

Upstream Uncertainty and Gas Field Development

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Gas Field Development - ATW

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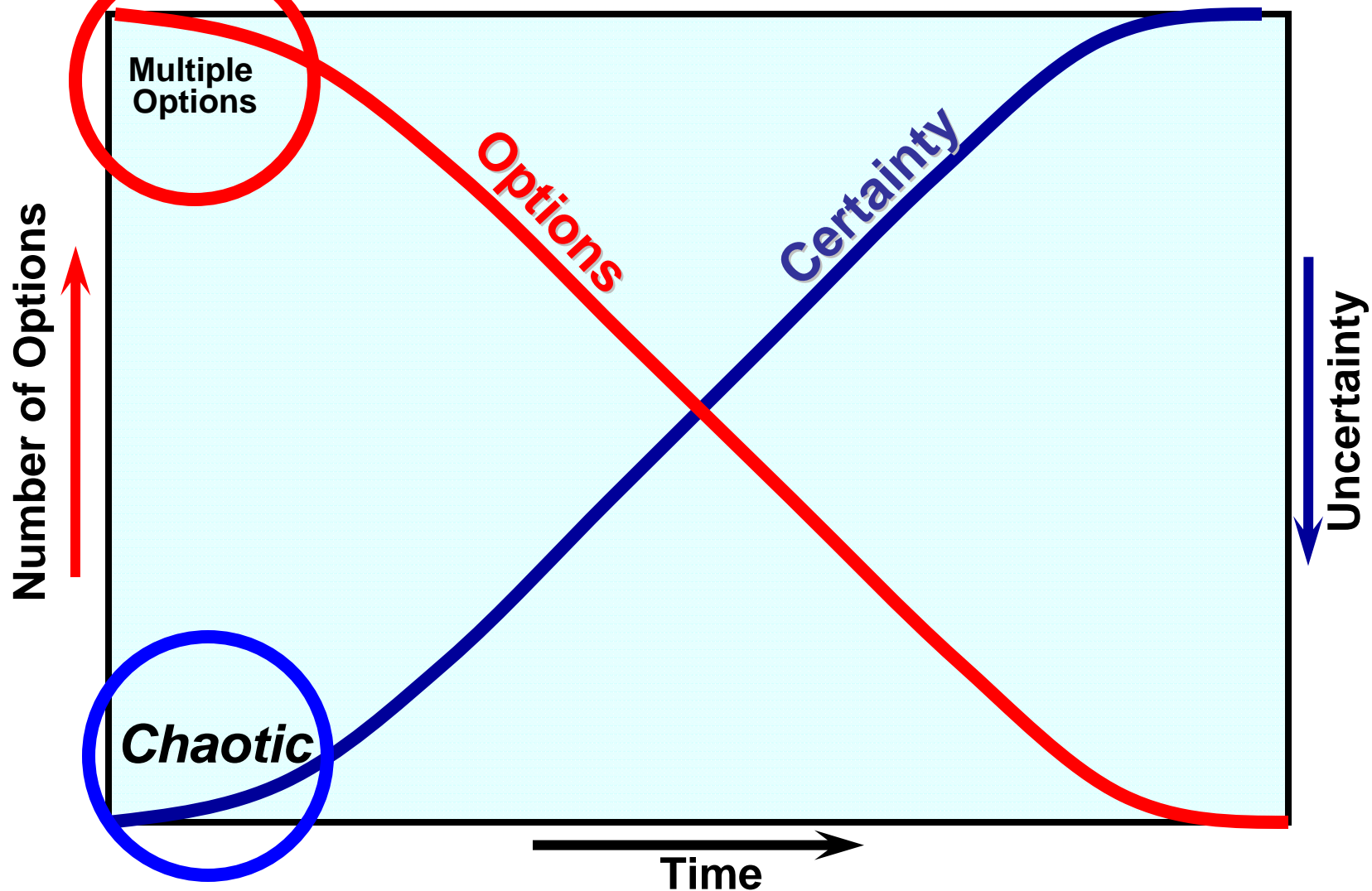
Risk & Uncertainty

