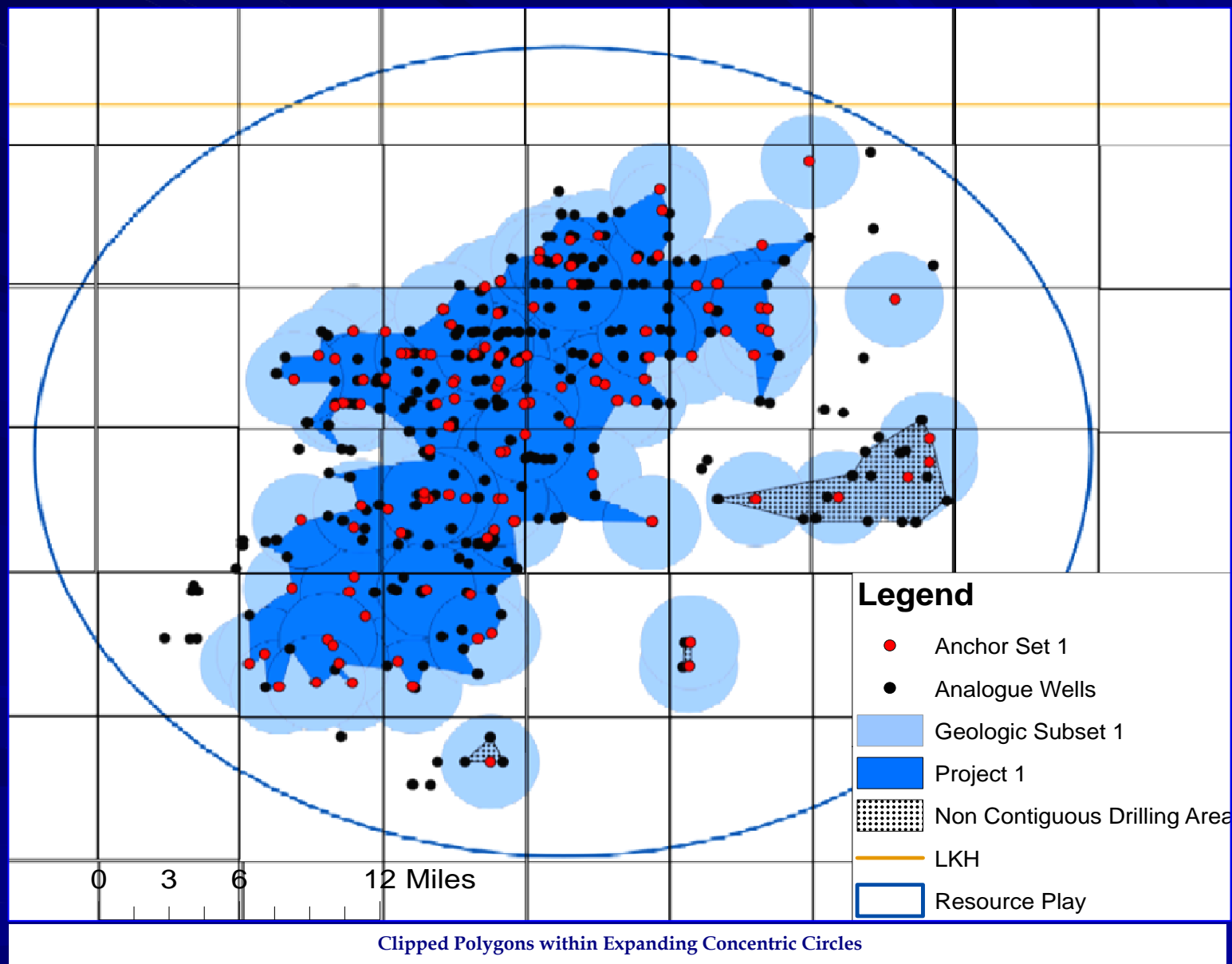
Chapter 4 - Estimating Reserves for Undrilled Locations in a Resource Play

- Identify Analogous Wells
- Create a Statistical Distribution for Analogous Wells
- Determine the Number of Drilling Opportunities
- Prepare a Monte Carlo Simulation
- Estimate Reserves using PRMS Definitions

Alternatives for Running Monte Carlo Simulations

- Method #1: Use P^ to approximate P90 value

- Method #2: Apply aggregation factor provided in Monograph

Method #1 - What Is P^ ?

