

Lecture Presentation

Advanced Multi-Well Formation Evaluation

Reservoir Production Mechanisms

Carlos Torres-Verdín, Ph.D.
Professor

Department of Petroleum and Geosystems Engineering
The University of Texas at Austin

1

What are the key factors governing the production performance of hydrocarbon reservoirs?

Key Factors:

1. Drive Mechanism
2. Porosity and Spatial Distribution
3. Permeability and Spatial Distribution
4. Hydrocarbon Saturation and Spatial Distribution
5. Volume, Hydraulic Connectivity, and Pressure Compartmentalization
6. Net-to-Gross
7. Areal Extent
8. Fluid and Rock-Fluid Properties

2

Fluid and Rock-Fluid Properties

Key Properties:

- 1. Interconnected Porosity**
- 2. Irreducible Water Saturation**
- 3. Capillary-Bound Water**
- 4. Absolute Permeability**
- 5. Permeability Anisotropy**
- 6. Capillary Pressure**
- 7. Relative Permeability**
- 8. Wettability**
- 9. Pressure-Volume-Temperature (PVT) Fluid Properties**
- 10. Wettability Alterations**

3

Factors Controlling the Production Behavior of a Hydrocarbon Reservoir

- 1. Geological model**
- 2. Petrophysical properties**
- 3. Spatial distributions of petrophysical properties**
- 4. Rock-fluid properties**
- 5. Mobility of fluids**
- 6. Pore-pressure support mechanism**
- 7. PVT properties of fluids**
- 8. Presence of localized pressure compartments**
- 9. Hydraulic communication of flow units**

4

Drive Mechanisms of Reservoirs

- 1. Pressure Depletion Drive**
- 2. Gas Drive**
- 3. Gas Expansion Drive**
- 4. Water Drive**
- 5. Gravity Drainage**
- 6. Combination Drive**

5

Primary Mechanisms

Oil Reservoirs

- 1. Pressure Depletion**
- 2. Water Drive**
- 3. Gas Cap Expansion**
- 4. Gravity Drainage**
- 5. Combination Drive**

Gas Reservoirs

- 1. Pressure Depletion**
- 2. Water Drive**
- 3. Combination Drive**

6

Secondary and Tertiary Mechanisms

Secondary

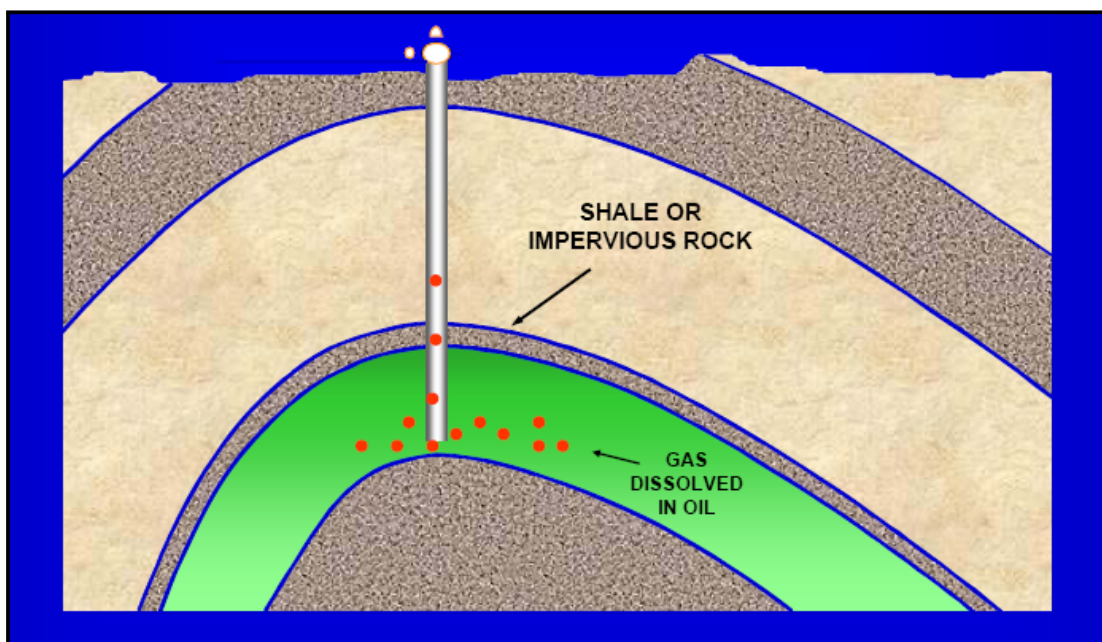
1. Water
2. Gas
3. Miscible
4. Steam Injection
5. Combination Drive

