SPE Distinguished Lecturer Program

The SPE Distinguished Lecturer Program is funded principally through a grant from the **SPE Foundation**.

The society gratefully acknowledges the companies that support this program by allowing their professionals to participate as lecturers.

Special thanks to the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) for its contribution to the program.

A Twenty-Five Year Perspective on Use of Pressure Transient Analysis

Robert H. Hite

Shell International E&P (ret.)

Blue Ridge PTA, Inc.

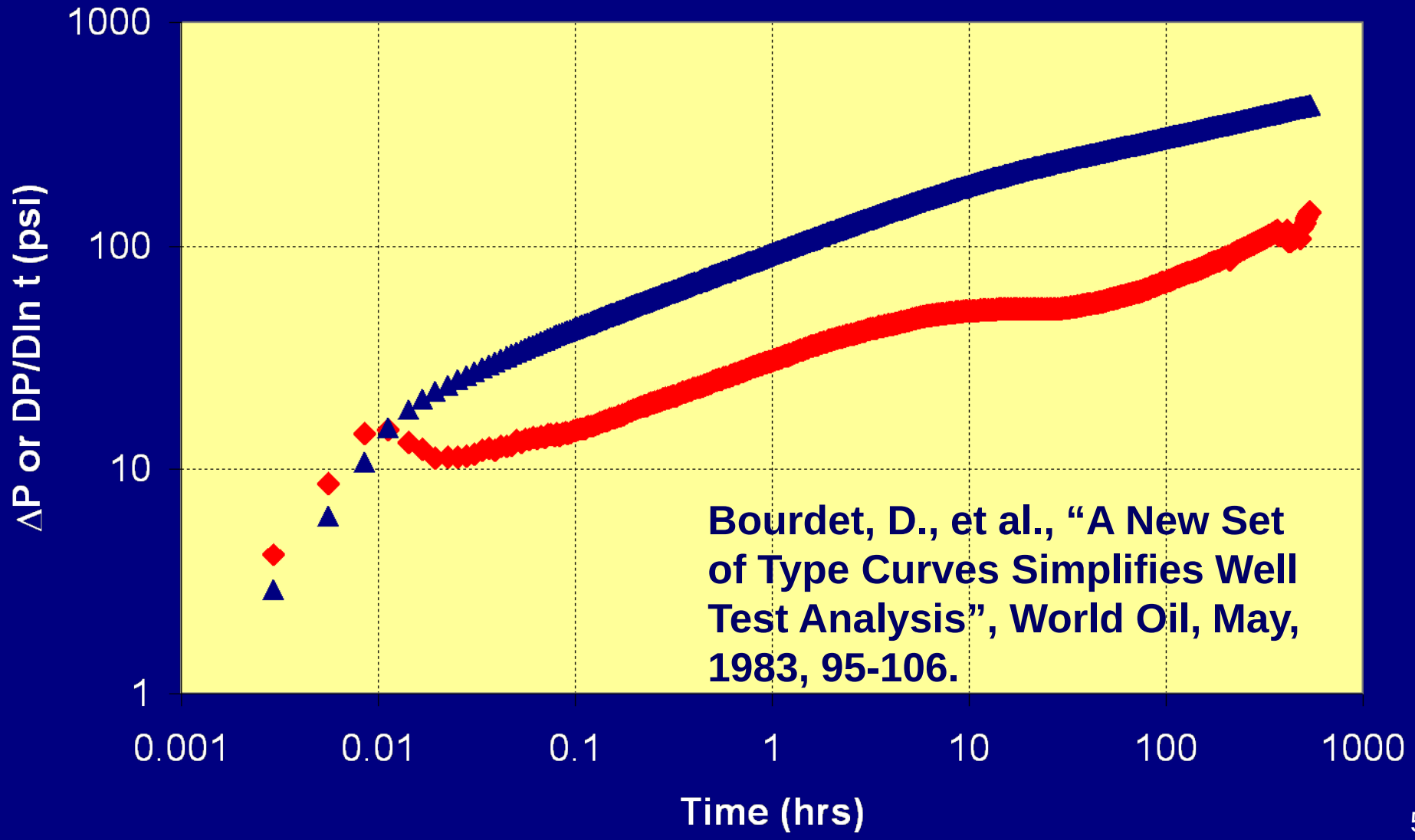
Society of Petroleum Engineers
Distinguished Lecturer Program
www.spe.org/dl

What’s in the Title?

- Twenty-five Years

1983
Tektronix 4014
Pressure Analysis
Workstation
PAWS
Cost 72,000 USD

Log-Log Diagnostic Plot
Bourdet 1983



What's in the Title?

- Twenty-five Years
- Use of Pressure Transient Analysis (PTA)
  - This lecture illustrates how we have used PTA in the last 25 years. By understanding that, you can use this technology better in the future.

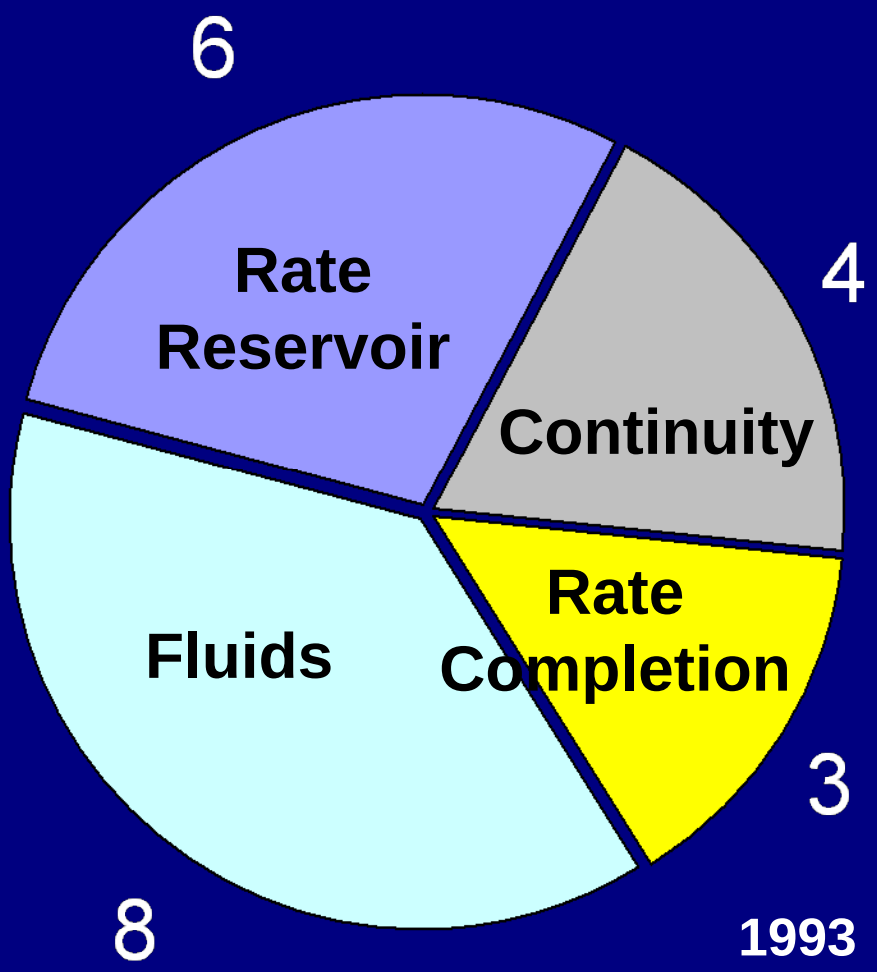
The Three Big Questions

- Why do we do it?
- How can we do it better?
- What’s the big picture?

Why Do We do Well Tests?

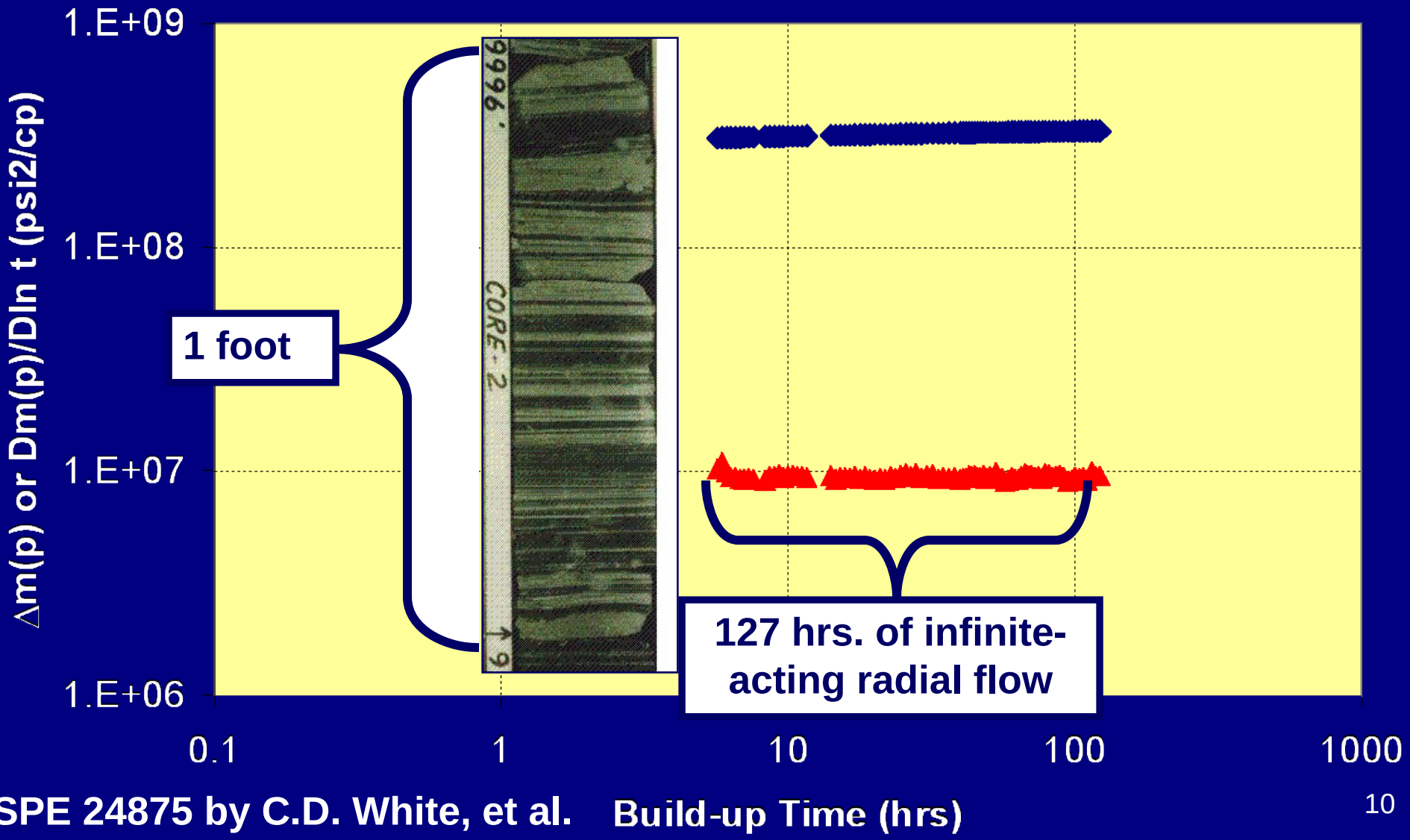
- Fluids - (gas or oil, PVT, surface processing issues, pipeline design)
- Rate - Reservoir (permeability)
- Rate - Completion (skin, length, conductivity)
- Continuity - (compartments, drainage area, nearby boundaries)

