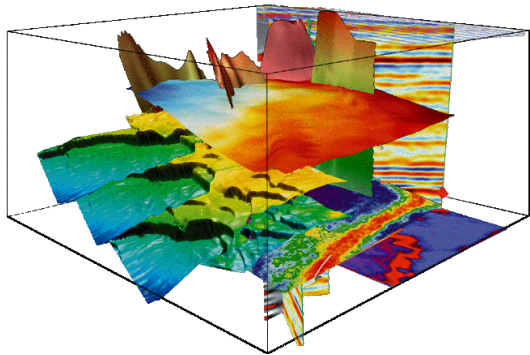


3D RESERVOIR MODELING PROJECTS



Accurate and complete evaluation of oil and gas reservoirs can only be achieved by application of state-of-the-art reservoir characterization/modeling. Software development over the past several years has evolved to the point where a leader in oil and gas modeling software has emerged. Schlumberger, a long time leader in oil and gas services and geologic and geophysical applications, has developed a suite of oil and gas application programs which provide “seismic to simulation” reservoir solutions. Multi-national “Super-Majors” have embraced Schlumberger’s Petrel software for distribution and use company-wide.

Petrel software encompasses a series of modules which all attain their inherent power to accurately describe the reservoir by dividing it into discrete manageable three dimensional chunks, or “cells” of rock. Each cell is then assigned numerous properties such as porosity, permeability, saturation, anisotropy, etc. Together with each cell’s myriad properties, the macro-assemblage of all of the cells and their geometrical inter-relationship is captured within the structural and stratigraphic model. Once complete, the static model of the aggregate of millions of three dimensional grid-cells, each with its own reservoir

properties, can be set in motion to simulate petroleum production in the oil-field.

One of the main advantages of the Petrel software suite is the connectivity of the various modules which extract as much data from as many sources as possible, such as subsurface data, seismic structural and velocity data, petrophysical and seismic derived rock and fluid properties, and geostatistical information. All of these sources of important reservoir properties are then propagated throughout the extent of the reservoir, in preparation for field performance simulation. No other methodology can bring to bear as much pertinent scientific and engineering data to predict reservoir performance. That performance can then be calibrated with production data in other Petrel associated modules.

Those Operators without an independent geocellular derived reservoir simulation cannot optimally develop their assets. Likewise, Stakeholders, NOCs and other non-operators cannot test or challenge the value of their asset in the face of a “high-tech” geocellular reservoir model.

PROJECT OBJECTIVES AND SCOPE

The purpose of oil and gas reservoir modeling is to facilitate evaluation of the field. Conversely, a field evaluation is of optimum use only where it provides the most accurate model of the reservoir reasonably obtainable. Anything less will not be an adequate information platform from which to develop and operate the field, and will not stand up to a properly derived geocellular reservoir model.

The Scope of the modeling project depends on the state of the input data, the quality of the geologic, geophysical and petrophysical interpretations in the field to date, and the business purpose for evaluation of the field. For instance, if there exists

a reliable 3D seismic interpretation, then it can be directly input into the Petrel 3D grid model, along with any salient seismic attributes. Generally, Interactive Petrophysical modeling will be required to optimize rock and fluid property calibrations and valuable regression analyses. Other elements of the modeling process such as facies distribution and geostatistical analysis will similarly depend on the quality of the data and interpretations available.

ERCO' management and staff are experts in determining the sufficiency of the interpretive database, as well as augmenting required geologic, geophysical and petrophysical interpretations in both 2D and 3D for model input and calibration. If necessary a complete structural/stratigraphic framework is constructed by interpretation of the seismic database, with integrated subsurface control and depth conversion. The well control also forms the petrophysical database for seismic calibration and porosity, permeability, and hydrocarbon saturation propagation field-wide.