Tertiary

1. CO₂
2. Surfactant
3. Polymer Injection

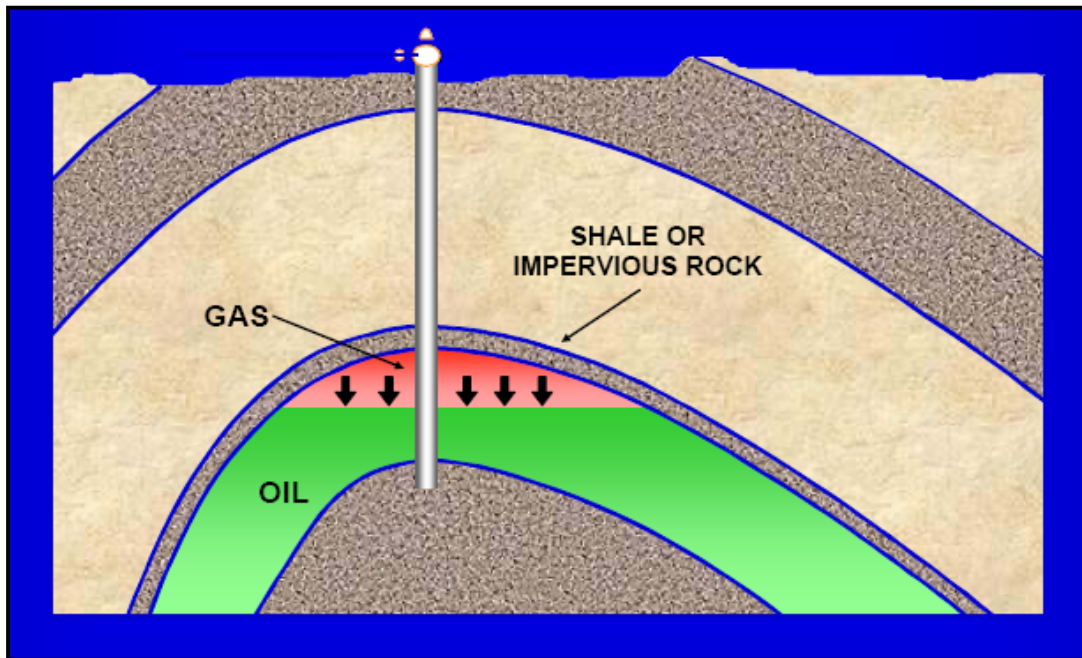
7

Pressure Depletion Gas Drive