Rationales for Exploratory and Appraisal Well Tests



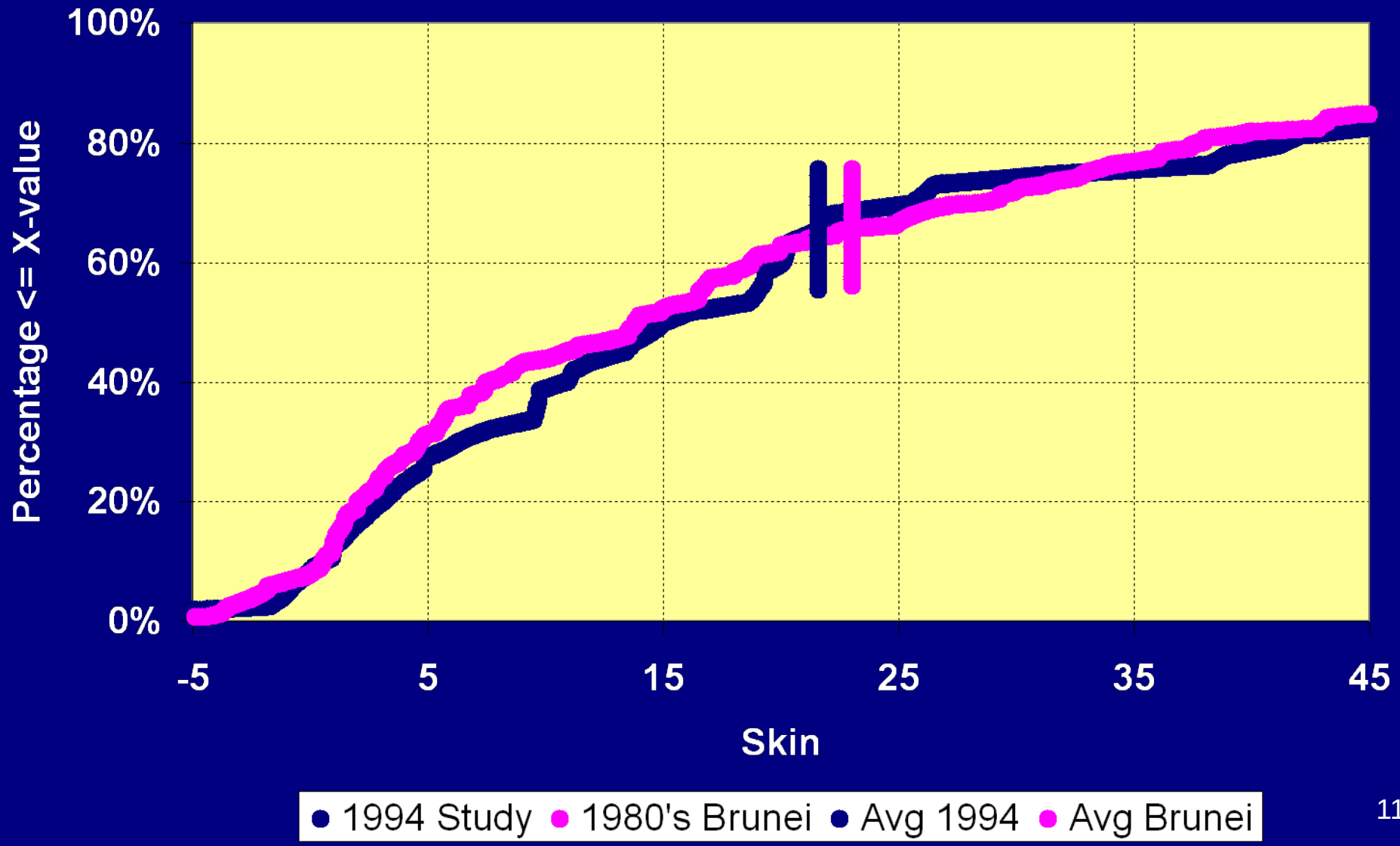
1993 Shell Case Studies

Continuity Well Testing Thin-Beds Tahoe

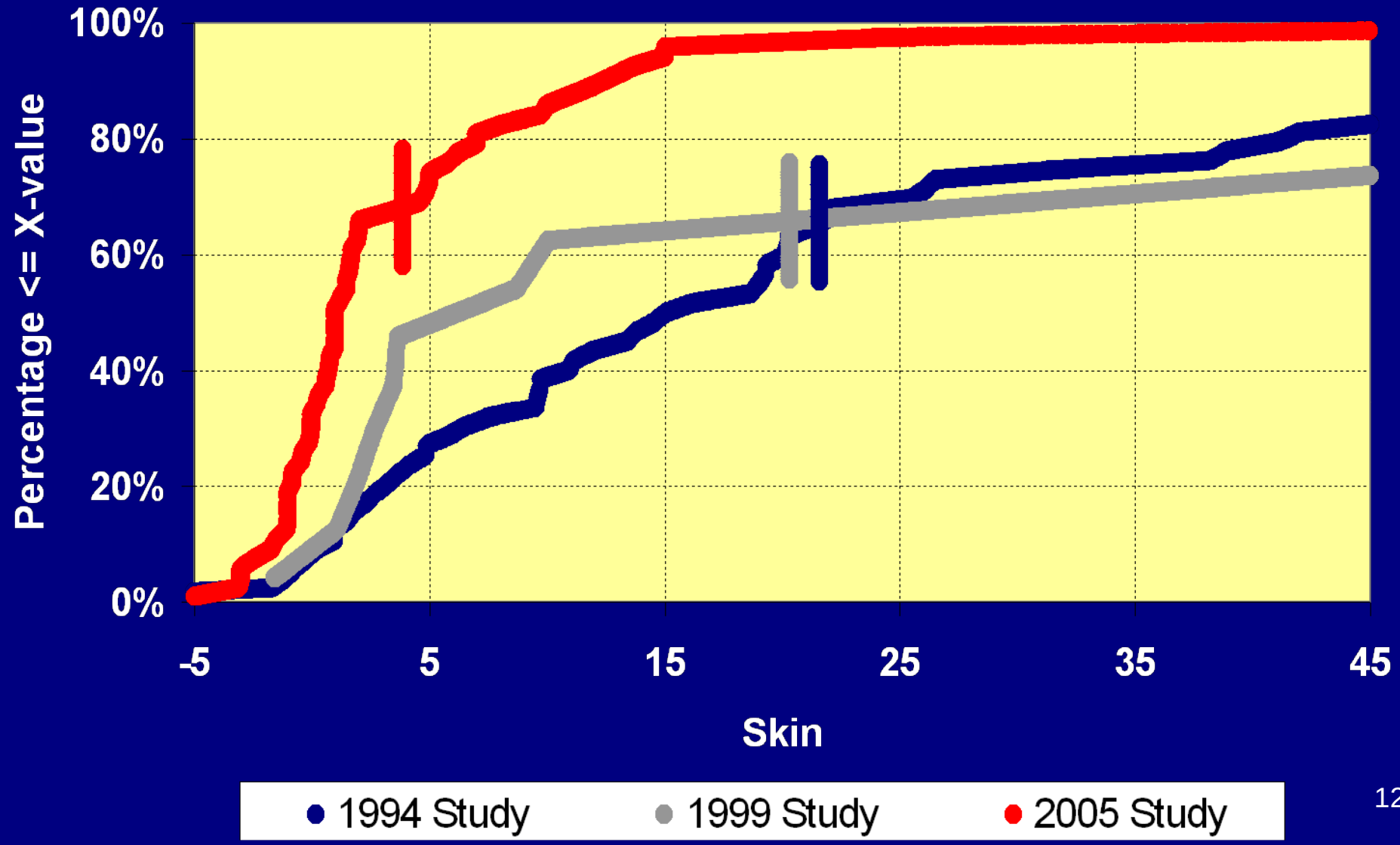


SPE 24875 by C.D. White, et al.