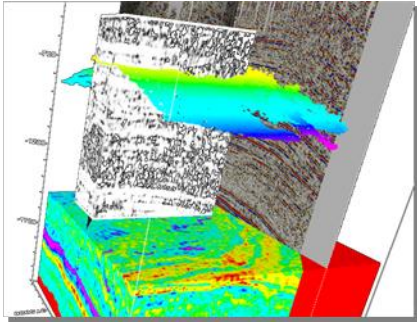
Advanced Technologies utilizes various state-of-the-art software modules to construct a robust 3D geocellular model, and to perform reservoir simulation and economic evaluation of the field or block. ERCO' staff recently were employed by Schlumberger in both the development and application of the most recent releases of the 3D modeling and simulation software. ERCO holds licenses with Schlumberger for use of the following oil and gas software:

- Petrel
- GeoFrame
- Interactive Petrophysics
- Eclipse
- FrontSim
- Avocet
- Merak

ERCO also has expertise in other Geological and Geophysical (seismic) workstation software, which facilitates integration of outside 2D and 3D seismic grids into the Petrel/Eclipse model.

ERCO's Geological, Geophysical and Engineering work-flows are designed to produce the most accurate 3D reservoir model and performance projection obtainable. This optimized work-flow is outlined below.

G&G Seismic to Simulation Workflows in Petrel



By G&G Manager: Cesar Abeigne, PhD

I - Geology:

A - Mapping and Geological Workflows

Start with 1 horizon + “dirty” fault sticks

Clean to get max dip sticks

Clip and remove empty faults

Auto create fault model and auto connect

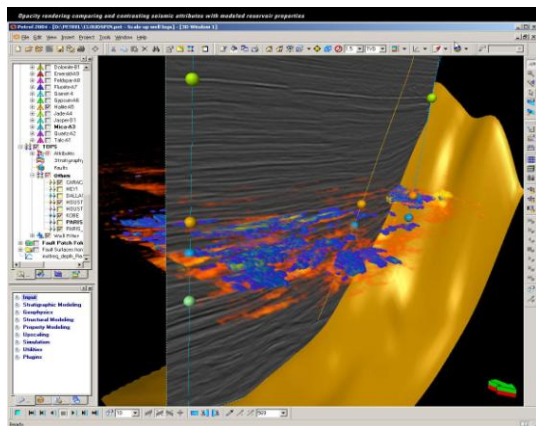
Run horizon modelling with default settings

Extract Fault Polygons from model

Grid interpretation to fault polygons

Multipoint Geostatistics

B - Structural Modeling:



Define new model

Create faults using selected faults sticks

Edit key pillars

Connect faults

Create faults from all fault sticks

Automatic generation of faults

Auto connection of faults

Fault Polygons

Fault QC & Edit

Create fault polygons

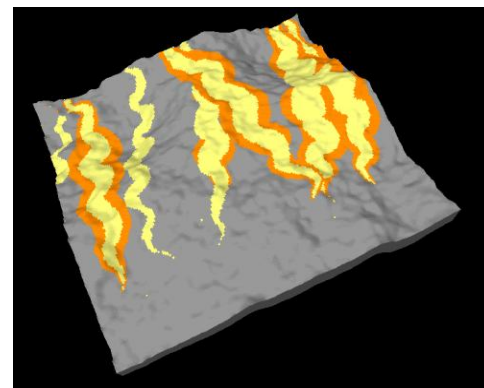
Check results

Create a structural map

Check the model 3D

Follow the workflow with depth conversion & model building

C - Facies Modeling



Deterministic

interactive drawing of facies

seismic volume extraction indicator kriging

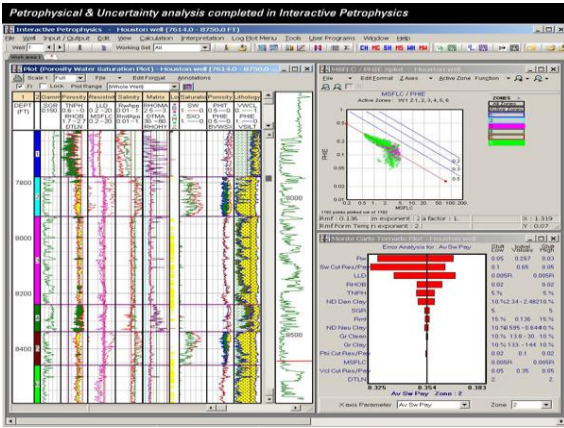
Stochastic

Pixel based (Indicator Simulation (blurred facies, sequential Indicator Simulation or facies transition))