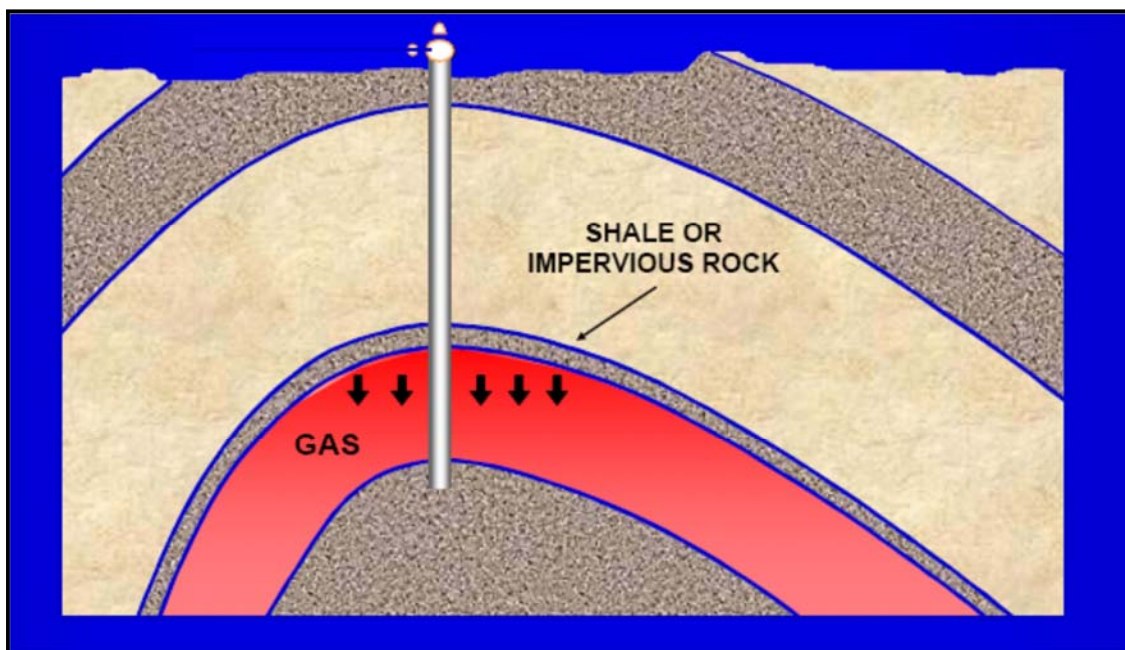
8

Gas Drive Oil Reservoir



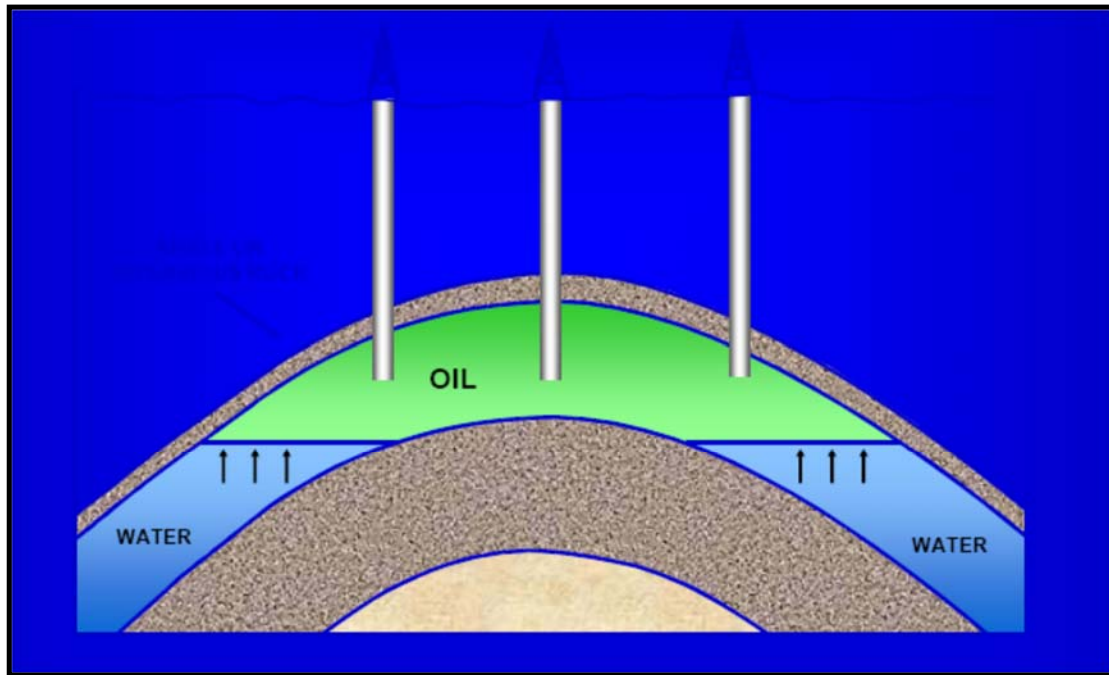
9

Gas-Cap Expansion Drive Reservoir



