VolTerra

A plug-in of Terra 3E for Assessing Hydrocarbons in Place and their Associated Uncertainties

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Outline

- VolTerra Method
- VolTerra Process
- Requested data
    - High resolution geological model
    - Thermodynamic data
    - Capillary pressure curves
- STOIIP & GIIP
- Case study
- Integrated workflow
- Conclusions

VolTerra Method

- Calculations rather than estimations of fluids (oil, gas and water) in place
  - Using right physics of the phenomena
  - On high resolution geological models
  - Before losing resolution due to upscaling
  - Gravity forces and capillary forces in porous media

- Hydrocarbon volumes depends on
  - Rocks properties
  - Fluid properties
  - Rocks fluids interactions

VolTerra Process
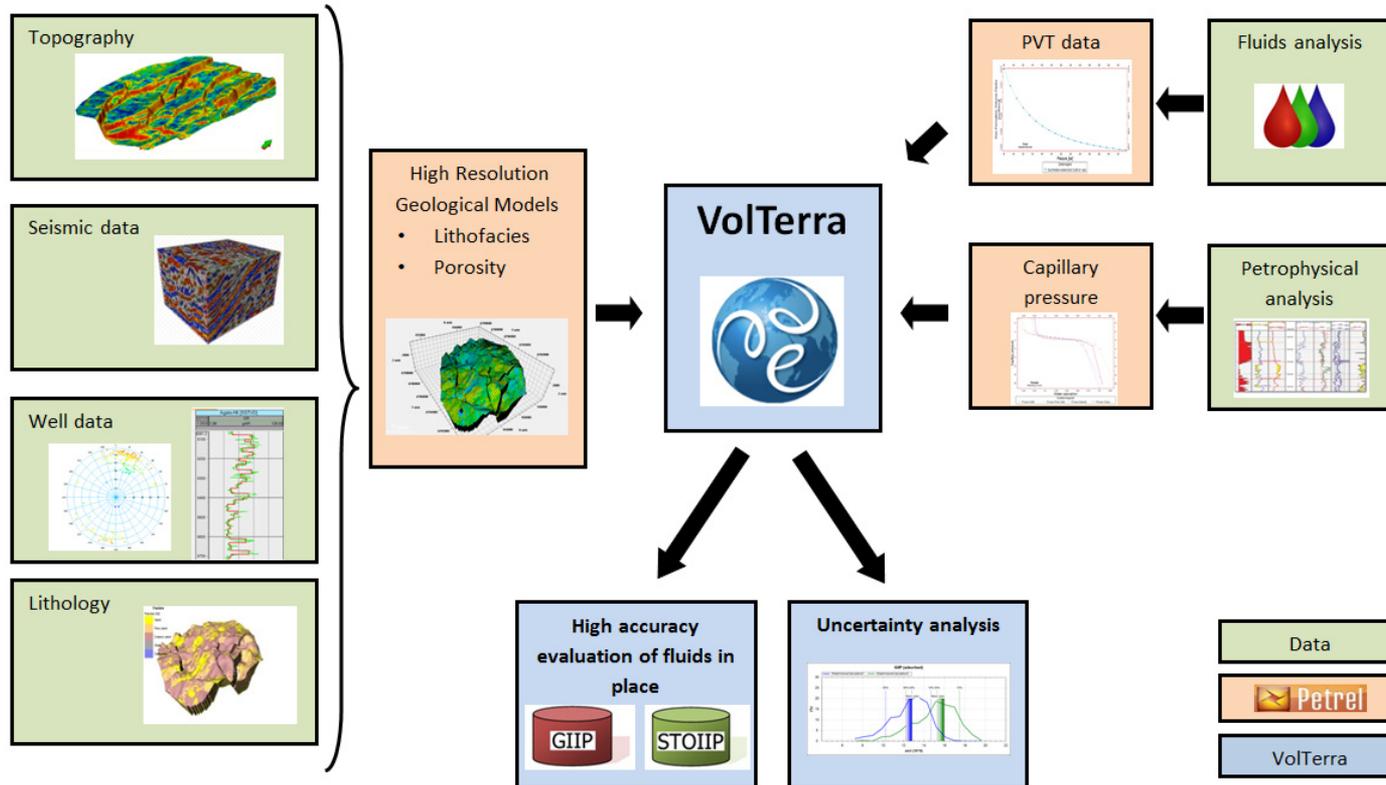
Requested Data - High Resolution Geological Model