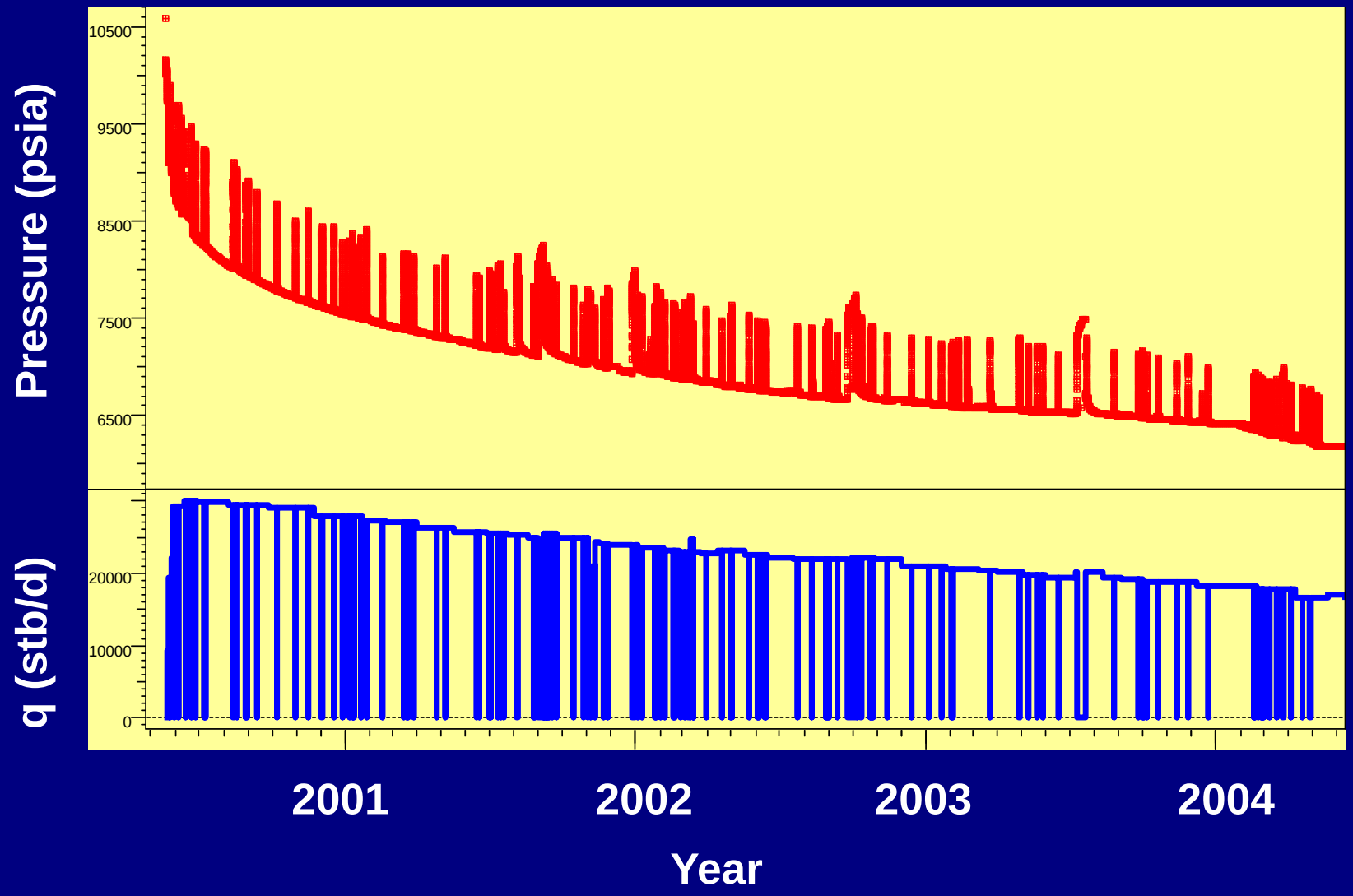
Skin Analyses on Gulf of Mexico Wells



Skin Analyses on Gulf of Mexico Wells

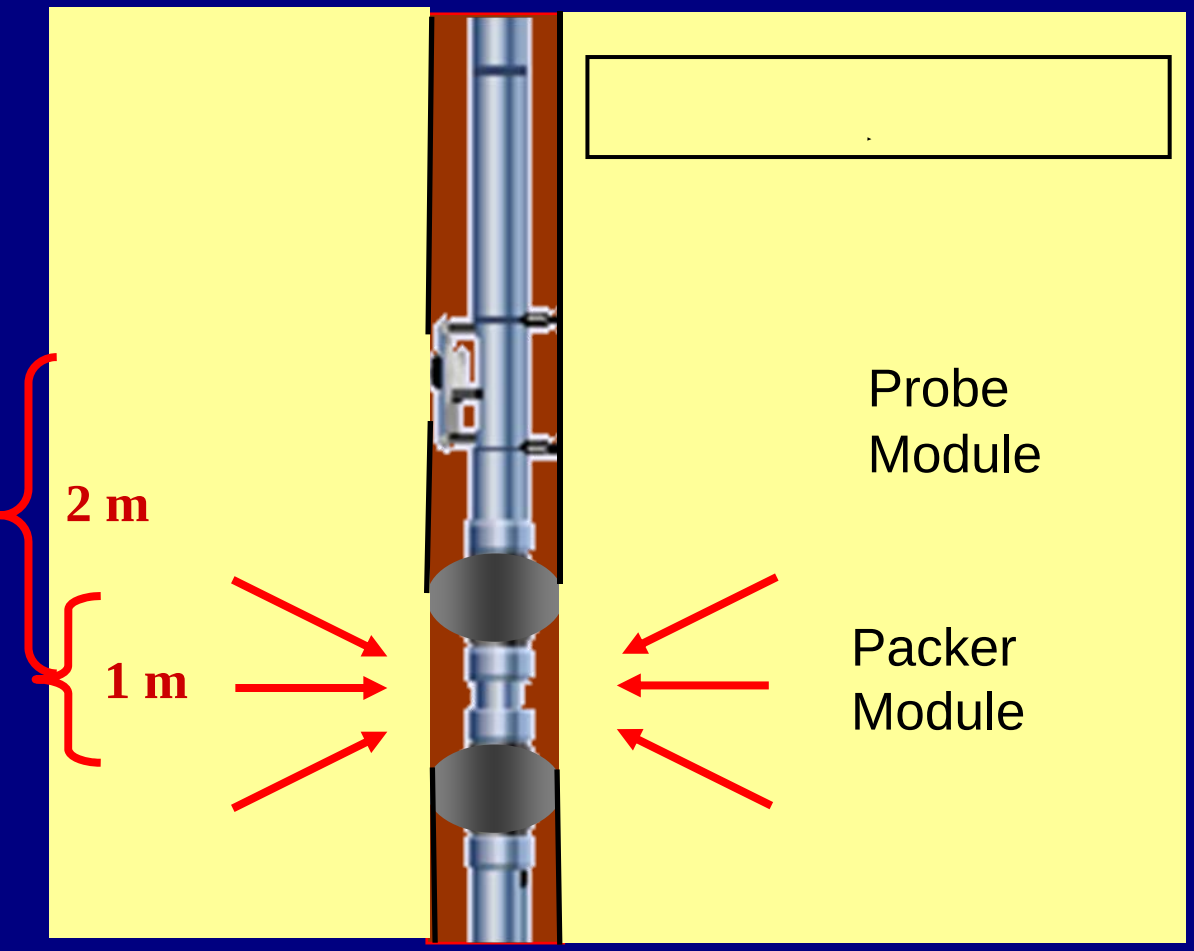


Permanent Downhole Pressure Dataset



Optimum Value Testing

Wireline Formation Tester Mini Drill Stem Test

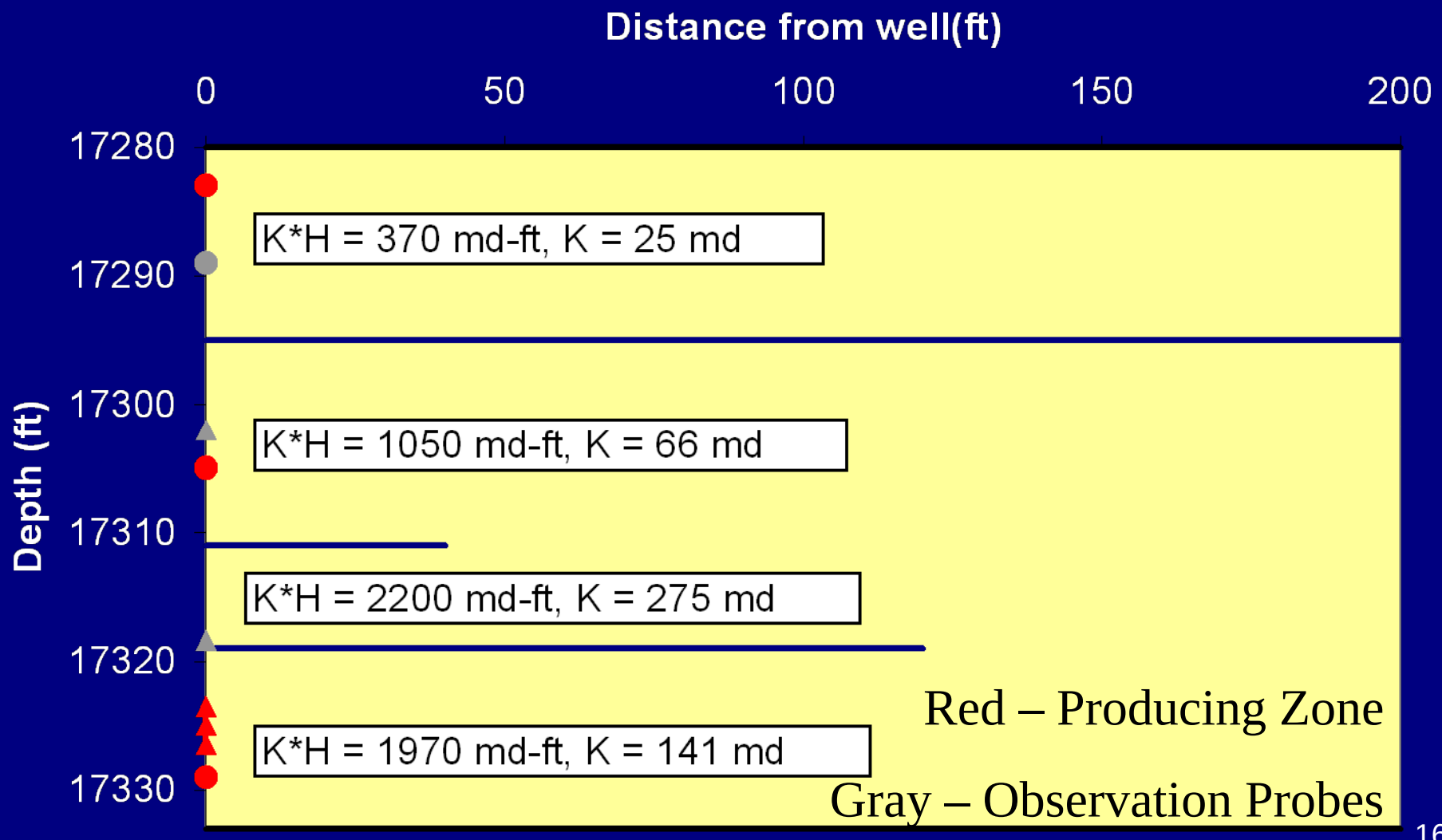


Another observation probe possible at 4.5 or 7m

Observation while Producing

Producing Interval

Distribution of Perm, 53-ft Thickness, K_{avg} = 106 md