Object based (Facies with defined shapes, Object, Fluvial, Adaptive channels)

Users defined GSLIB algorithm

D - Petrophysical Modeling



Deterministic

Interpolation with smooth effect, kriging, moving average

Stochastic

regeneration local variation (SGS)

Regional local variation

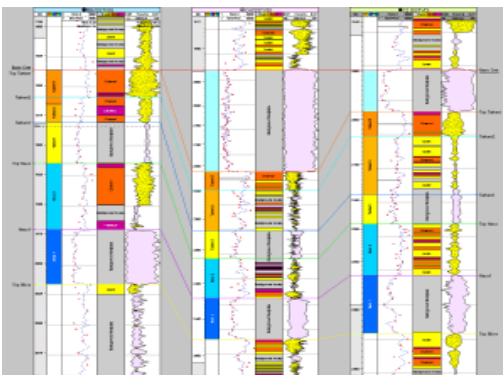
Data analysis

Porosity modeling

Permeability modeling

Modeling based on seismic attributes

E - Well Correlation



Well Section

Well Templates

Ghost curves

Well tops

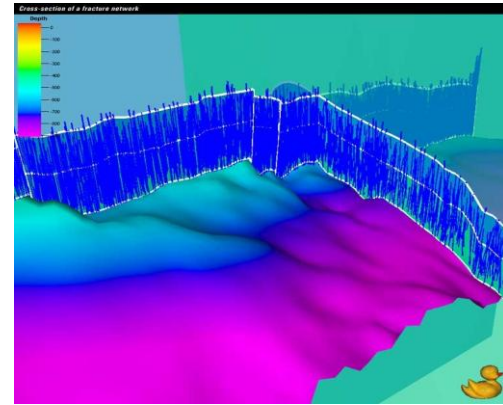
Displaying surfaces, horizons and contacts

Log calculators

Well section fence

Creating a discrete log

F - Fracture Modeling



Data conditioning

Import, display and QC data

Build geological model

Create Discrete Fracture Network (Rho, K, Sigma)

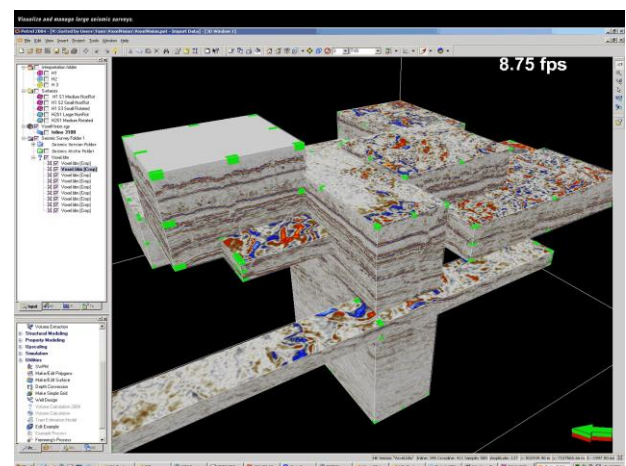
DFN properties estimation

DFN upscaling in 3D grid

Simulate, validate and Iterate

II - Geophysics:

A - Seismic Visualization and Interpretation:



Performance & Scalability

Autotracking

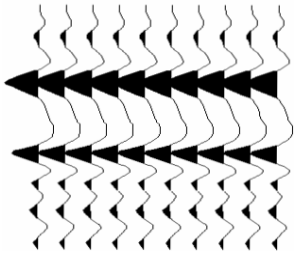
3D Paintbrush auto-tracker

Fault interpretation

Automated fault polygon generation

Seismic attributes

B - Synthetics:



Check Shot Calibration & Drift Curve Editing

Deterministic Wavelet Extraction

Wavelet builder and viewer

Interactive Stretch Squeeze

C - Velocity Modeling and Depth Conversion:

Stacking Velocities

Dix Conversion

Create Interval velocity surfaces

Check data consistency

Build Velocity Model

Generate Velocity Seismic

Depth converting objects

D - Inversion:

Well Calibration QC (Multi-well for training & validation)

Well Log data QC and pre-processing

Generate the Acoustic Impedance cube

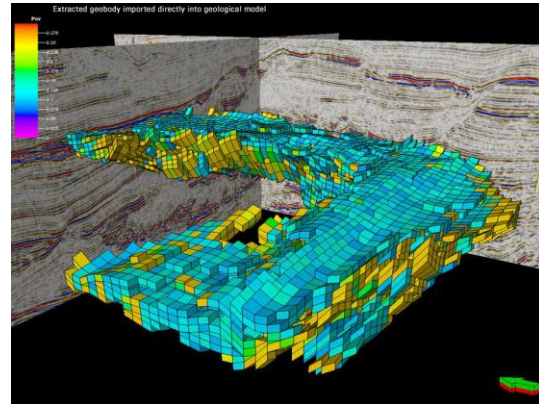
Check output

Refine parameters

Use cross-validation data

It is possible to generate another property cube
(density, porosity)

E – GeoBodies



Creating probes (Opacity-based detections)

Box probe

Borehole probe

Horizon probe

Geobody extraction

Sampling into a grid (Geology and Modelling)

III - Process Manager and Uncertainty analysis workflows in G&G

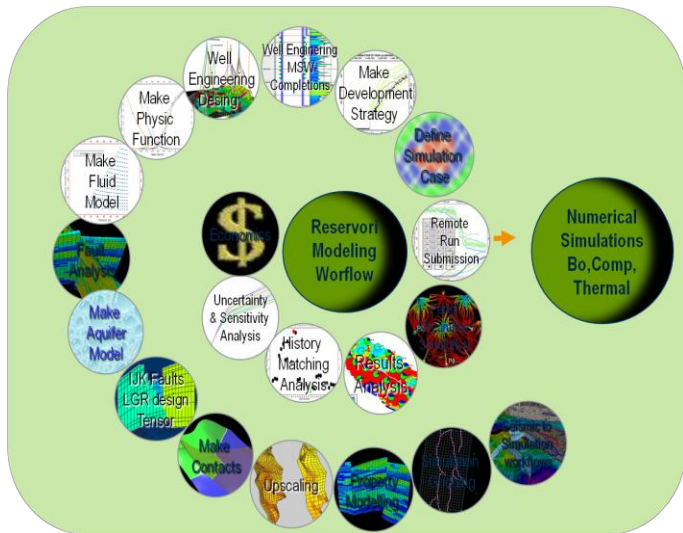
Create base case interactively

Create base case workflow from base case

Choose task

Identify uncertain and control parameters

Reservoir Simulations Workflows in Petrel

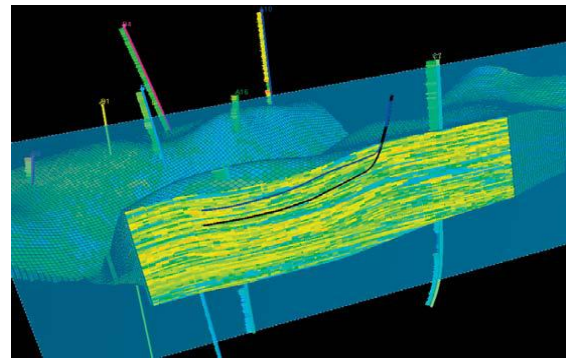


**By: Manager of Reservoir Engineering:
Belkis F Andrade**

Reservoir Modeling and Simulation Workflow:

- Input Simulation data quality control and validations
- Static Grid Model Upscale
- Dynamic Grid Model Constructions (LGR Tensors definitions, Amalgamation, Faults Dynamic Controls)
- Reservoir Definitions (Upscale, Simple Models, Fracture-DualPor, Geo-Multiproperty-Upscale)
- Fluid Model Definitions and Constructions, Aquifers & contacts Descriptions
- Rock Functions Definitions and Core Analysis with Petrophysics
- Well Engineering & Completion Design
- Well Flow Control & development Strategies
- Results Analysis, Visualization, History Match, Uncertainties analyses.

I.- Input Reservoir data



he Reservoir Input data is based on Simulation Cases and Static Model Validations.

