Al-Ayen University

College of Petroleum Engineering

Numerical Methods and Reservoir Simulation

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Lecture 1: Key Steps in a Simulation Study (Part 1)

Outlines

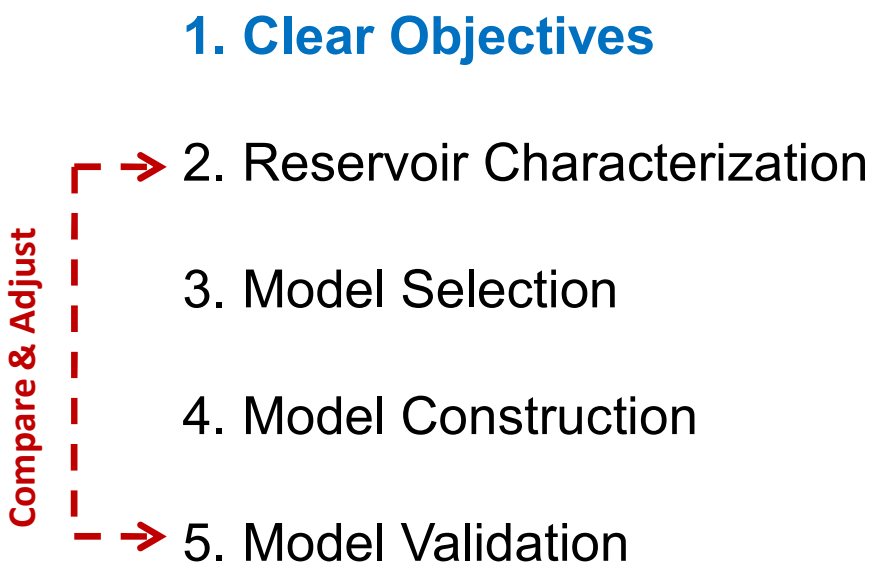
- Syllabus
- Key Steps in a Simulation Study

Syllabus

Numerical Methods and Reservoir Simulation

Interpolation,(Linear; Lagrange); Matrices, Review of matrix properties, Determinants, inverse of matrix; Solution of system of linear equations (Gaussian elimination, Gauss Jordan method, Jacobi method, Gauss Seidel method); Least square method (Linear equations; Polynomial equations); Reservoir simulation (Introduction, types of simulators); Flow through Porous Media (derivation of single-phase, one-dimensional flow equation, Two and three-dimensional flow equation); Finite Difference Method (Taylor series; Forward difference; Backward difference; Central difference; Concepts of explicit and implicit methods); Solution of system of difference equations (tridiagonal algorithm); Use of Irregular Gridding: Transmissibility; The finite difference form of the flow equation in terms of Transmissibility; Averaging of rock and fluid properties; Solution of radial form of the flow equation; Two dimensional flow, setting up the finite difference form; Ordering schemes; Standard row ordering; Standard column ordering; Resulting matrix structure; Introduction to multi-phase flow through porous media.

Key Steps in a Simulation Study



Clear Objectives

Examples of Reservoir Study Goals

Typical Goals for New Fields (Appraisal Stage):

- Define reservoir's internal & external boundaries
- Define reservoir pay, volume, & reserves
- Determine optimum number, location, & configuration of wells
- Optimize timing and sizing of facilities
- Select optimum recovery process
- Estimate potential recovery performance
- Anticipate future produced fluid & operational changes
- Determine critical gas and water coning rates

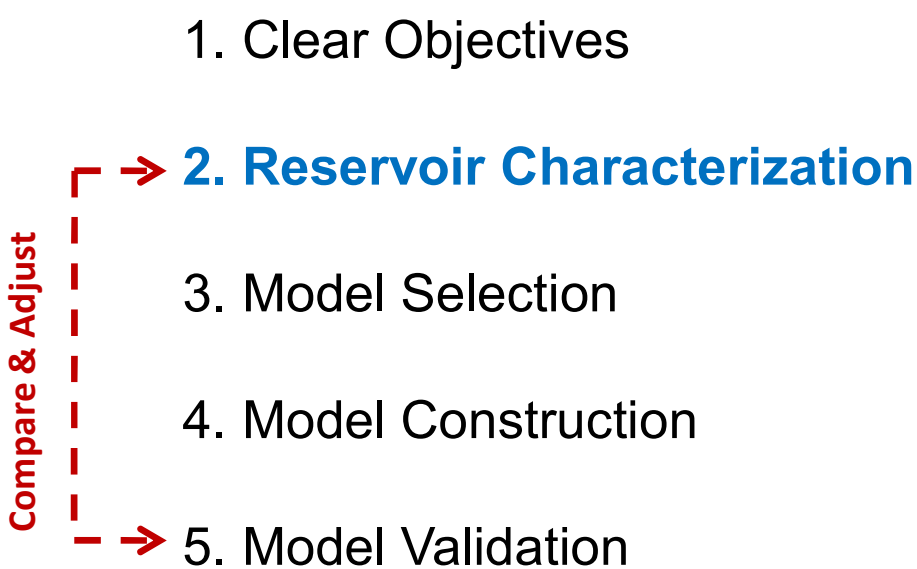
Clear Objectives

Examples of Reservoir Study Goals

Typical Goals for Mature Fields:

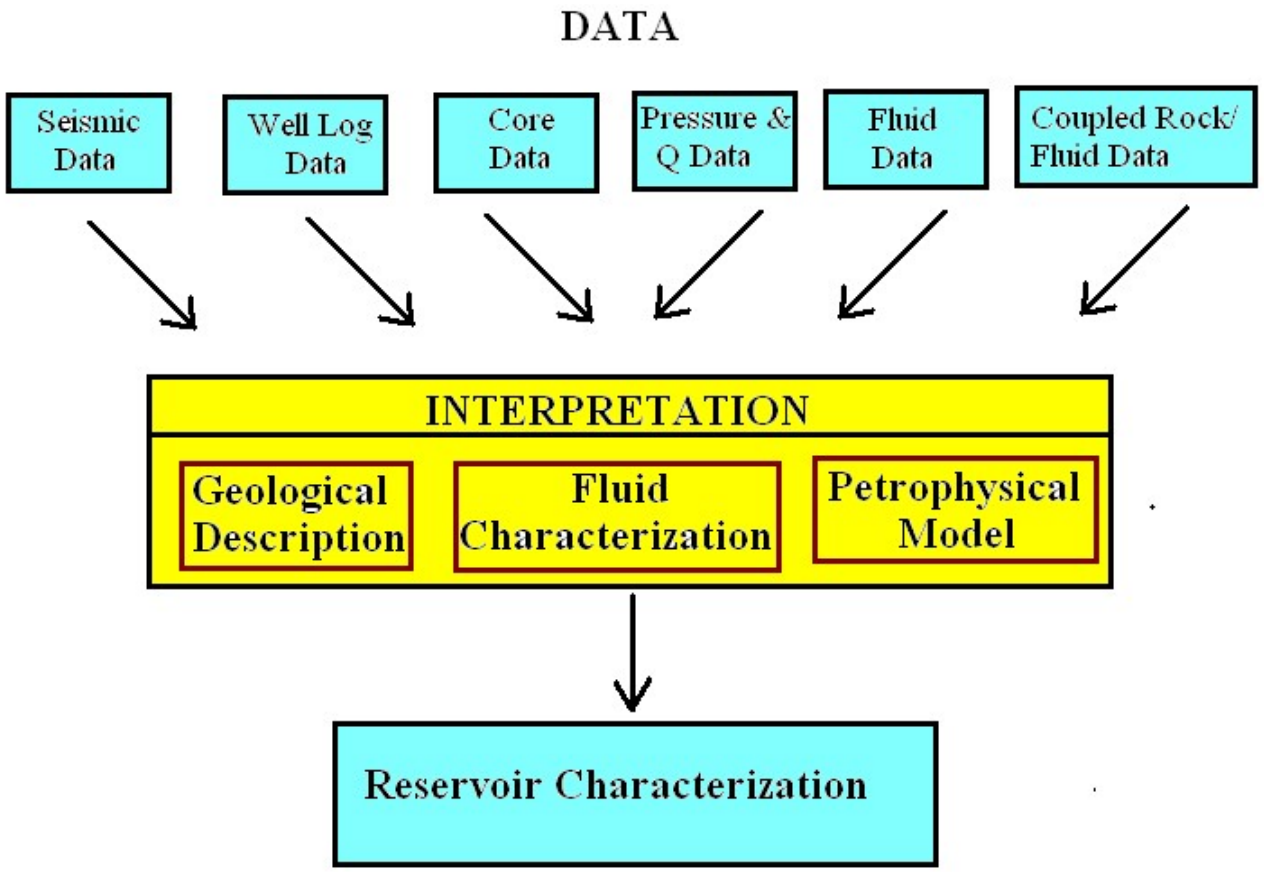
- Monitor fluid contact movement
- Evaluate productivity degradation
- Evaluate historical reservoir performance. Determine why performance did not match predicted recovery
- Determine source of produced water and/or gas. Identify wells with workover potential
- Monitor reservoir sweep to locate by-passed oil
- Specify infill drilling requirements
- Estimate benefits of secondary recovery or EOR
- Determine connectivity between multiple reservoirs