Practical Deconvolution

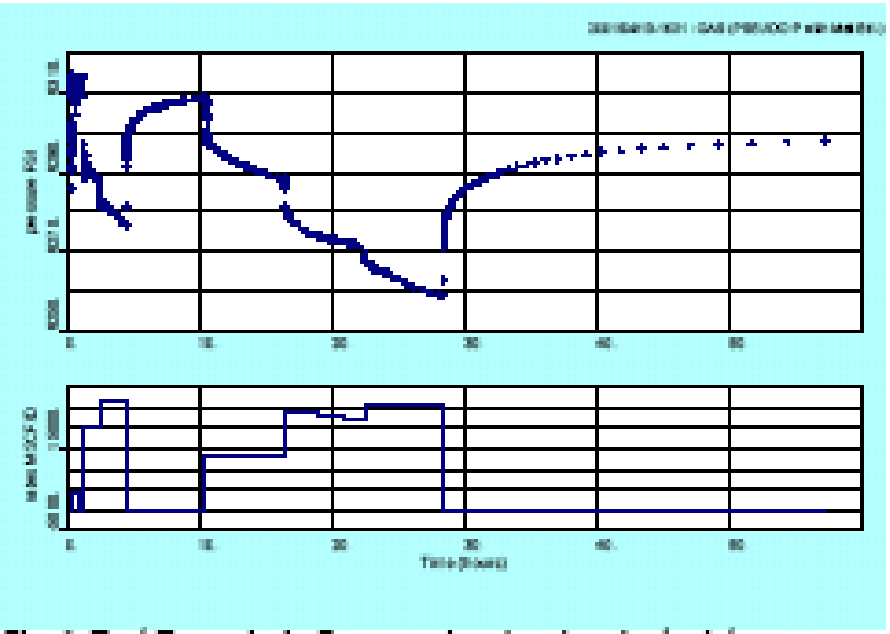


Fig. 1. Test Example 1. Pressure (markers) and rate data

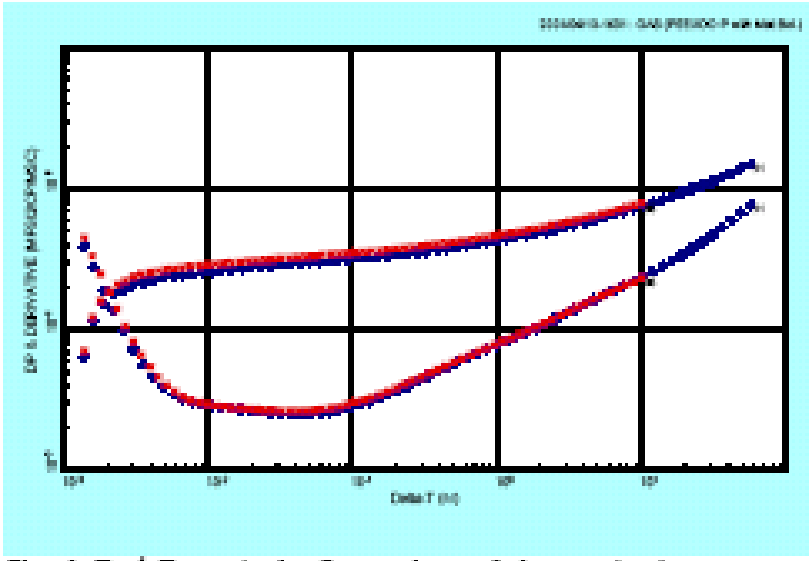


Fig. 4. Test Example 1. Comparison of deconvolved responses derived from PBU 1 and PBU 2 pressure data using the initial reservoir pressure of 6314.3 psi.

SPE 90680 by M. Levitan, et al.

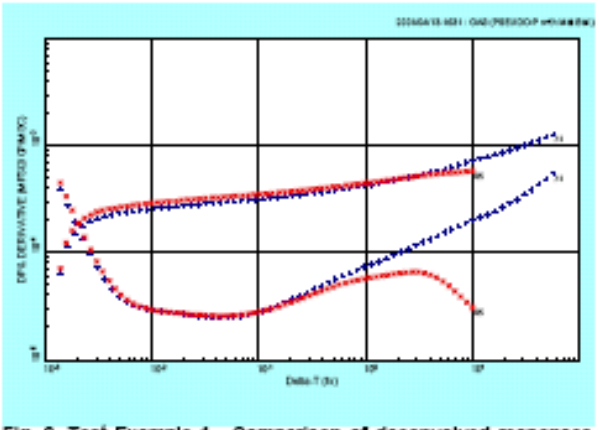
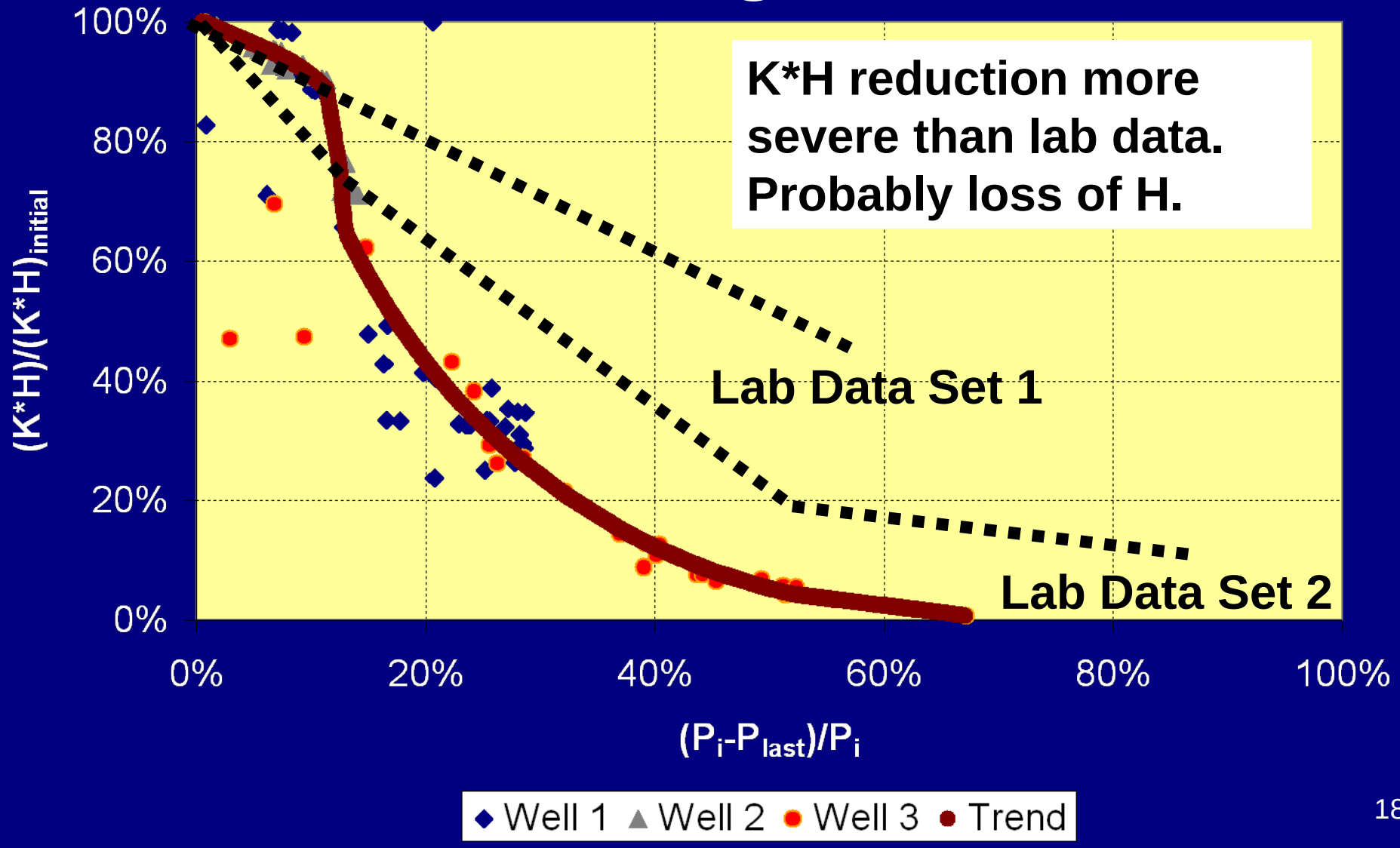
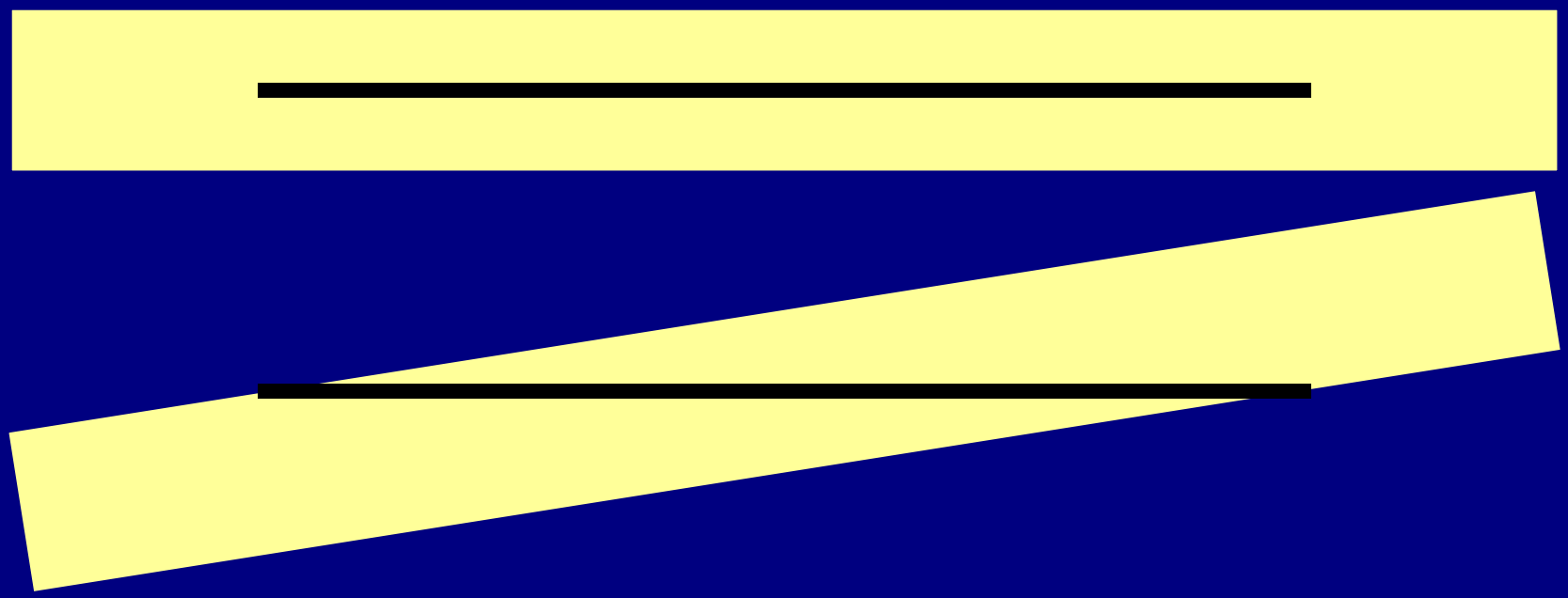