- Simulations Production Logs/Dynamic Logs (Geomechanics Well data)

- Logs RFT/PLT

- Global Well Productions/ Injections Data

- Well events/Status/ Completions Data

- Fluid Descriptions (tables, PVT Out)

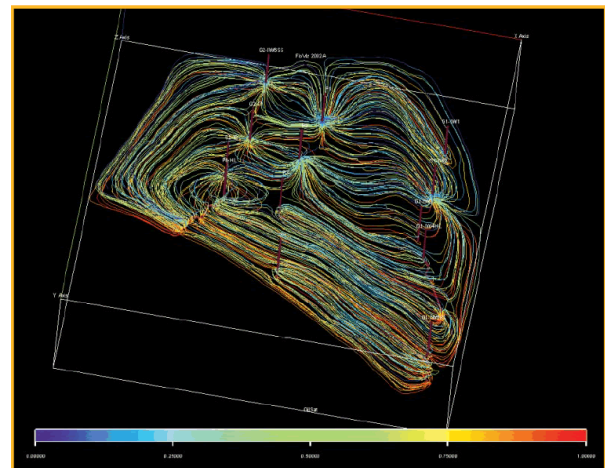
- Rock Physics Data

- Development Field/Wells Strategies

- Well Segmentations Folder (Smart Wells)

II.- Dynamic Grid Validations

A.- Simulation grid Modeling

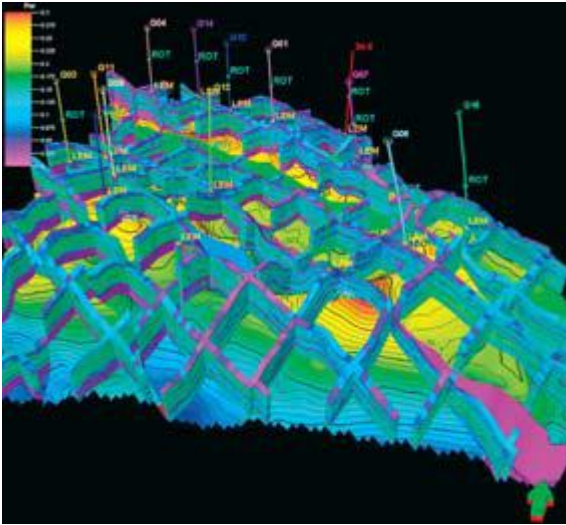


- Grid Size/type Definitions (Cartesians/Corner point)

- LGR Definitions/ LGR Desing Tensors (Cartesian local grids around wells, infill wells or in polygons)

- Sector modeling Constructions
- Flows Boundaries Conditions
- Simulation faults Definitions
- Fracture Model Gridding vs. Dynamic data Validations (PLT Logs, Simulation Logs, Completion wells, Geomechanics)

B. – Property Modeling



- Faults Properties Analysis
- Refined Gridding / Sector modeling properties Definitions
- Fracture Properties Definitions (Micro, Macro Mega) vs. Simulation Properties (Sigma, Poro, Perm, Intensity, etc)

C.- Upscaling

- Upscaling Methods Ranking
- Static Grid Model Upscaling
- Upscale onto LGR / sector Modeling Upscaling
- LGRs Amalgamation, Faults Dynamic Controls Export
- Make contact (adjust)
- Geostatistic Upscaling , Uncertainties Analysis of Reserves Quantifications
- Fracture Model Property Upscaling (matrix, Fractures type, Bug)
- Sector Model Upscale for Hydraulic fractures

- Well logs Upscaling & Validations vs. PLT's

III. Well Engineering



- Well Path & Completion design
- Well equipment Designs(Tubing, casing, valves, pump, liner, perforations, squeeze, stimulations, Plug, PLT's, PTA, etc.).
- Simulated production logs (descriptions by completions and perforation interval)
- Design well segmentations for Multilaterals/horizontal wells/Smart wells

IV. Simulation Definitions

A.- Make Fluid Model

- Create Black Oil Fluid Properties
- Define Compositional Reservoir Fluid (Oil, Gas, water)
- Build Fluid Model from Different Correlations
- Graphs visualization quality control and Curves checking