- **WHEN: *Projects characterized by financial risk and uncertainty***

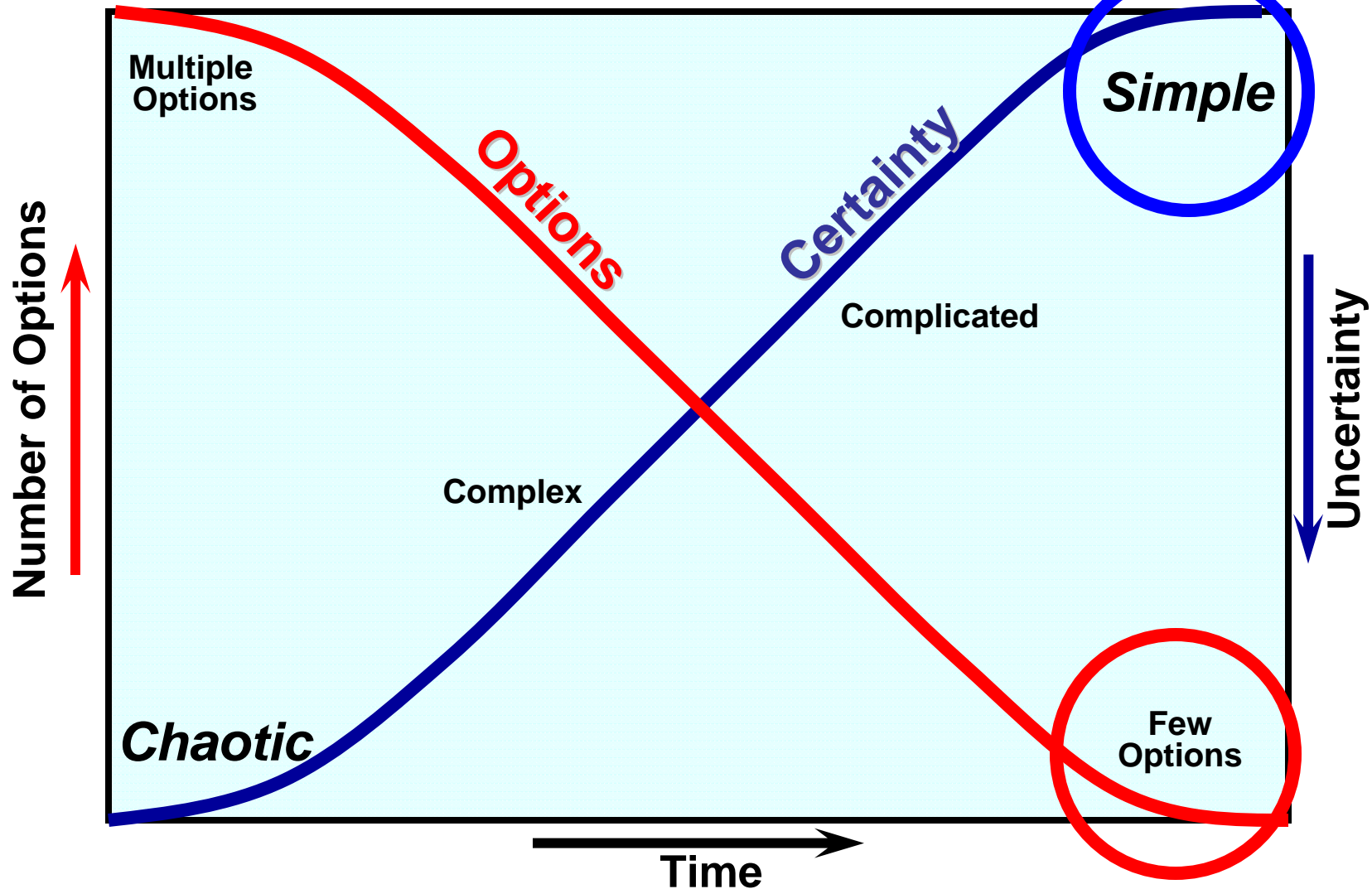
- **WHAT: *Basis for Decision Making***
 - ✓ Risk – Confidence that something is happening
 - ✓ Uncertainty – What is going to happen and how often?

- **WHY: *Direct resources to maximize value***
 - ✓ To approximate certainty in an uncertain world
 - ✓ Improve quality of decisions