Fig. 2. Test Example 1. Comparison of deconvolved responses derived from PBU 1 (red) and PBU 2 (blue) pressure data using the initial reservoir pressure of 6310 psi.

How does Perm-Thickness Change?

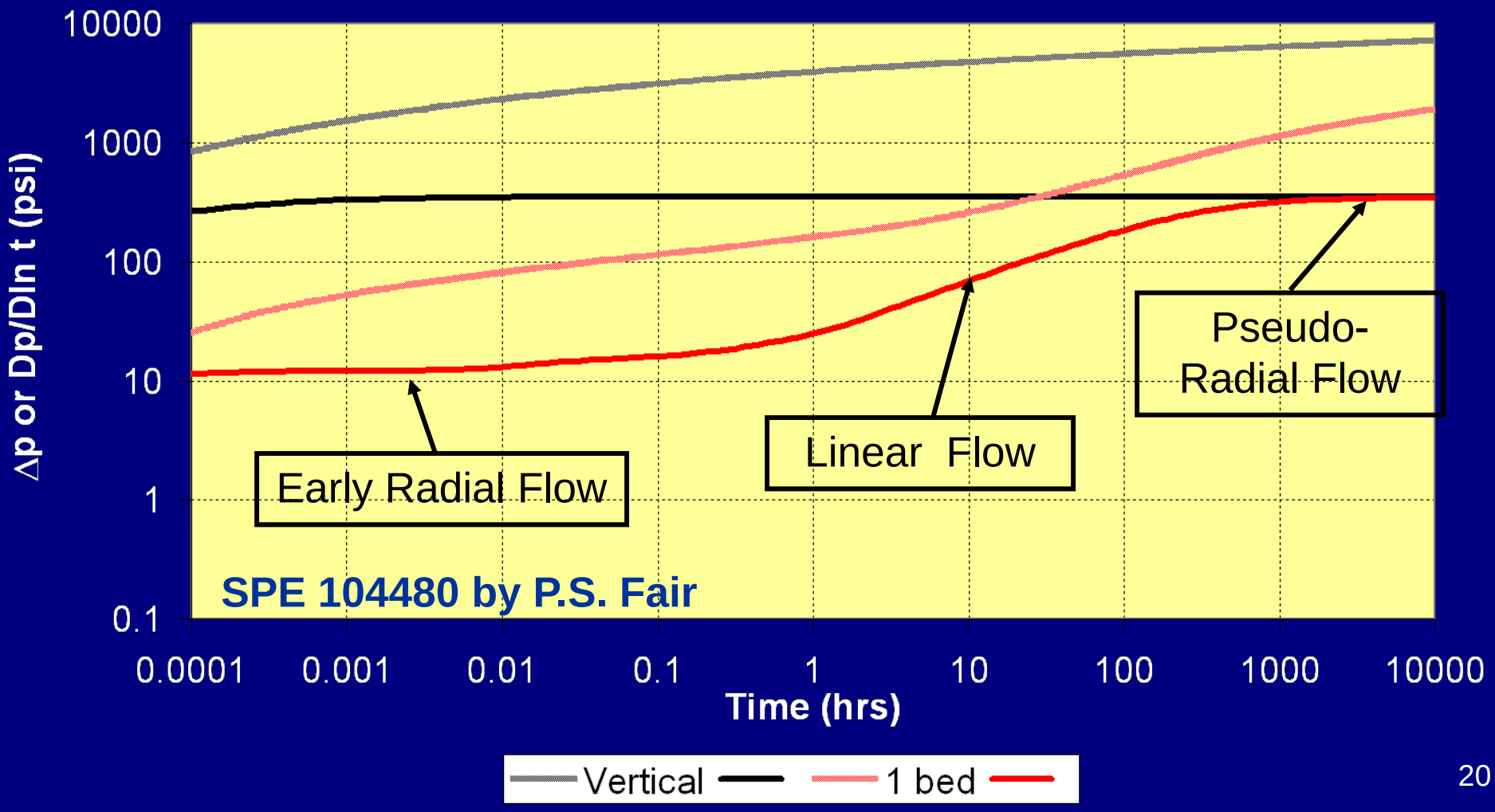


What is a horizontal well?