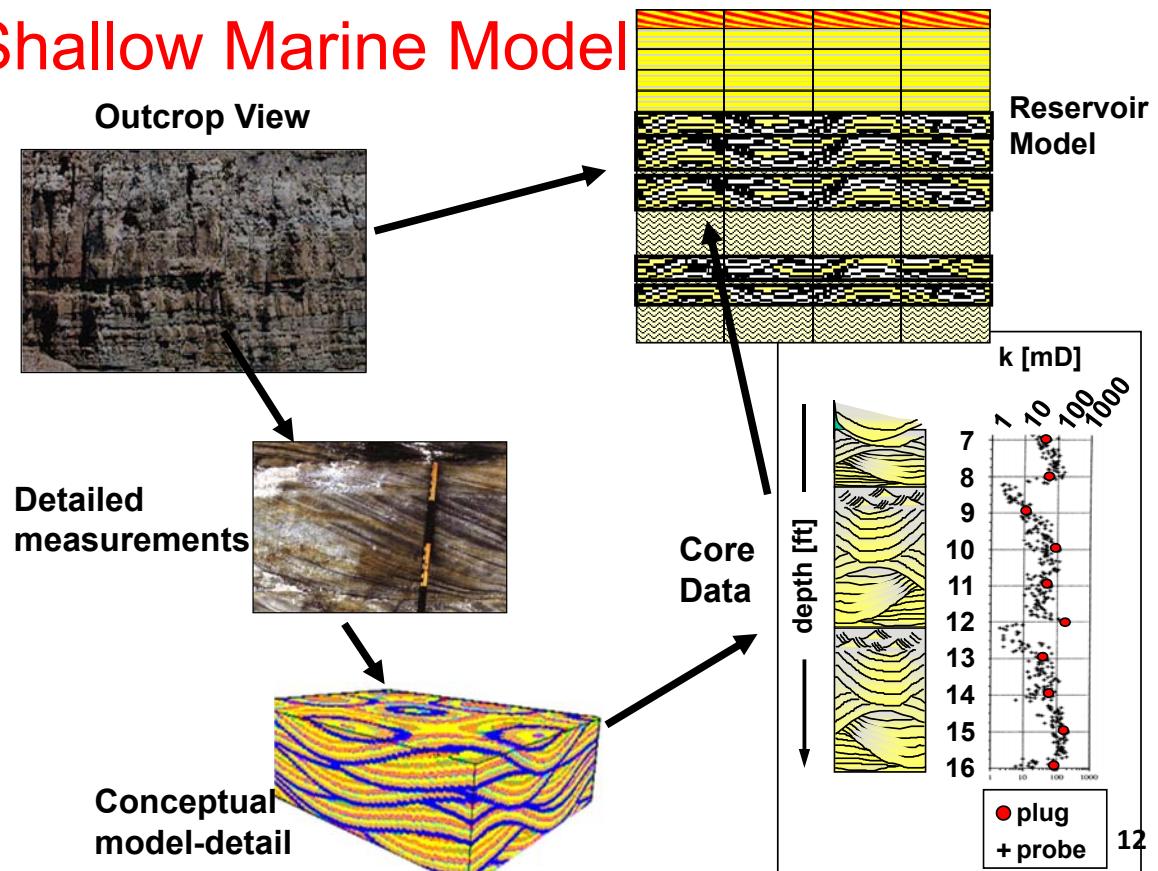
10

Water Drive Reservoir



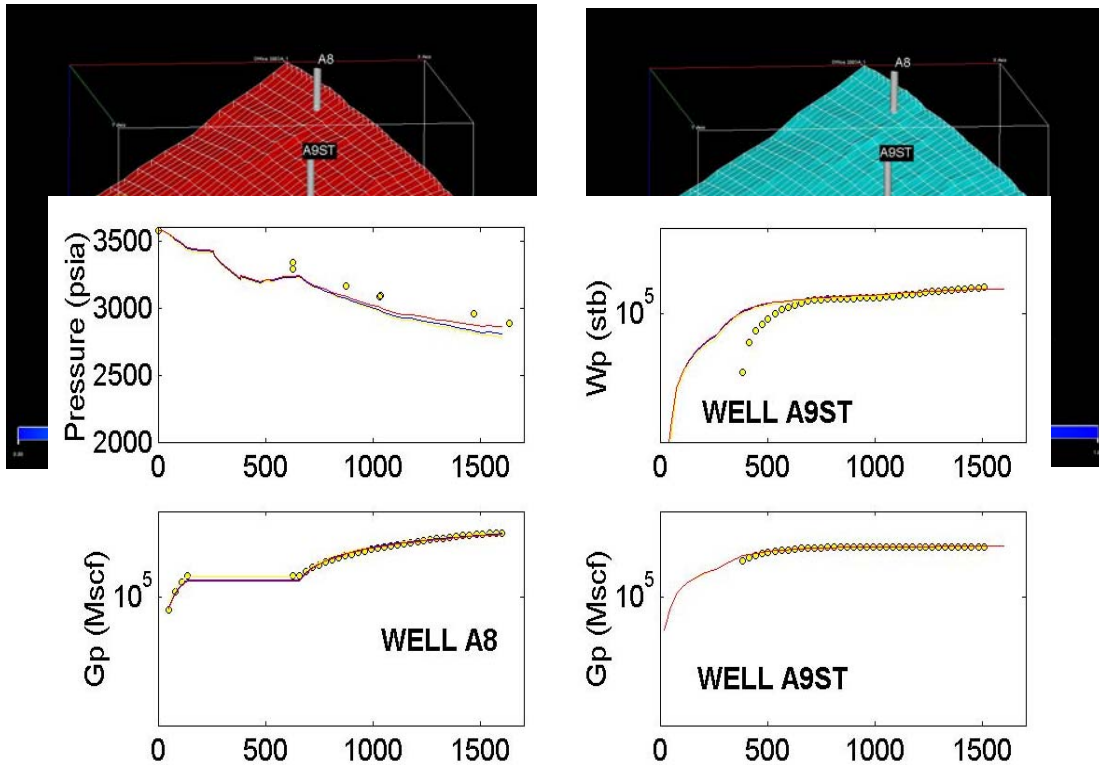
11

Shallow Marine Model