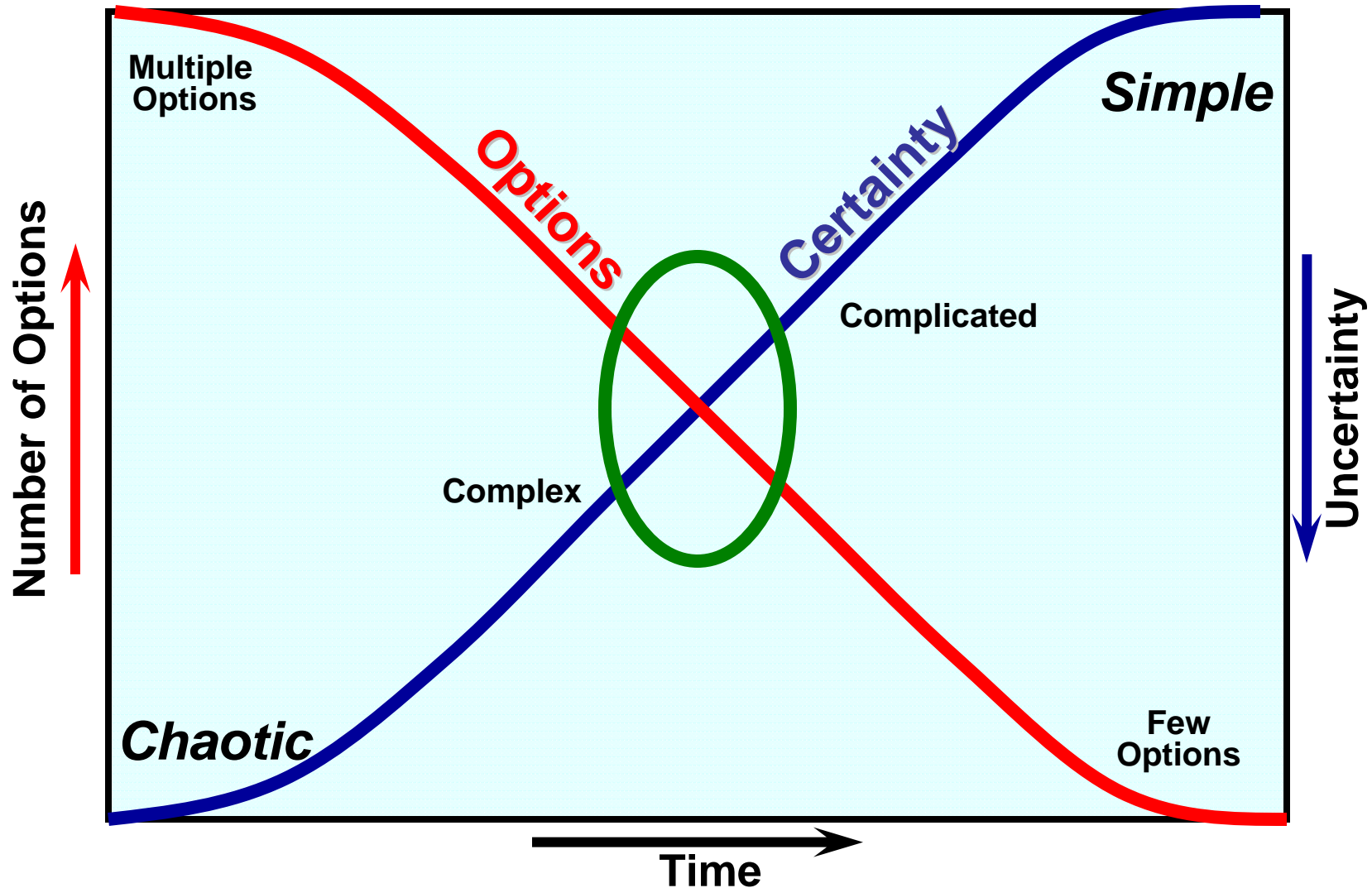
Options & Uncertainty Change with Time



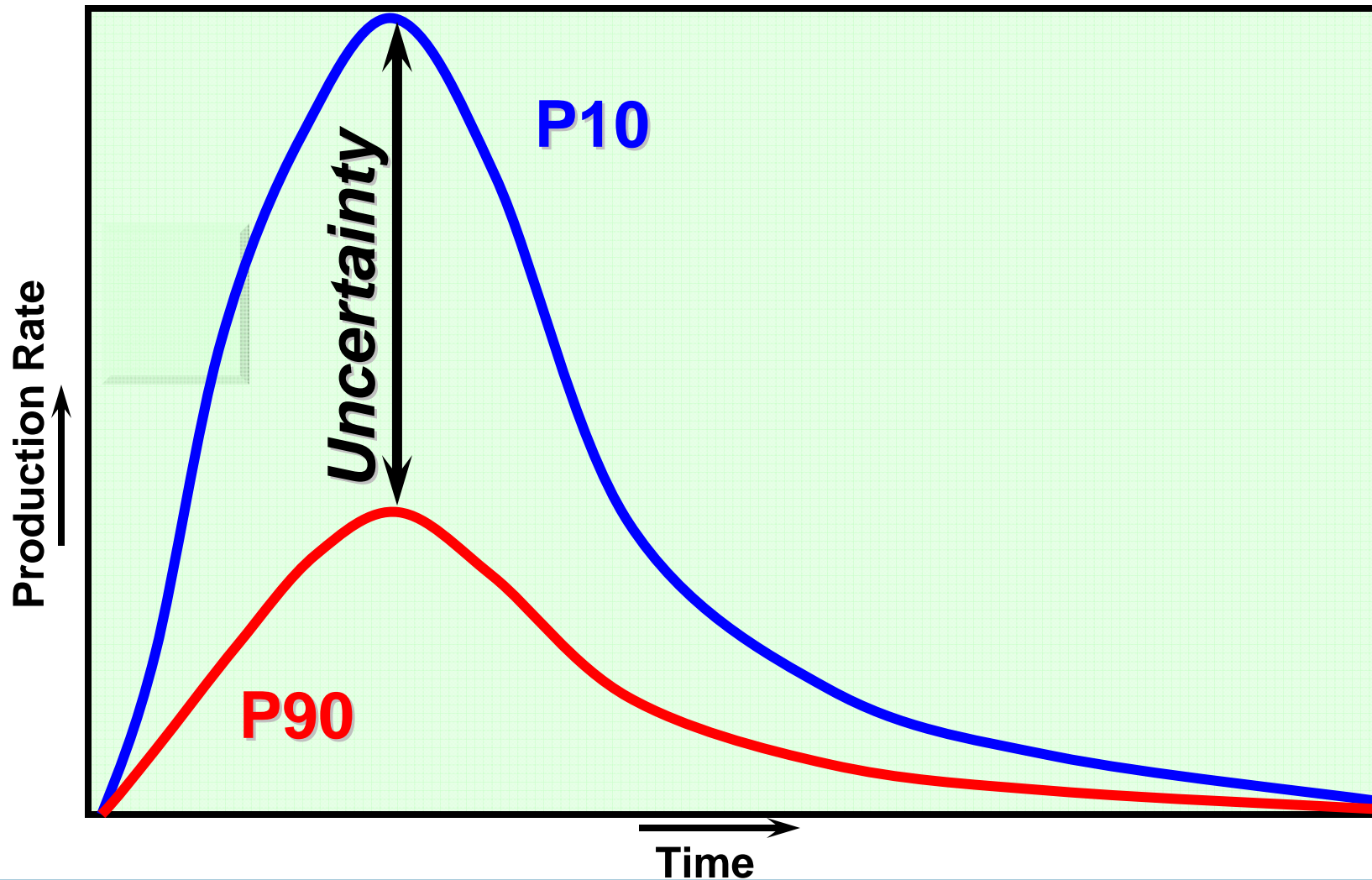
Options & Uncertainty Change with Time