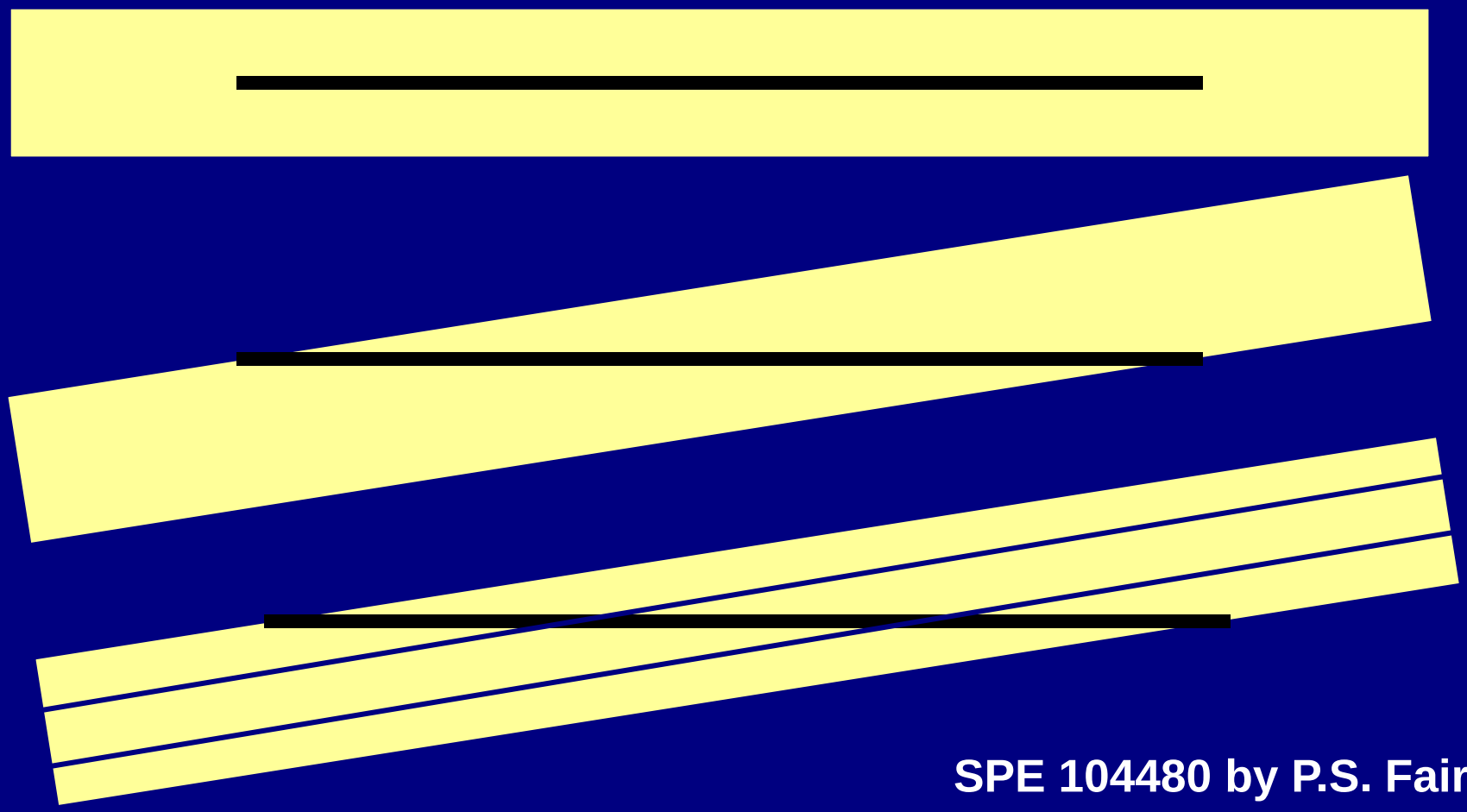


SPE 104480 by P.S. Fair

Varying Numbers of Beds in 88-degree Slant Well

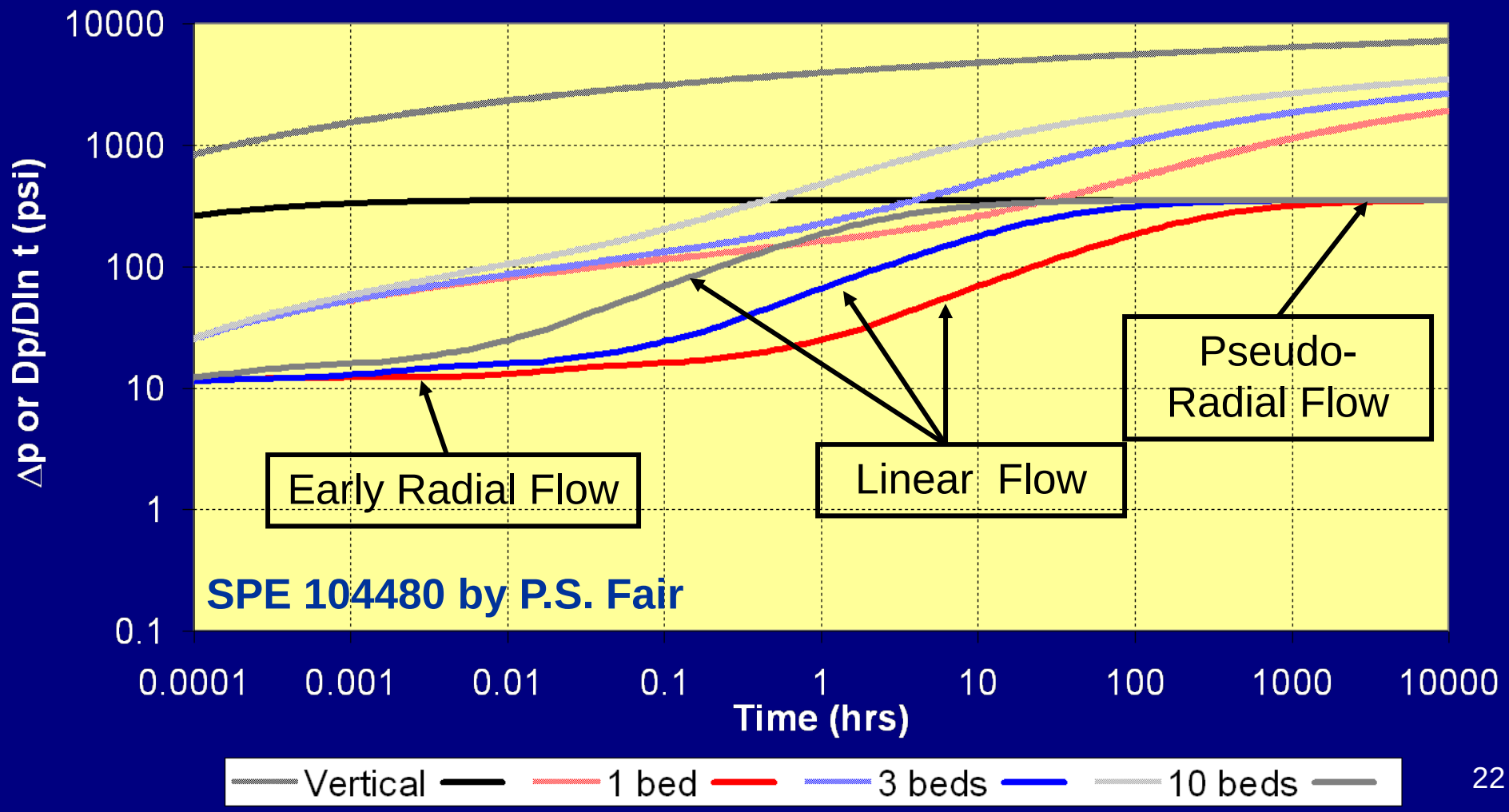


What is a horizontal well?



SPE 104480 by P.S. Fair

Varying Numbers of Beds in 88-degree Slant Well



Summary and Conclusions

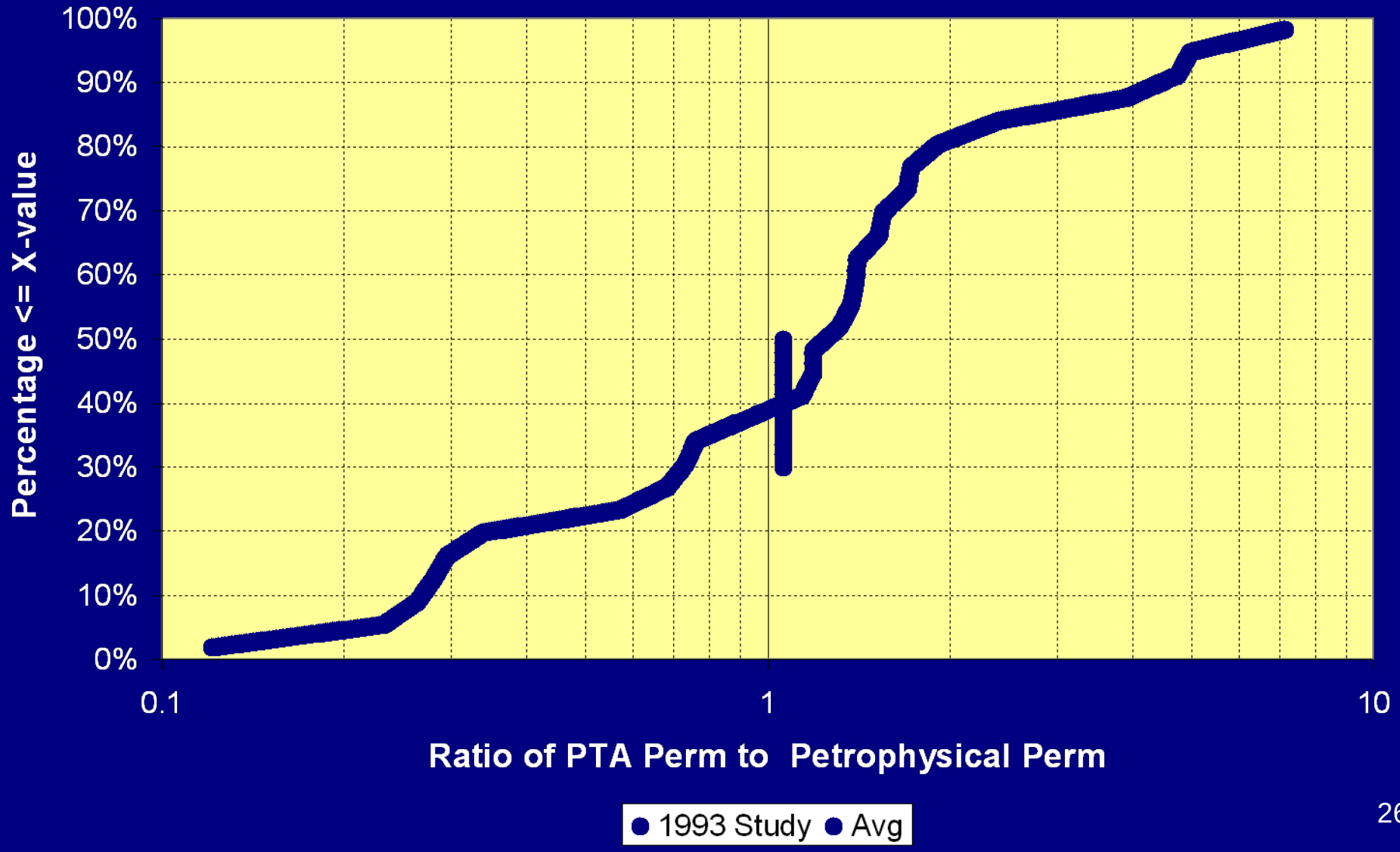
- Why do we do it?
  - Pie chart – 21-test 1993-lookback
  - Continuity test - thin beds
  - Skin distributions
- How can we do it better?
  - Permanent downhole gauges for well and reservoir management
  - Wireline Formation Tester – cheaper, safer, and greener but more information

Summary and Conclusions

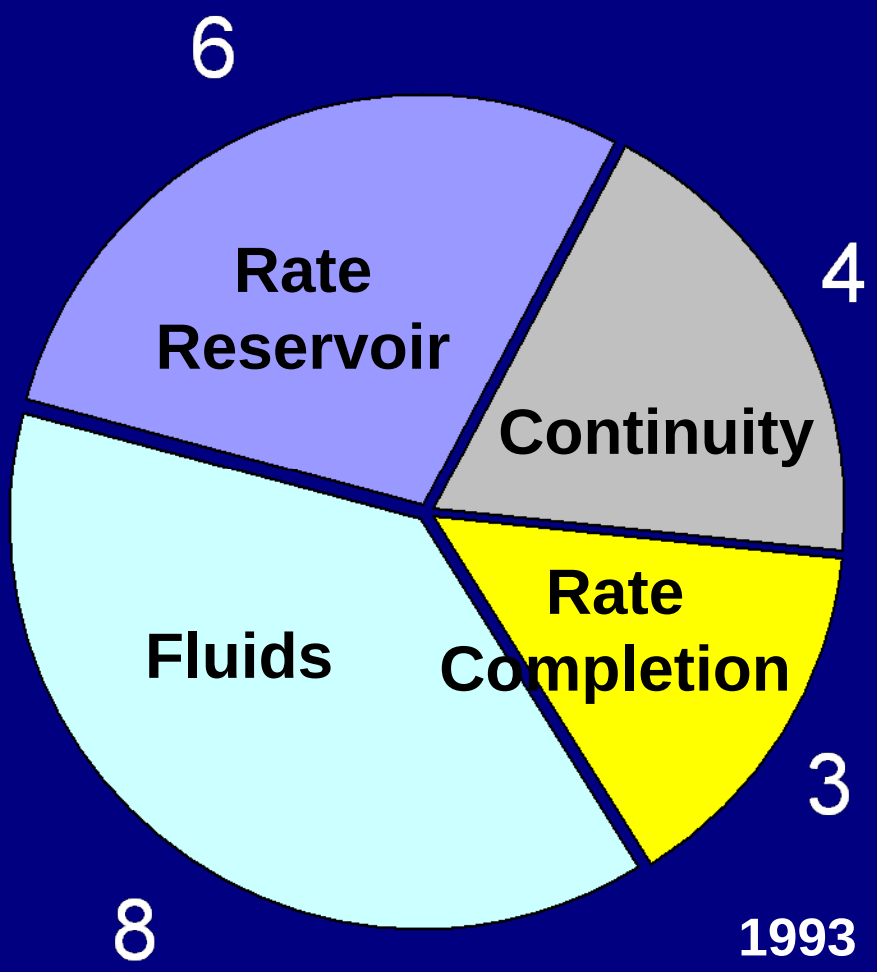
- What's the big picture?
  - PTA results versus petrophysical lab perm data
  - Geological layering for accurate interpretation of horizontal wells
- Most examples are from Gulf of Mexico but principles are universal.