B.- Make rock physics functions

- Create relative permeabilities from Corey correlation
- Create a Rock Compaction Function
- Create Rock Compressibility

C.- Make Aquifer Model

- Define Aquifer area (polygon)
- Define Aquifer Type (Numerical, Carter tracy, Fetkovich)

- Describe Aquifer Properties

D.- Make Development Strategies

- Flow Wells Control Definitions

- Set predictions control and History match Constrains

- Identify uncertain and control parameters

- Ranking Development strategies (by Field, by group, By wells or by Completions)

E.- Define Simulation Cases

- History Match Analysis based on Reservoir Performances and dynamic statements

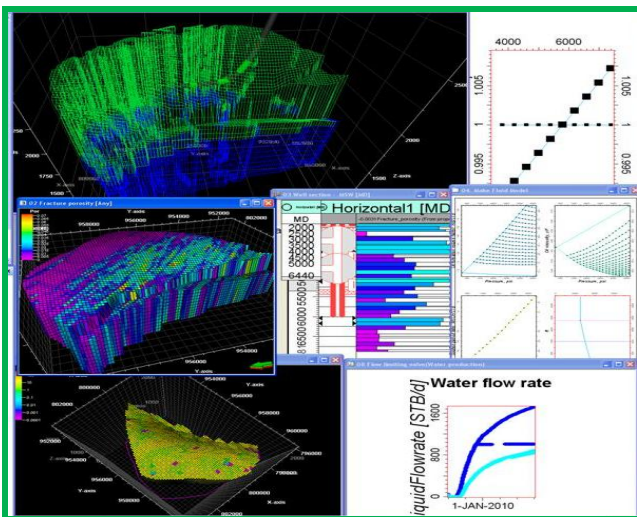
- Predictions Model based on Field strategies (Conventional Decline or Enhanced recovery process)

- Simulate, validate and Iterate.

- Uncertainties and sensitivity analysis and Ranking

F.- Merak economic

- Optimized simulation results based on Economic analysis.



INTERNATIONAL PROJECT MANAGEMENT

Advanced Technologies' management and staff are petroleum experts from around the world. As such, management and staff are experienced in most oil and gas regions, and speak fluently the language of many oil producing nations including:

- Europe
- West Africa
- South America
- SE Asia
- Continental US and Alaska

Our management and staff each have Masters or PhD degrees in Geophysics or Petroleum Engineering. Each of our technical managers recently held senior technical positions with Schlumberger, where they developed advanced modeling and simulation software technology, and conducted advanced 3D geocellular field models and reservoir simulation for large international projects.

3D RESERVOIR MODELING FEE SCHEDULE

Advanced Technologies provides 3D reservoir modeling services on a project basis. Depending on the size of the field, the extent of the seismic grid and well data, and petrophysical suite, a Team of Geologists, Geophysicists, and Reservoir Engineers will be assigned to construct an accurate 3D Geocellular Reservoir Model using the appropriate Petrel modules. The client will receive a full-scale, field-wide 3D geocellular model containing all available reservoir characteristics. The model will include structural maps, isopach maps, OOIP, Net Pay, 3D seismic and horizon Visualizations, Volumetric Calculations, fluid volume calculation. This will be followed by the results of the Reservoir Simulation, with projected oil, water and gas schedule, based

on field development plans optimized by the 3D field model. Economic analysis and sensitivity testing will include Net Present Value (NPV) calculation.

The Client receives all intermediary and final 3D Model products including Reservoir Visualizations, Cross-Sections and Time-Slices, and a Comprehensive 3D G&G Model Report. Reservoir simulation provides the Client with the most accurate deterministic and stochastic projected reservoir performance and economics available.

The Fees Schedule for technical experts and senior management is as follows:

Daily Rates¹:

- | | |
|--------------------------------|---------|
| • Senior Geoscientist/Engineer | \$4,000 |
| • ERCO Principal | \$4,500 |

CONTACT INFORMATION

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The Woodlands, Texas 77380

¹ Daily rates exclude software license fees. Travel and expenses reimbursible at cost.