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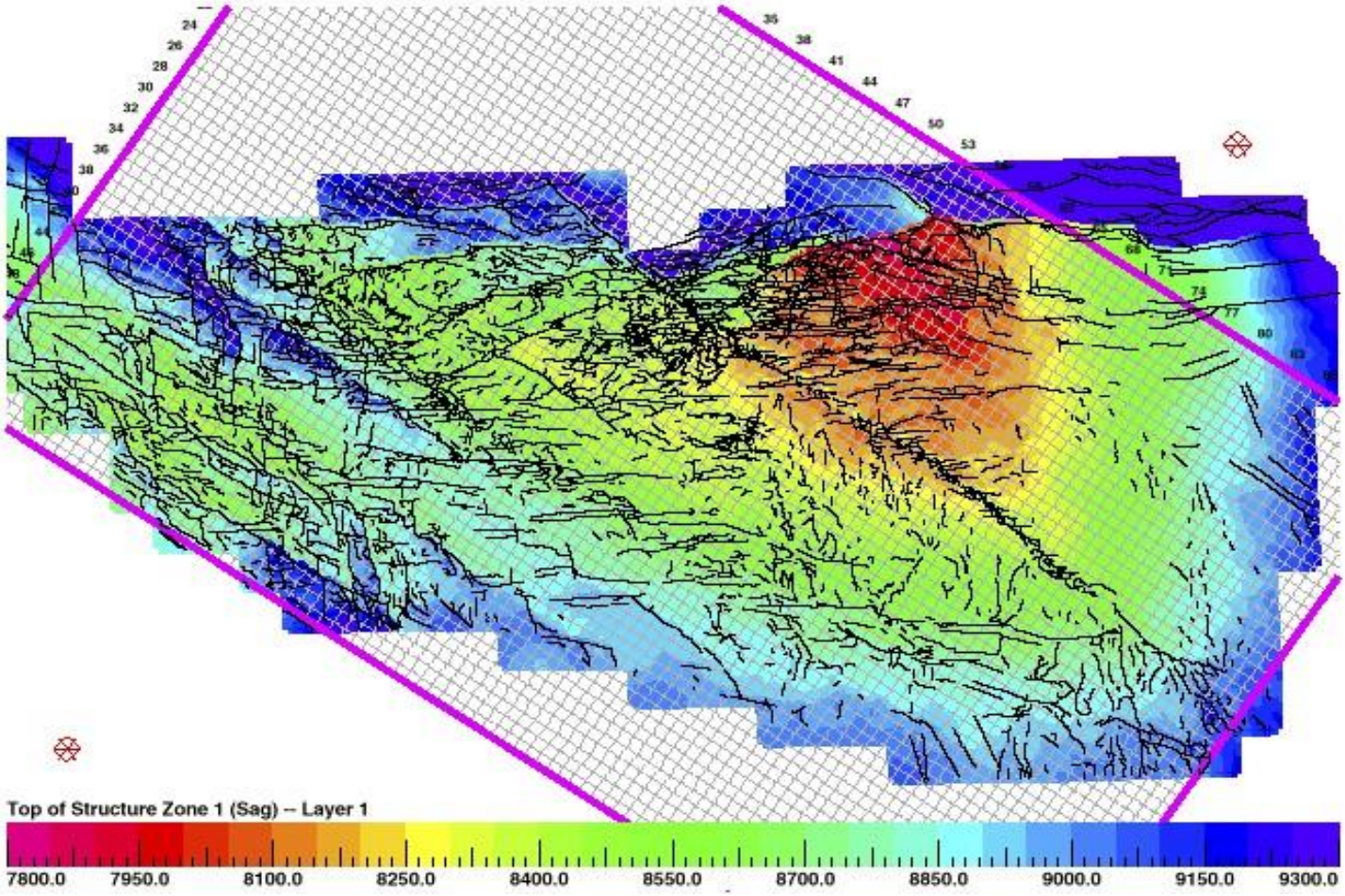
Advanced Reservoir Management Solutions

Reservoir Simulation & Forecasting Course Outline



Prepared by
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Agenda

Day 1

Chapter 1 - Overview

Class Objectives

- Introduce and teach recommended workflow
- Make maximum use of all available data
- Develop core skills in QC of simulation input/output
- Learn elements of sensitivity and uncertainty analysis
- Be able to make better forecasts and quantify the confidence interval
- Learn how characterization data is used and incorporated into reservoir simulator