Backup
&
Extras

Estimation of PTA Perm from Petrophysical Data

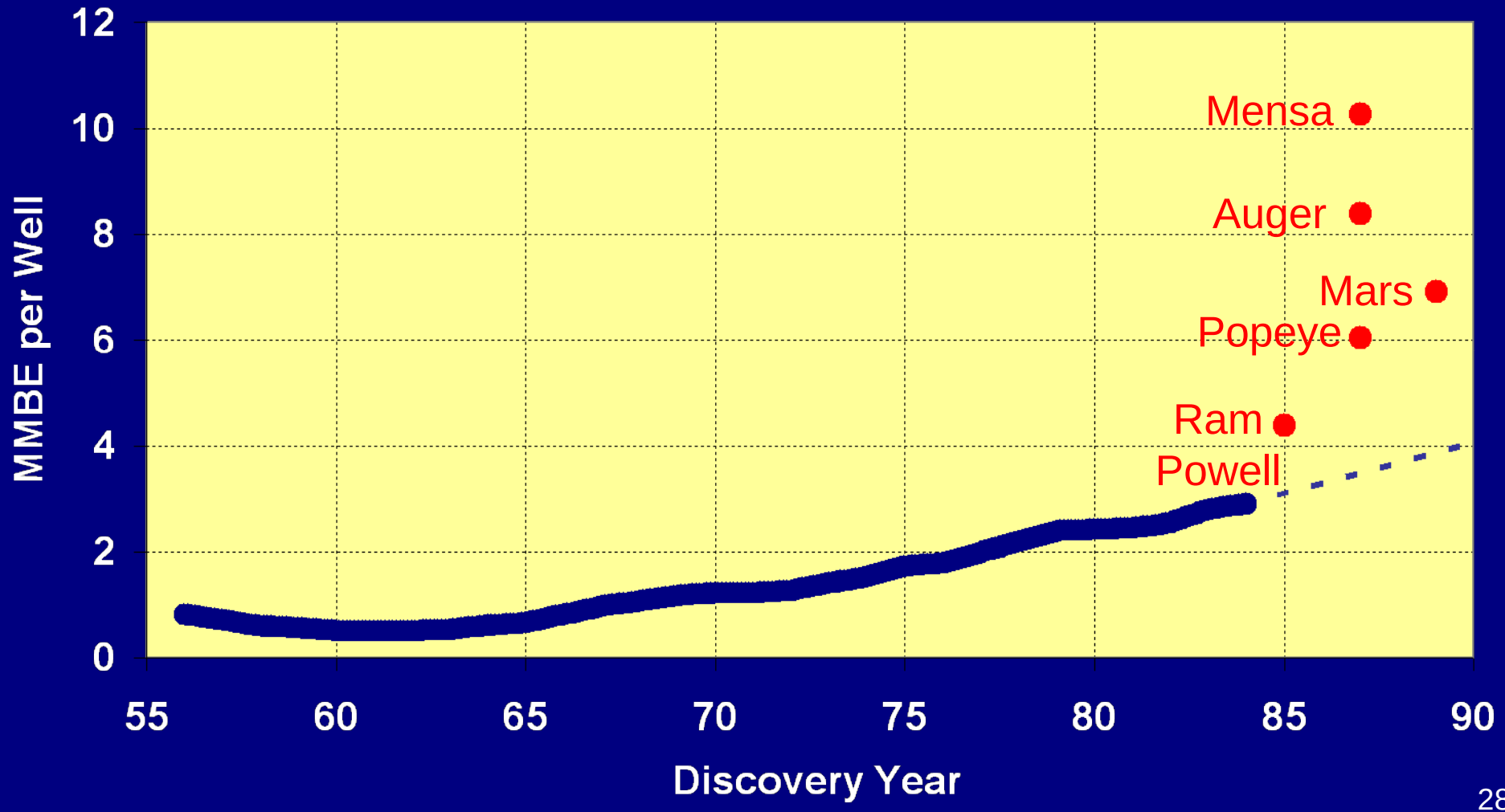


Rationales for Exploratory and Appraisal Well Tests

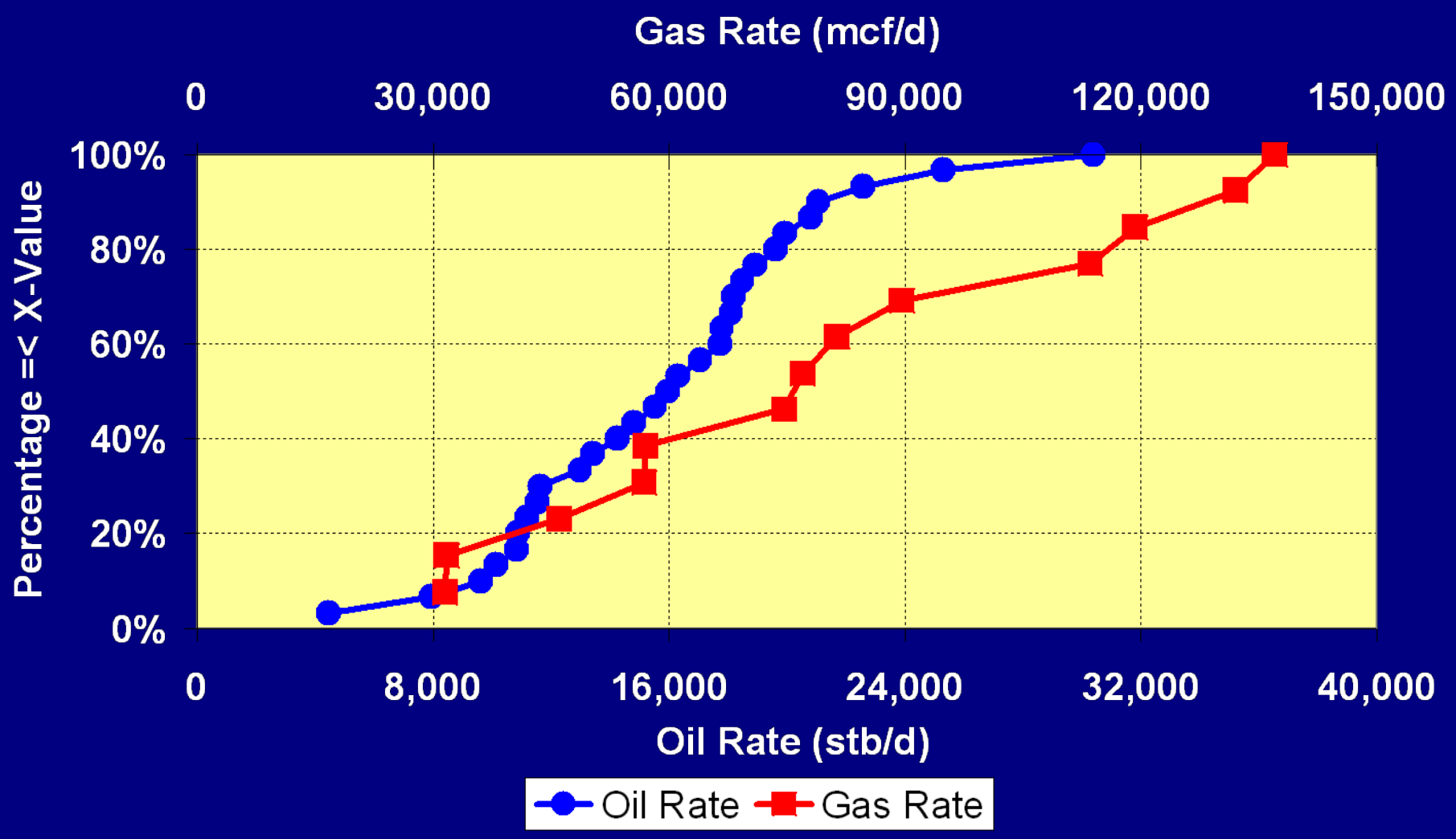


1993 Shell Case Studies

Shell Offshore Inc.
Average Ultimate Recovery



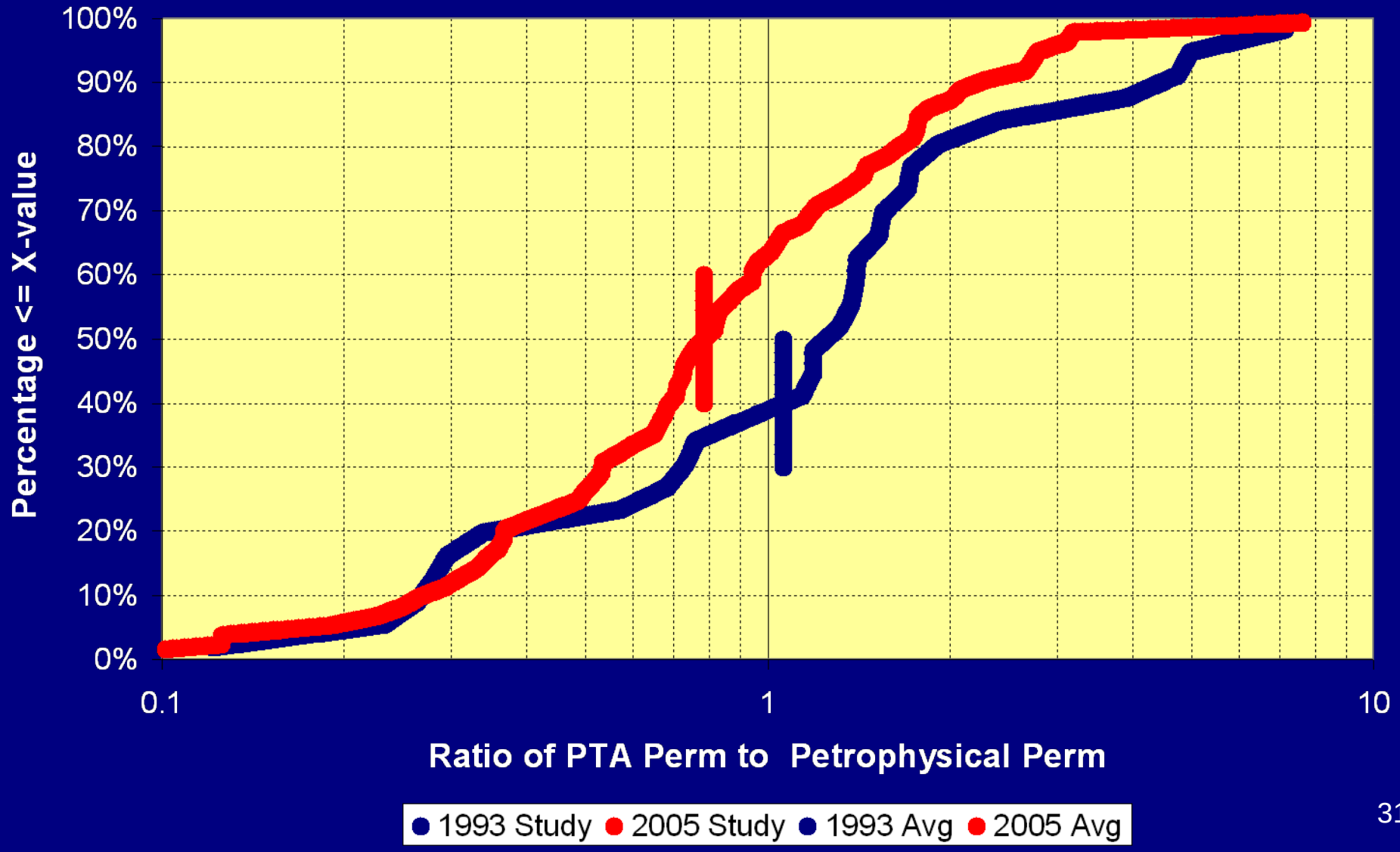
1999 Deepwater Initial Well Rates



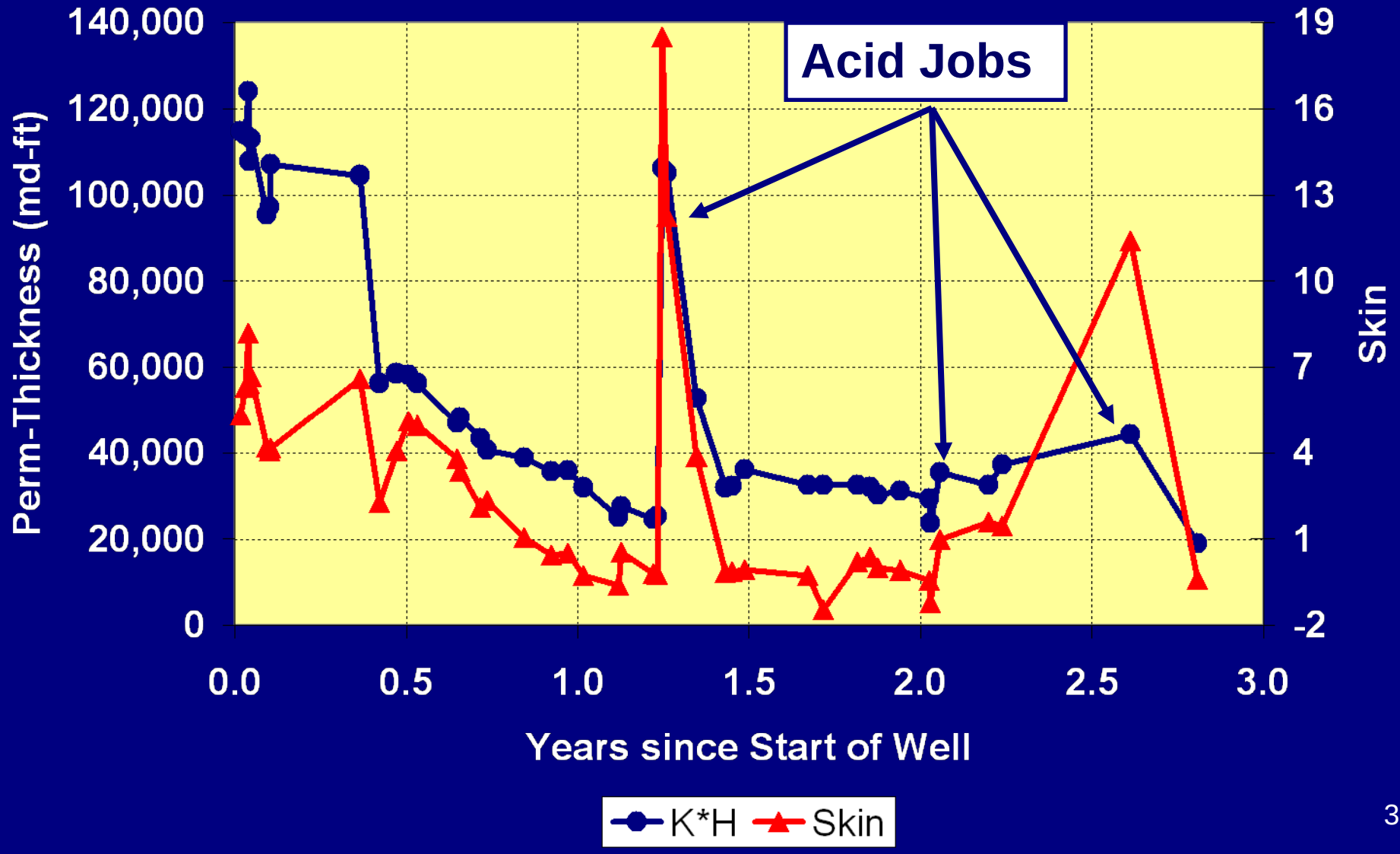
Optimal Value Testing What is it?

- Fit for purpose with lowest cost and HSE impact
- Any test where hydrocarbons are not produced directly to surface