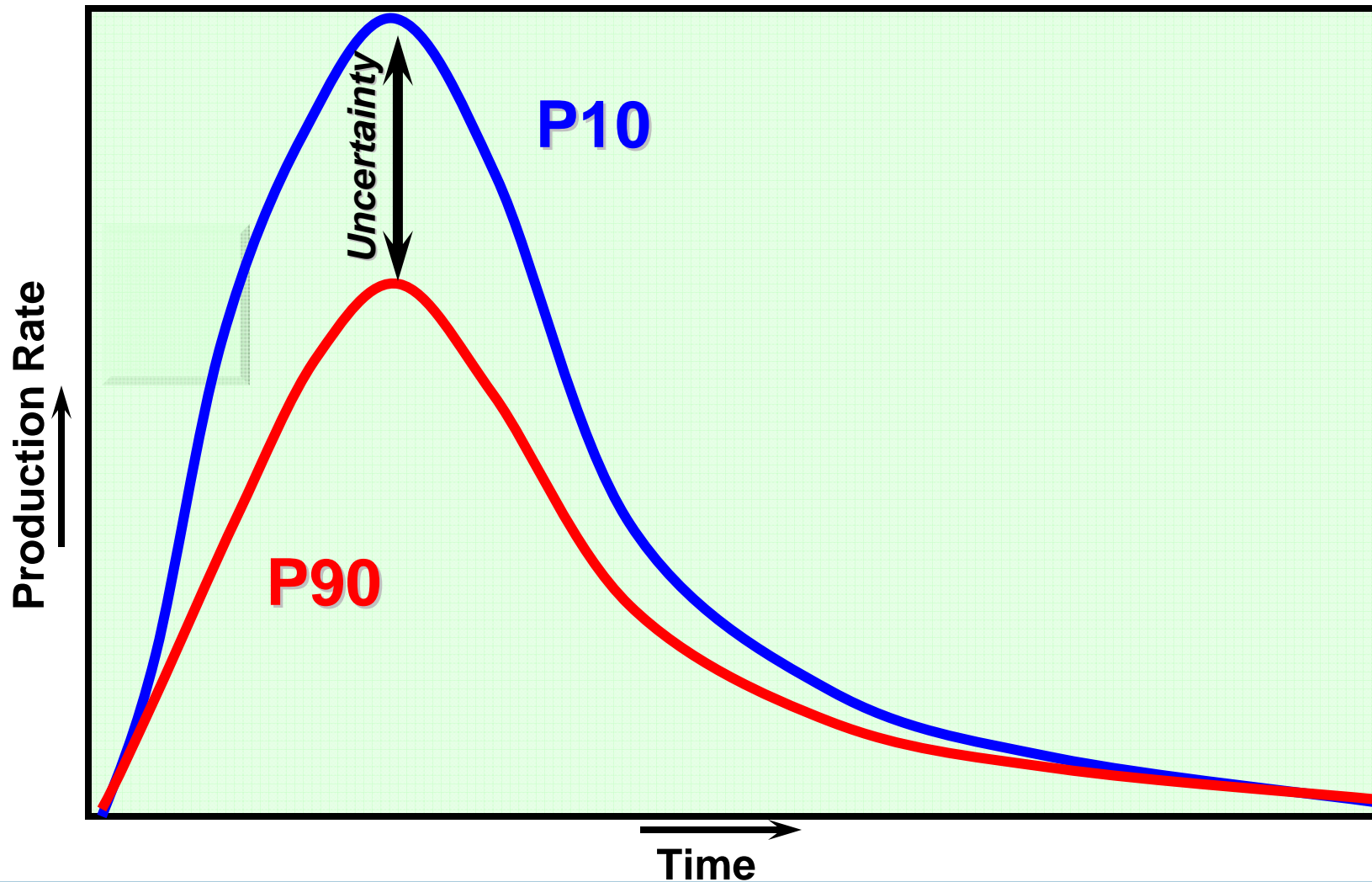
Options & Uncertainty Change with Time



Production Rate

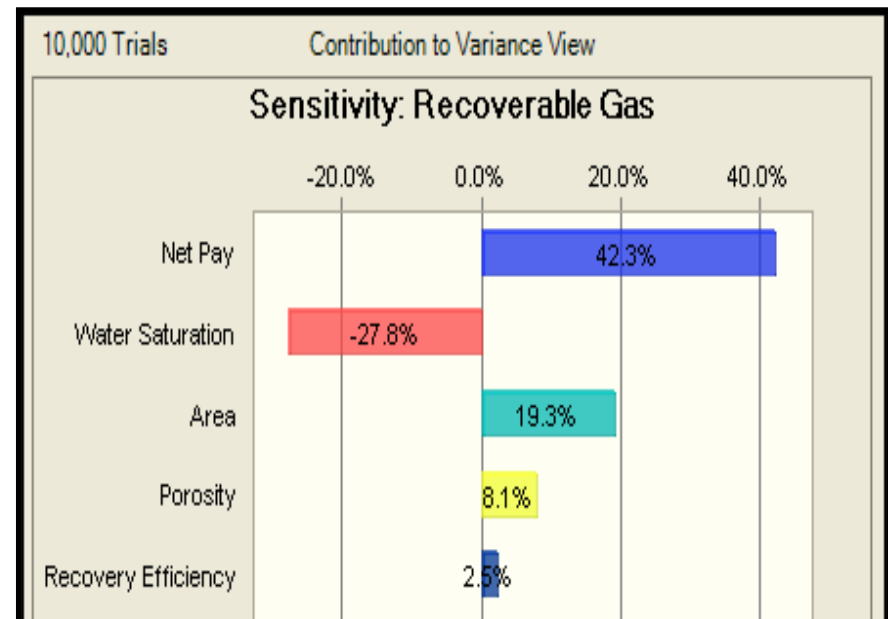


Production Rate

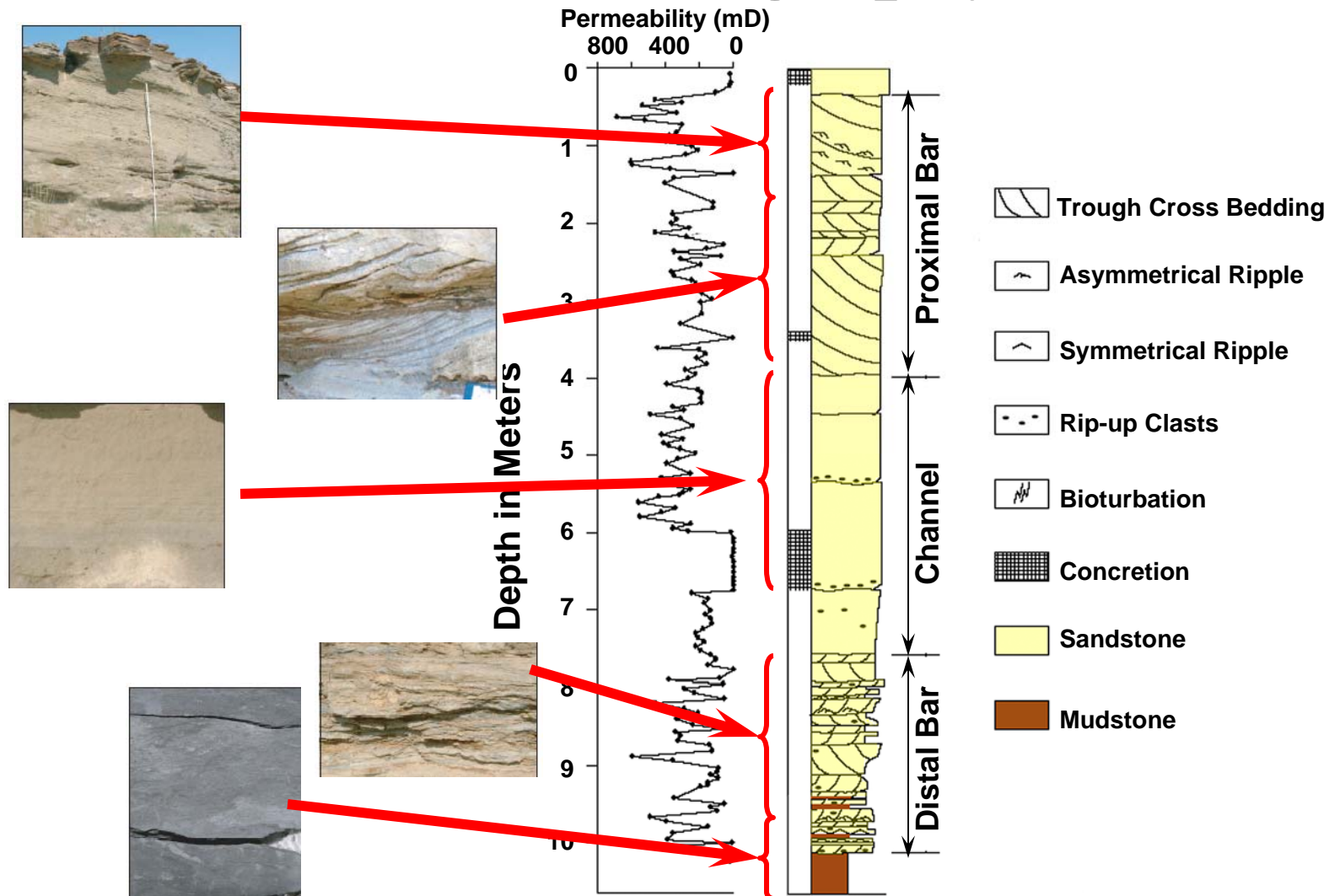