Understand uses and misuses of simulation studies

Chapter 2a - Structure and Stratigraphy

- Structural Framework
  - Faults (complexity vs. flow model grid constraints)
    - Sealing and conductive
    - Reverse and intersecting (e.g., flower structures)
  - Reservoir Tops - Surfaces/Horizons
- Stratigraphy
  - Layering and hydraulic flow units
  - Lithology vs. sequence (time) based stratigraphy
  - Lateral and vertical connectivity
- Fluid Contacts
  - Free Water Level (FWL):
  - Water Oil Contact (WOC):

Chapter 2b - Rock Properties

- Facies
  - Types - lithological, depositional, etc.
  - Rock Quality Index (RQI)
  - Pore throat geometry (Capillary Pressure)/J-function banding
- Porosity
  - Core and Log based
  - Conventional core experiments
  - Effective porosity
  - Corrections to reservoir conditions
- Pore volume compressibility
- Permeability Core based
  - Transforms with porosity and facies
  - Corrections to reservoir conditions

Property Distribution

- Deterministic
- Geostatistical
- Seismic attribute aided

- Water Saturation (Sw)
  - Sw - Drainage Capillary Pressure (Pc) vs. Sw
  - J-Function OOIP
    - Irreducible Saturation
    - Transition zone
- Relative permeability
  - End Point Scaling
  - Wettability

Day 2

Chapter 2c - Upscaling and Geologic Uncertainty

- Upscaling to the Flow Model
  - Cut-off Determination in the Geo-cellular model
  - Property averaging (e.g., porosity, dominant facies)
  - Flow-based up-scaling (e.g., permeability)
- Geologic Uncertainty
  - Sources of uncertainty
  - Property uncertainty

Chapter 3 - Fluid Properties

- Fundamentals
  - Why is PVT important to model?
  - What PVT data is used in a model?
  - How does PVT data vary by reservoir type?
- Where does PVT data come from?
- Errors in estimating PVT data
- Laboratory procedures to obtain PVT data
- Estimation of PVT data from correlations and EOS software

Chapter 4 - Dynamic Data

- Pressure transient analysis
  RFT, MDT
- Static and flowing bottom hole pressure histories
  Production and injection histories
- Tracers
  - Well to well
  - Single well chemical tracer tests
- Open & cased hole logs
- Injection & production logs
- Step-rate tests
- Production allocation
- Wellhead temperature vs. rate
  QC of Dynamic Data

Day 3

Chapter 5 - Drive Mechanisms and Material Balance

- Why do a material balance analysis? How do we do it?
- What data do we need & how do we QC the data?
- How is material balance analysis used to help build the reservoir simulation model?

Chapter 6 - Numerical Model Construction

- The flow equations being solved by the simulator --in enough detail to understand the complications that can occur in a simulation run.
- The basis for selecting a solution algorithm to be used in the simulator.
  Practical aspects of "gridding" a reservoir for simulation
- How the data we have talked about in the class gets into the simulator.
  Trouble-shooting instabilities in simulation runs.

Day 4

Chapter 7 - History Matching

- Learn what is meant by "history match" & what is objective of the history match
- The process - why do we do it this way?
  - Recommended approach
  - What performance parameters do we match?
  - What are the "big knobs" to achieving a history match?
  - How do we find the big knobs?
  - Sensitivity of results to input variables
- The feedback loop with the geo-model
  - Why do we need to have a feedback loop with the geo-model?
  - How do we complete the loop?
- When are we done?
  - How good of a match is needed?
  - Make sure the match objectives are Fit For Purpose
  - How do we speed up the process?
  - How can match more effectively and quickly?
  - How long will it take to get a match?
- Assessing quality of history match

Day 5

Chapter 8 - Predictions

- Elements of Making a Prediction
  - Objectives of predictions
    - Scenario development
  - Transition from history to predictions
    - Well Model
    - Well Model Calibration
    - Simulation Well Tuning
  - Mechanics of predictions
    - Well controls and constraints
    - Facility controls and constraints
    - Actions resulting from limits
    - "How to" build different types of prediction scenarios
    - Opportunity modeling (infill drilling, injector placement, etc)
- Analysis of Simulation Results
  - Use of analytical methods to QC simulation output
    - Decline curves
    - Recovery factor comparison
    - Analogies

Chapter 9 - Uncertainty Analysis

- Uncertainty Analysis
  - Framing the Problem
  - Methods of analysis
    - Decision Trees
    - Monte Carlo Analysis
    - Experimental Design - Proxy Models
  - P10, P50, P90 Forecasting
  - Impact of key variables on predictions

Chapter 10—Quality Control, Review

- Have we identified opportunities during data analysis?

Geology Review of key elements in static model

- Rock property review
- Upscaling issues from static model to simulation model

PVT questions to be answered before study

- Construction of the simulation model
- History match review
- Keys to good Predictions
- Handling Uncertainty