Introduction to Simulation

Prepared by:

Thomas W. Engler, Ph.D.,P.E.

Fall 2009

New Mexico Tech
SCIENCE-ENGINEERING-RESEARCH-UNIVERSITY

Why develop a reservoir simulation model?

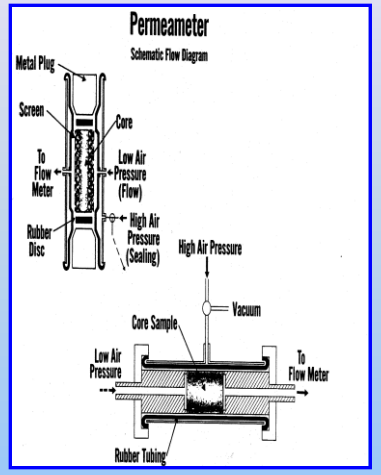
- provide detailed performance predictions for multiphase, heterogeneous reservoirs

- Evaluate single well performance

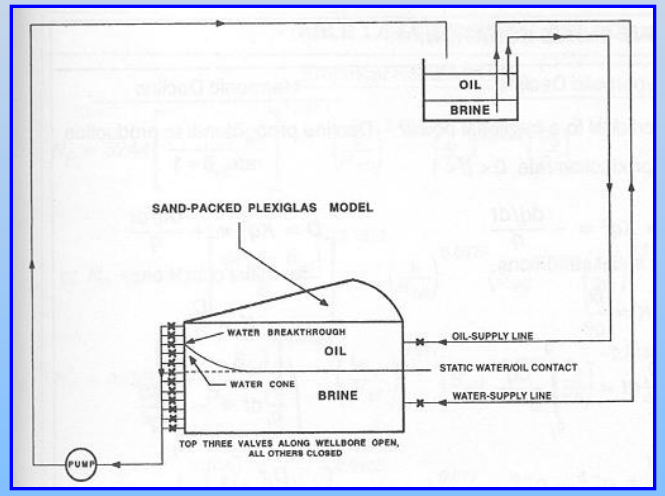
Improve/optimize reservoir management

Modeling Approaches

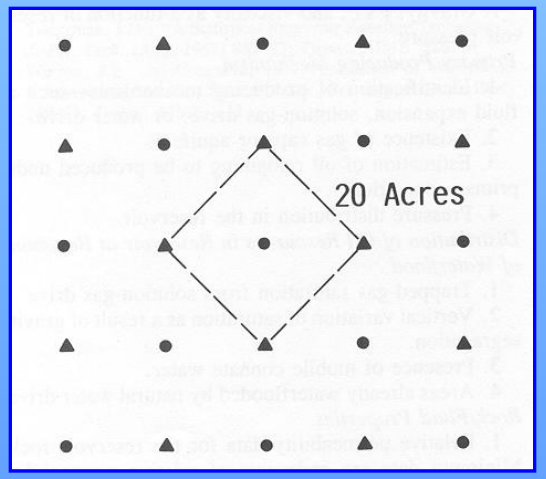
1. Analogy
2. Physical
   a. Elemental – core