Fundamentals of Risk Analysis

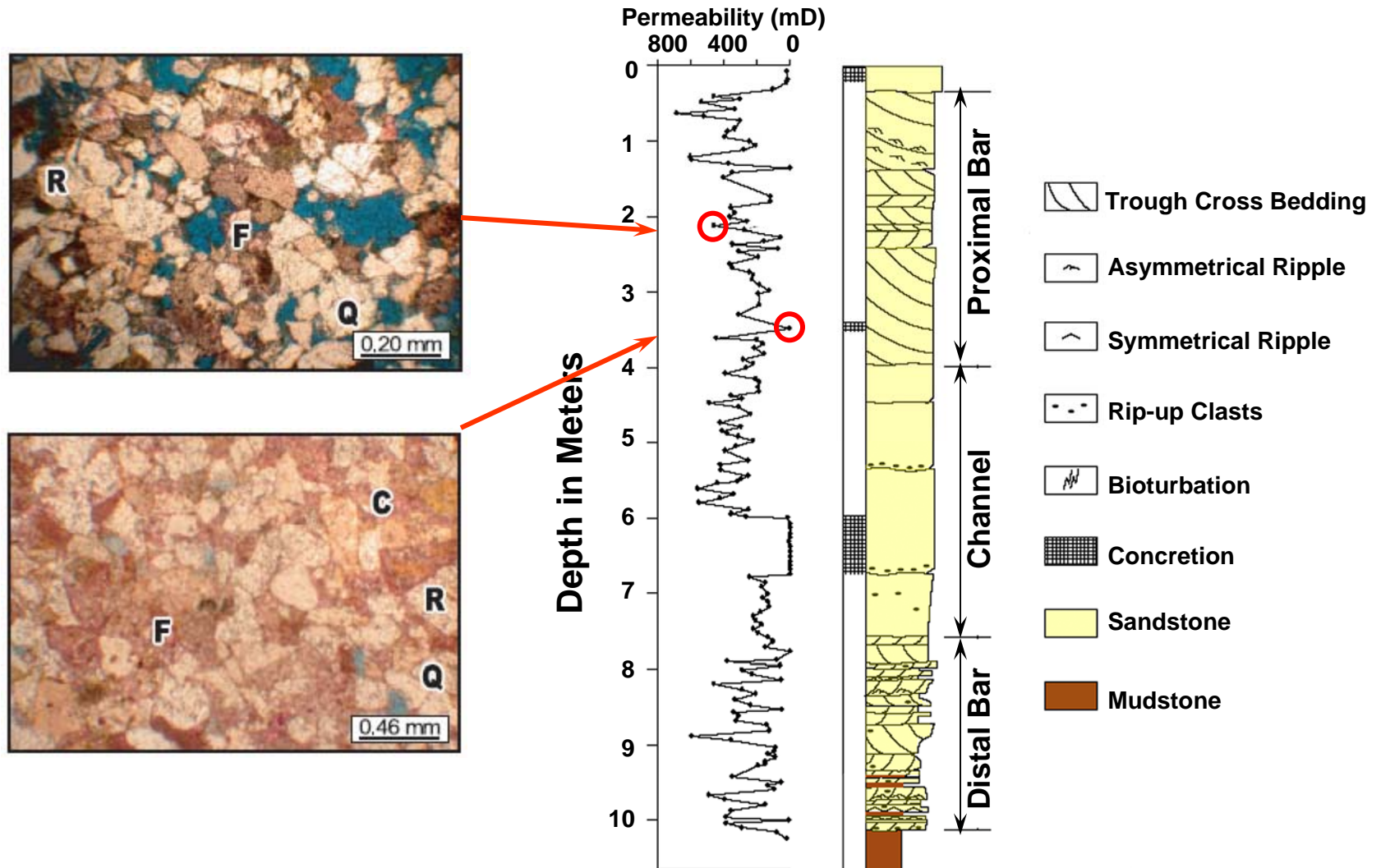
- Isolate key variables
- Quantify the variables
- Understand the uncertainty for each variable
- Understand the model