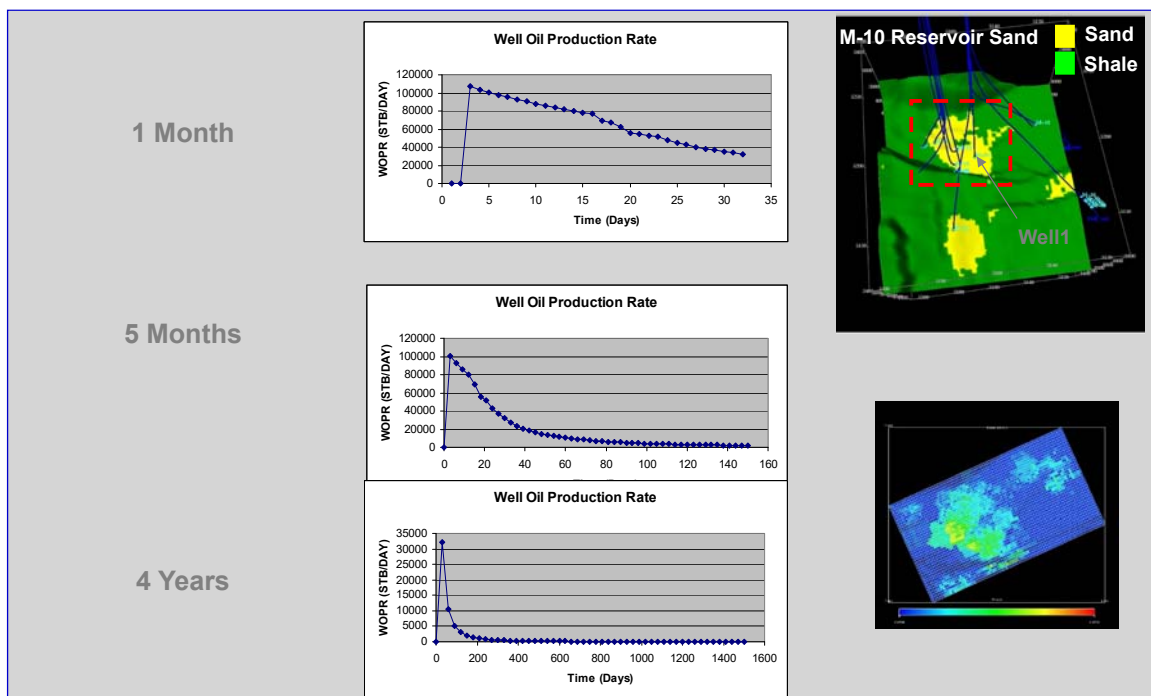
12

Reservoir Simulation



13

Fluid-Flow Simulation (Well Oil Production Rate)



14