   b. Scaled – packed sand, cut stone

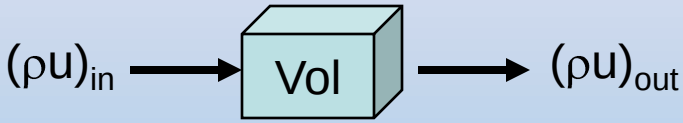


   c. Field pilot – single pattern

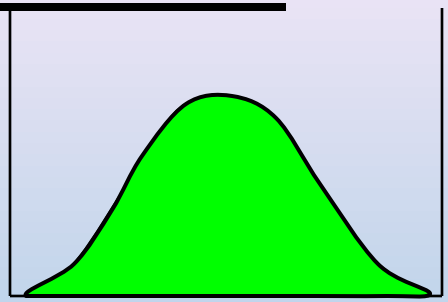


Modeling Approaches

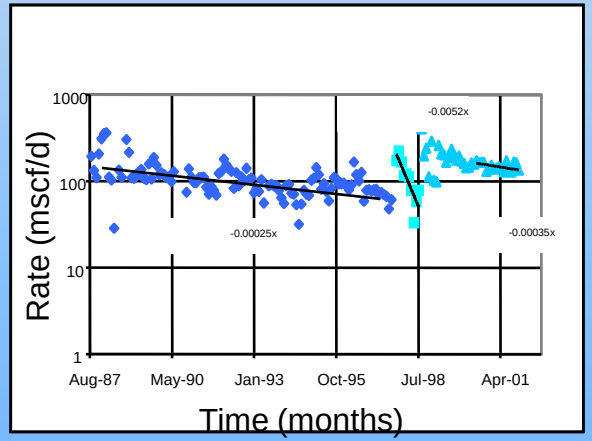
3. Mathematical



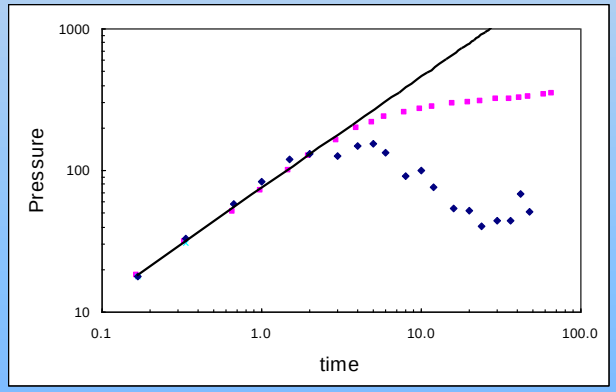
Material Balance



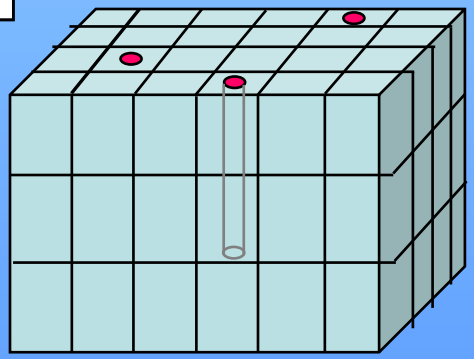
Statistical



Decline Curves



Analytical



Numerical

New Mexico Tech
SCIENCE·ENGINEERING·RESEARCH·UNIVERSITY

Comparison
Simulation to Field Pilots

- Can **repeat** frequently from initial conditions
- **Time** to evaluate results is fast
- Lower **cost**?
- **Simulates** field conditions
- *Results*: May be used to design pilot.

- Lack of **repeatability** (one shot proposition)
- **Time** for evaluation of pilot results can be lengthy
- **Costly**
- **Real** conditions
- *Results:* may be used to modify model