  - New in toolbox
    - ★ Wireline formation test
    - – Closed system test
    - – Injection test

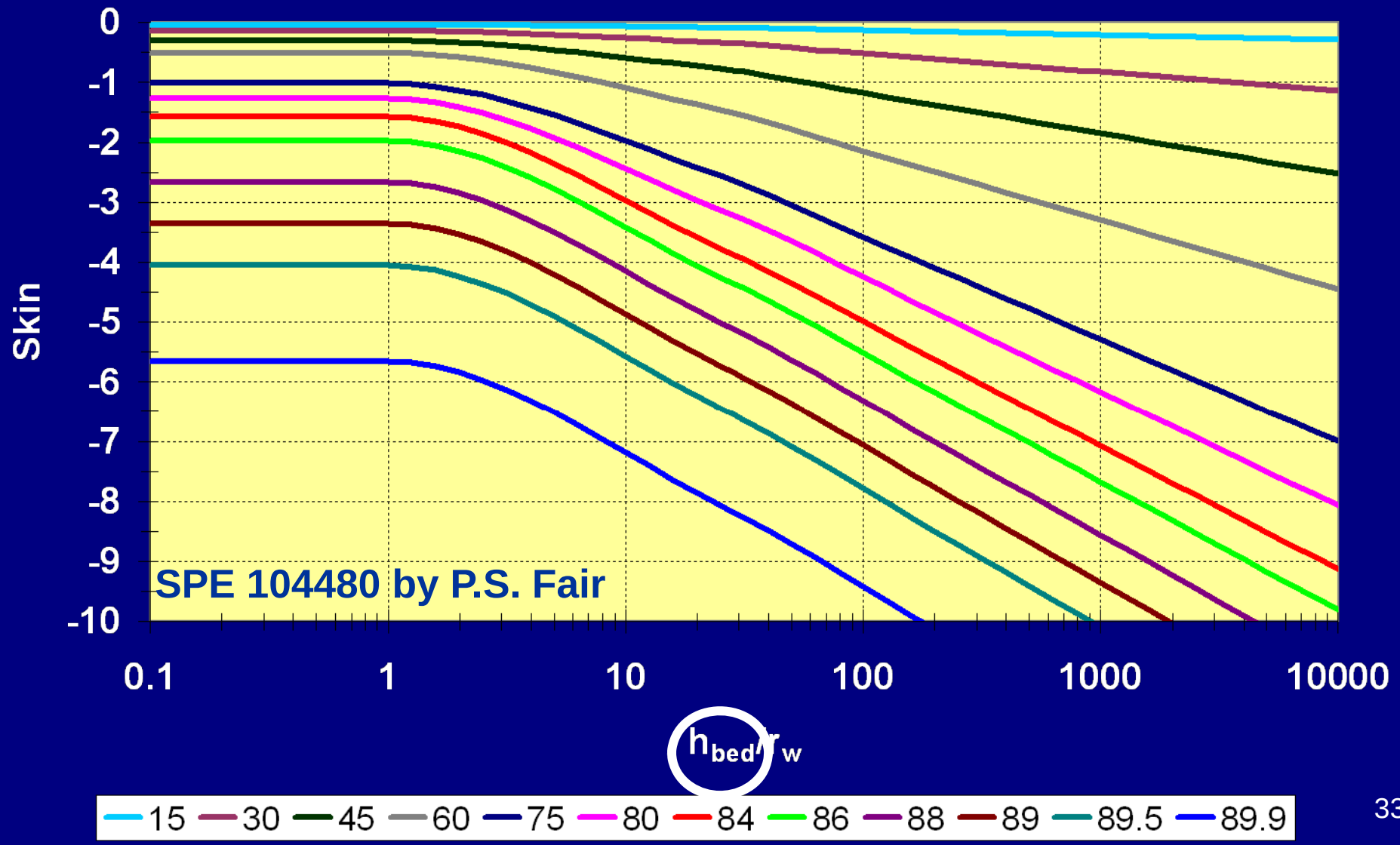
Comparison of Permeability Estimates



Sequential BU's Showing Loss of H



Pseudo-Skin Factors for Slant Wells



Holistic Well Testing

- All of the input data
- All of the gauges
- All of the build-up
- All of the build-ups
- All of the production history
- All of the non-well test data
  - Operational
  - Petrophysical
  - Geological