- Search for reality checks
 - ✓ Analogies
 - ✓ Correlation



Functional Stratigraphy



Functional Stratigraphy



Petrophysical Heterogeneity



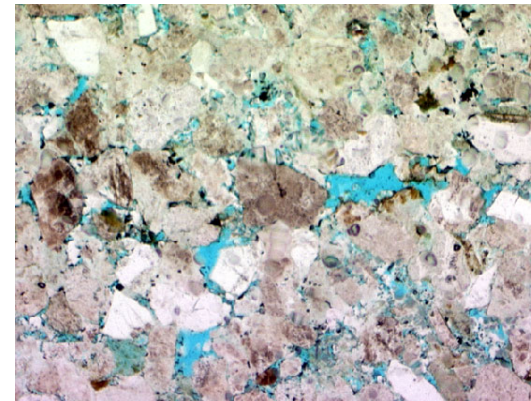
Intergranular / Intercrystalline



Intercrystalline & Moldic



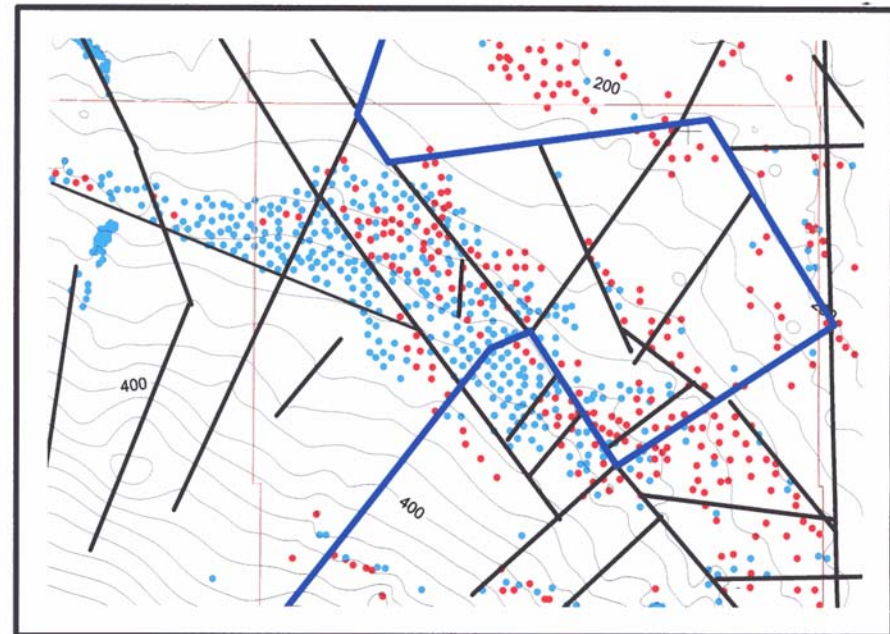
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Micro-fractures