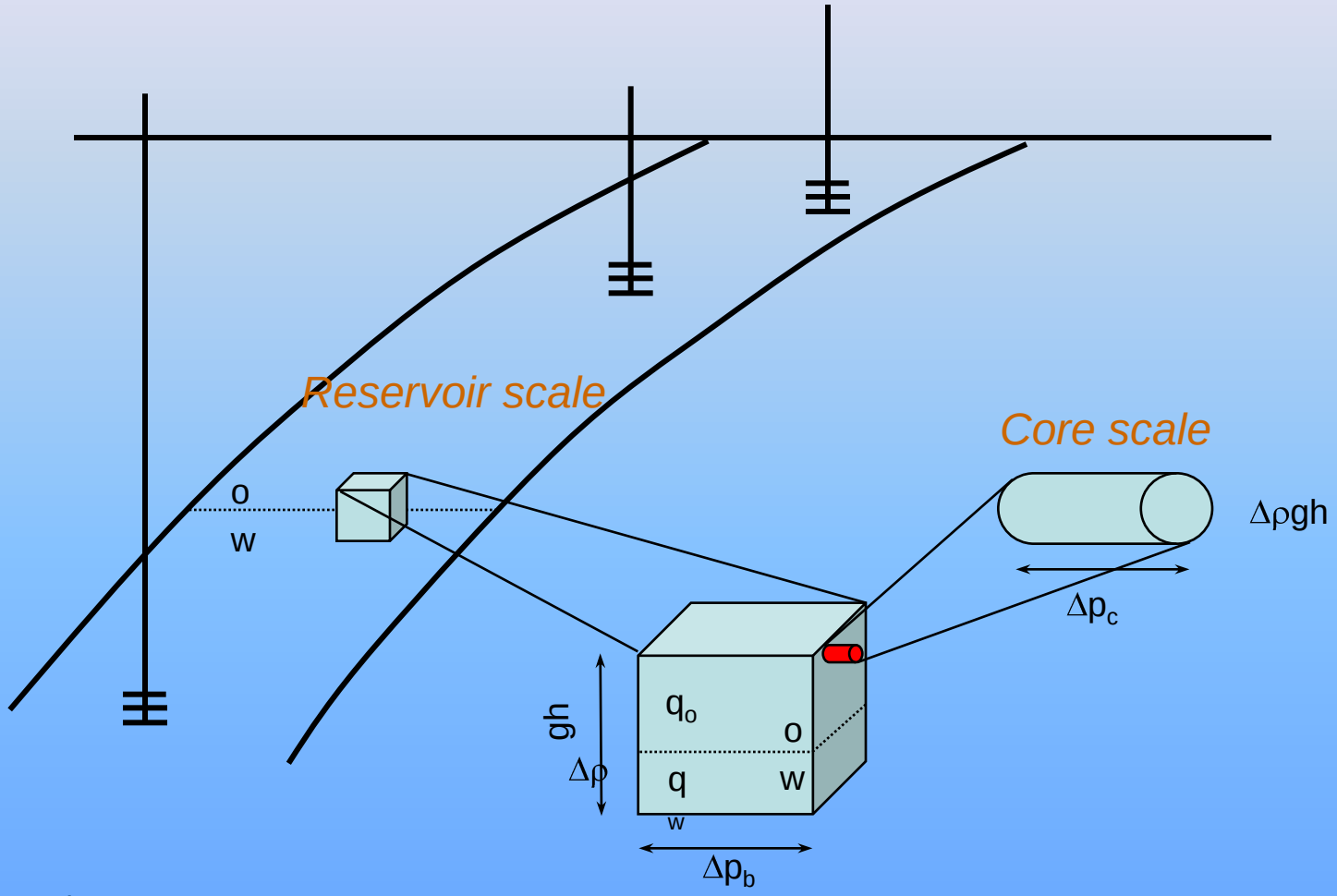
Comparison

Simulation to Lab models

- Imaginary reservoir, requires physical model results
- Numerical dispersion
- Grid orientation effects
- Solution technique accuracy
- Scale????

- Core experiments use actual reservoir rock and fluids.
- Results distinguish mechanisms of fluid flow
- Measurement/human error
- Scale????

Scale



New Mexico Tech
SCIENCE-ENGINEERING-RESEARCH-UNIVERSITY

Comparison
Numerical to Analytical

- Multi-dimensional
- Allows for variations of parameters…
- Based on fundamental equations

- Zero-dimensional tank models
- No variations in parameters with regard to space or time

New Mexico Tech
SCIENCE-ENGINEERING-RESEARCH-UNIVERSITY

Planning

Step	Time
Problem Definition	
Data Review	
Data Acquisition	
Model Design	
History Matching	
Prediction	
Editing, analysis, reporting	

New Mexico Tech
SCIENCE-ENGINEERING-RESEARCH-UNIVERSITY

Problem Definition

- assemble information about the reservoir and operations
- define practical objectives and scope of study
- preliminary analysis of the reservoir mechanics, e.g., coning, gravity

Data review and acquisition

- review of quality and quantity of data, sources of data
- assess if sufficient data is available to meet objectives, or revise objectives or obtain more data
- sensitivity of reservoir performance to parameters!

New Mexico Tech
SCIENCE-ENGINEERING-RESEARCH-UNIVERSITY

Model Design

- Individual well or full-field model? Radial or cartesian?
- Type of reservoir fluid?
- Type of process to model?
- Quality of geologic and petrophysical data?
- Time and cost constraints?