Key Steps in a Simulation Study



Reservoir Characterization

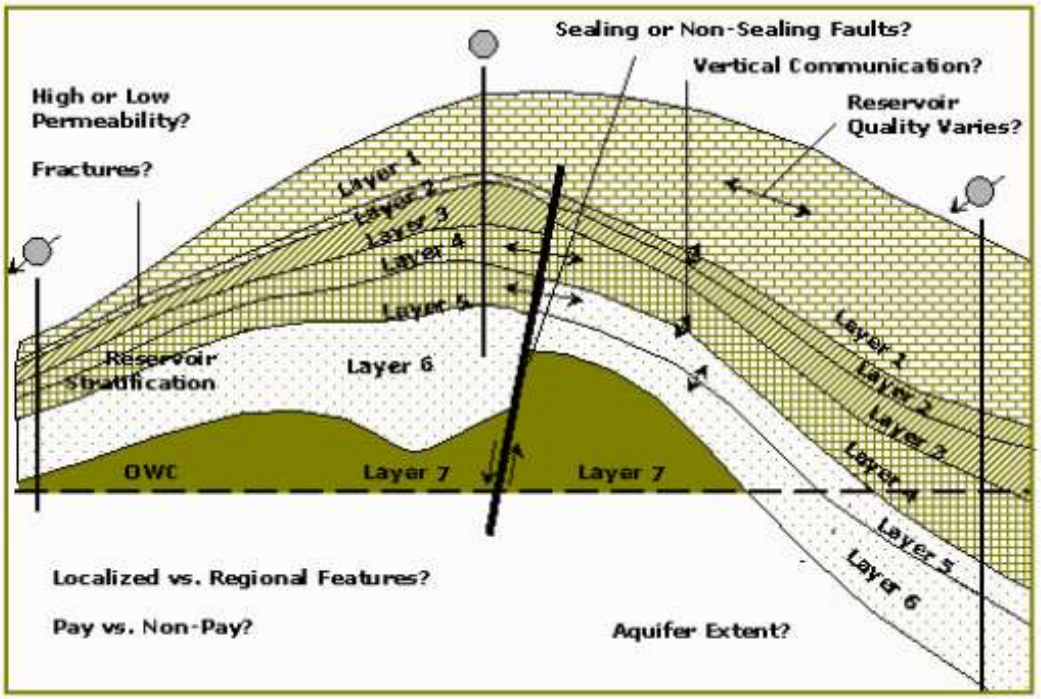
Three Inter-Dependent Components



Reservoir Characterization

Geological Description

A geological description must identify the key factors which affect flow through the reservoir:



Reservoir Characterization

Fluid Characterization

Fluid characterization defines the physical properties of the reservoir fluid mixture, and how they vary with changes in pressure, temperature and volume.

Steps to characterize the reservoir fluids:

- Classify the fluid type
- Determine reservoir fluid properties
- Describe reservoir production mechanisms

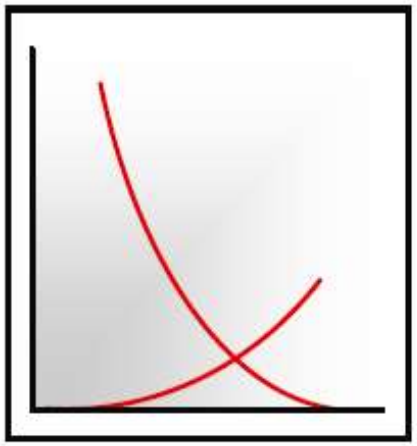
Reservoir Characterization

Petrophysical Model

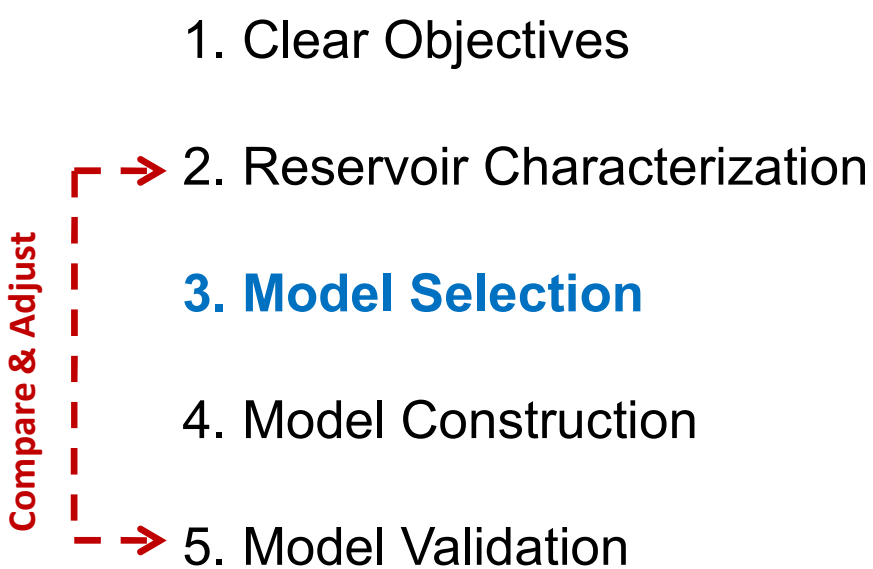
The petrophysical model defines where the volumes of oil, water and gas are located in the reservoir, as well as how fluids behave in the presence of the rock.

To define the petrophysical model of the reservoir, you must determine:

- Rock Wettability
- Capillary Pressure
- Relative Permeability
- Residual Oil Saturation
- Fluid Contacts



Key Steps in a Simulation Study



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