- P^ (P-hat) is the Average of P_{mean} and P50 for the single well EUR distribution

- P^ is Often Close to the P90 Value for an Aggregation of Wells

- Consequently, it is a useful measurement when evaluating a large group of wells

- Recommended for use when comparing various EUR distributions in our Concentric Radii Method

Method #2 - Proved Aggregation Factor
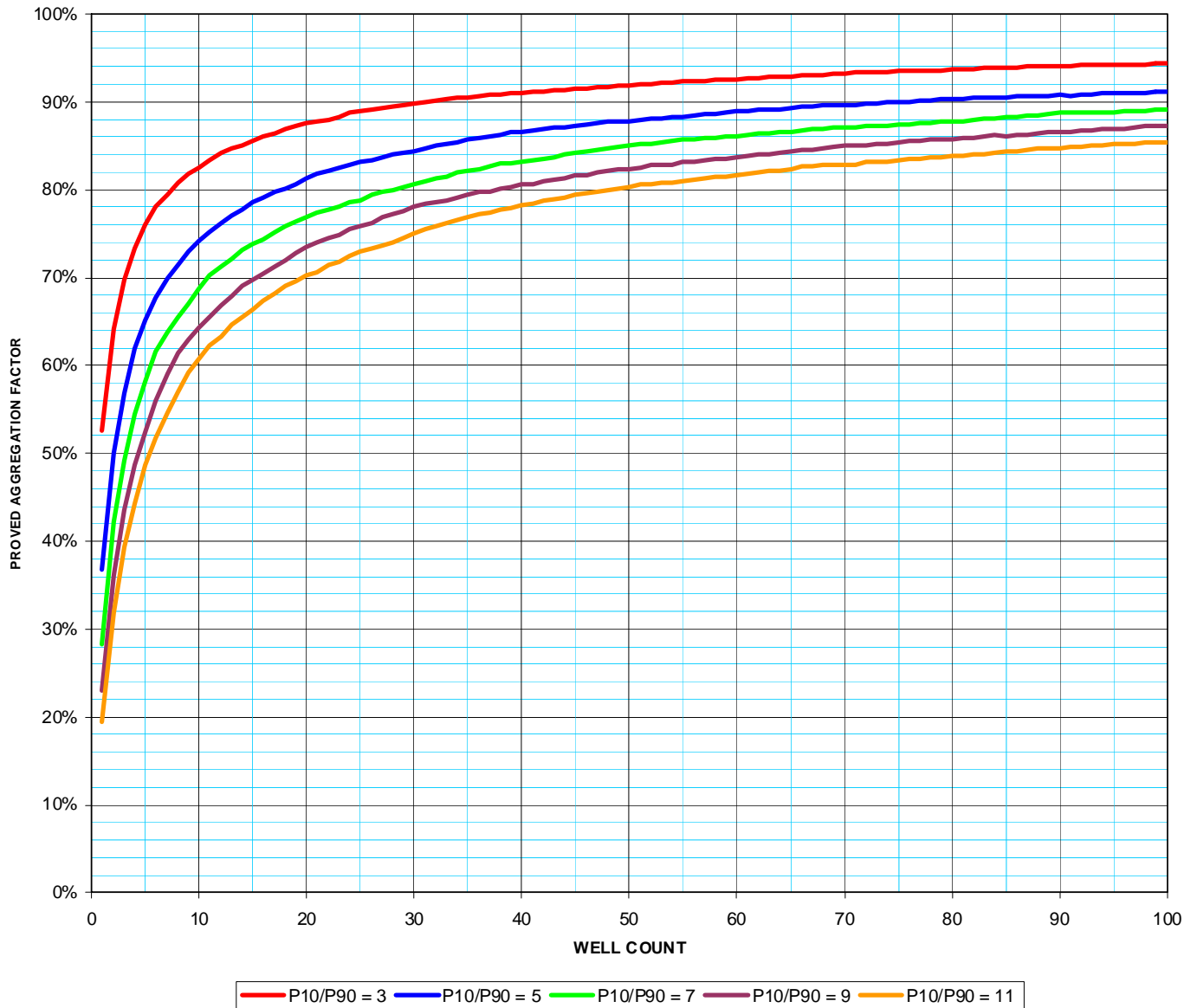
Concepts that deviate from past procedures

- Expanding beyond the one-offset constraint
- Proved areas or enclosures as defined by this method are not deterministic
- Aggregation results and P90 will vary as a function of the well count or remaining locations

Final Comments on Evaluating Resource Plays

- Our Resource Play Committee can not over-emphasize the <u>necessity</u> of exercising good judgment in evaluating resource plays.

- Maintain perspective

- Rely on experience

- We see Monograph 3 as a starting point, not the final say on these issues.

Current Status – Monograph 3

- The Resource Play Committee has submitted a Final Draft to the SPEE Board
- This draft is currently undergoing a final round of peer review
- When approved, we anticipate that an electronic version will be made available to the public

Disclaimer

Please note that all of the views and opinions expressed within this presentation are opinions held solely by the author and by members of SPEE's Resource Play Committee; they represent neither the opinions of *DeGolyer and MacNaughton* (Texas Registered Engineering Firm F-716) nor of its management.

Questions?

I'd like to express my sincere appreciation to all the companies that participated in this work:

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DeGolyer and MacNaughton