New Mexico Tech
SCIENCE-ENGINEERING-RESEARCH-UNIVERSITY

History Matching

- adjust input variables to validate model through matching performance parameters

- A successful history match does **not** guarantee a field match

  Uncertainty….nonuniqueness

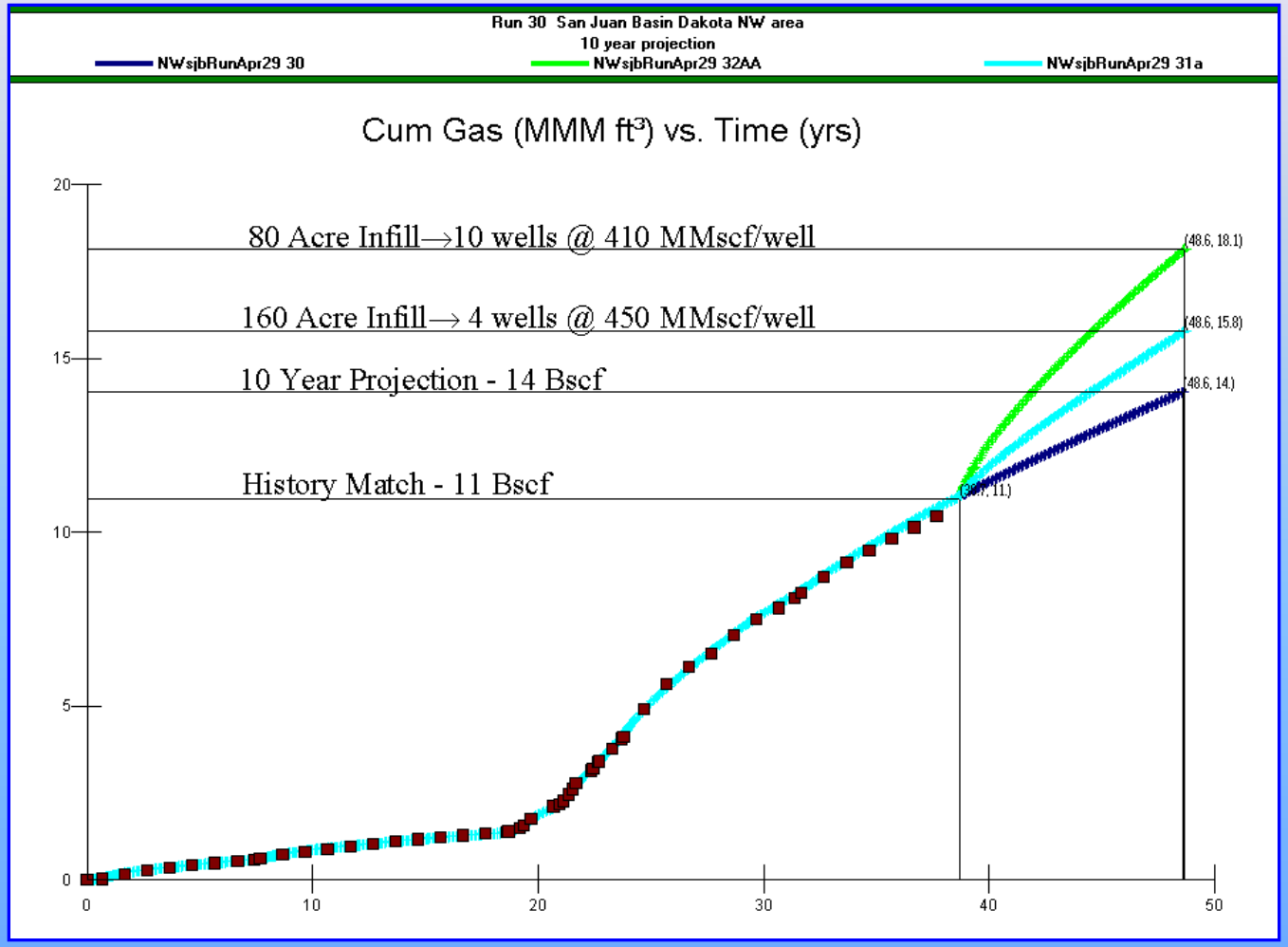
New Mexico Tech
SCIENCE-ENGINEERING-RESEARCH-UNIVERSITY

Prediction

- Predict future performance to make better management decisions
- Perform sensitivity analysis and observe impact of results

New Mexico Tech
SCIENCE-ENGINEERING-RESEARCH-UNIVERSITY

Prediction- Example



Medford