Faults & Fractures

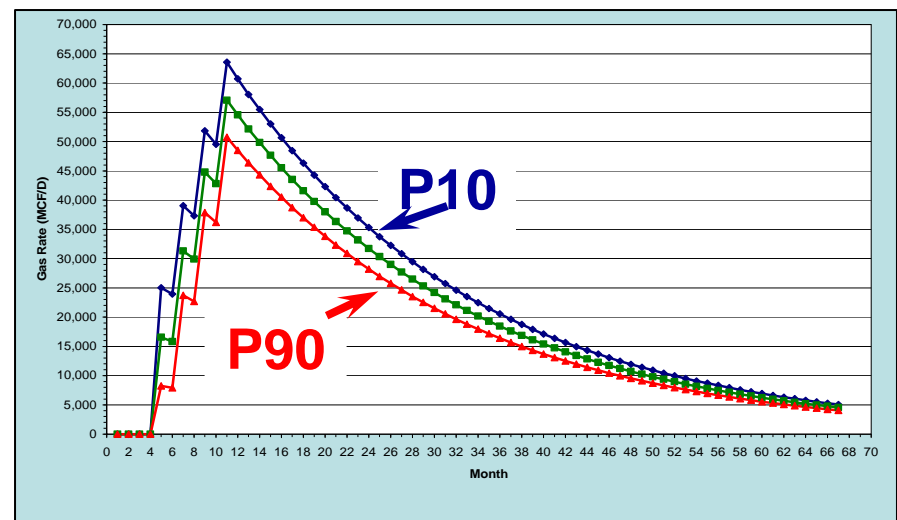
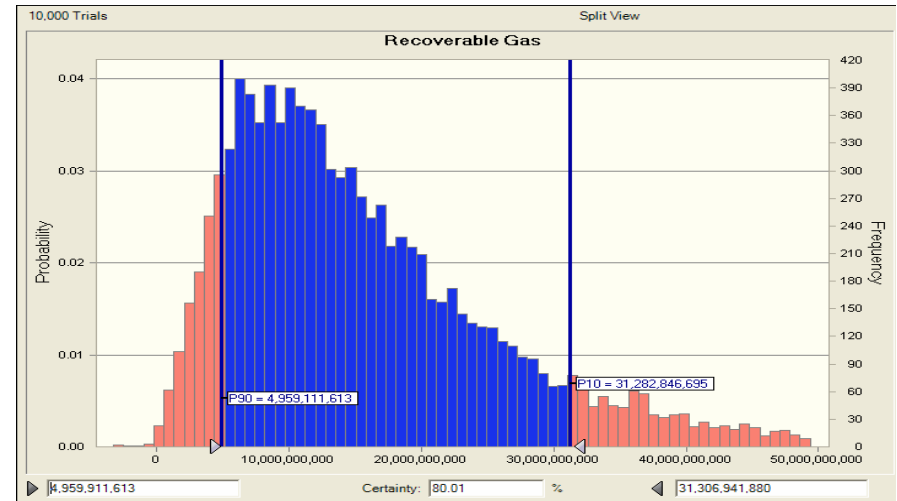
- **Fractures & faults compartmentalize most fields**
- **Sealing vertical faults create the “mystical” permeability barriers encountered in field development**
- **Vertical faults often localize micro-fractures that enhance production in close proximity**
- **Reactivated vertical faults act as migration pathways for hydrocarbons throughout the stratigraphic column**



Blue: Lowest 75% Cum Gas Production
Red: Highest 25% of Gas Production

Facilities Planning Process

- **P10 / P50 / P90 Forecasts**
 - ✓ Reserve Estimates
 - ✓ Base Production Forecasts
- **Future Projects (New Drills, Sidetracks, Workovers)**
 - ✓ P10/P50/P90 Reserves
 - ✓ P10/P50/P90 Initial Rates
 - ✓ P10/P50/P90 Production Start Month
- **Additional Information**
 - ✓ Facility Capacity
 - ✓ Downtime (Historical Unscheduled, Planned, Storm)



Understand Upstream Uncertainty

- **Quantify the variables**
 - ✓ **Understand the “ROCK”**
 - Lithologic description of cuttings and cores
 - Core analysis
 - ✓ **Outcrop and Field analogs**
 - ✓ **Geophysical imaging**
 - Seismic
 - Potential fields
- **Iterative interaction between geologists and engineers**
- **Apply uncertainty to the variables**
 - ✓ **Base production forecasts**
 - ✓ **Future projects**