- 3D geological model described in
  - Lithofacies
  - Porosity
  - Net-to-gross (optional)
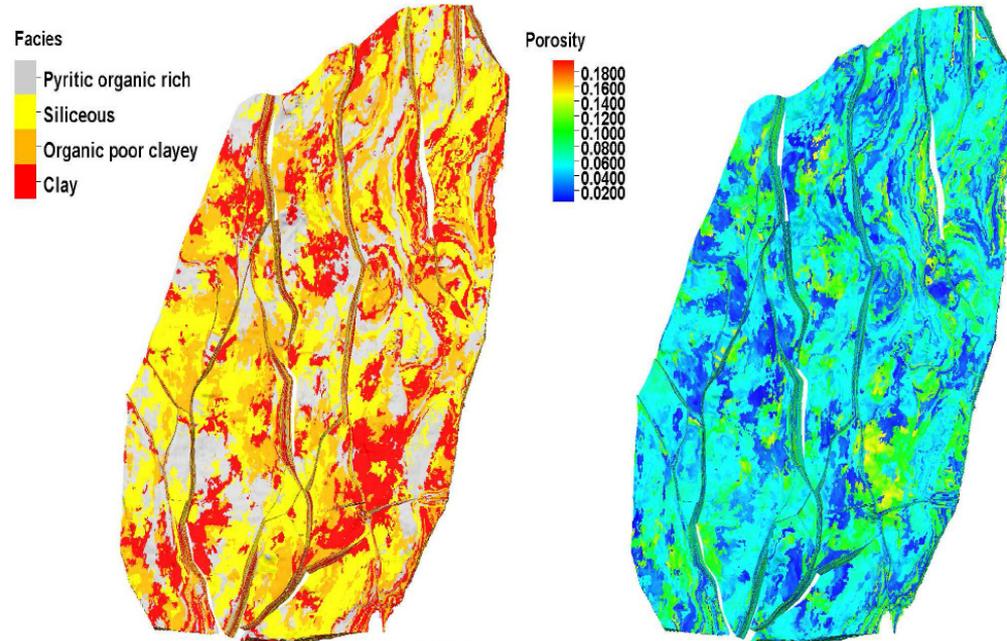
Requested Data - Thermodynamic Data

- Densities, volume factors and solution ratios of existing phases (Oil, Gas and Water)

  - ρ_g, ρ_o, ρ_w
  - B_g, B_o, B_w
  - R_s : Solution gas-oil ratio
  - R_v: Vaporized oil-gas ratio

Requested Data - Thermodynamic Data
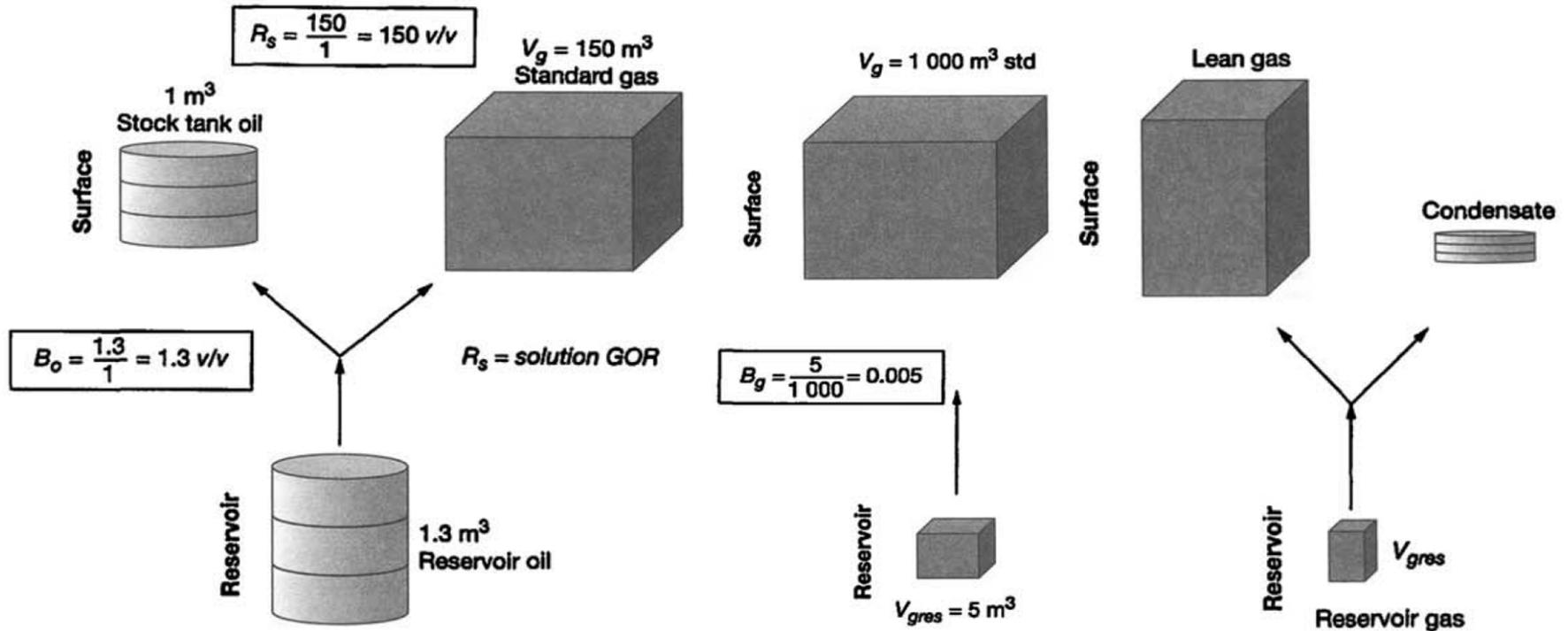
Fluids relationship (Donnez, 2007)

Requested Data - Capillary Pressure Curves

- Capillary pressure:

$$P_{cgw} = P_g - P_w$$
$$P_{cow} = P_o - P_w$$
$$P_{cgo} = P_g - P_o$$
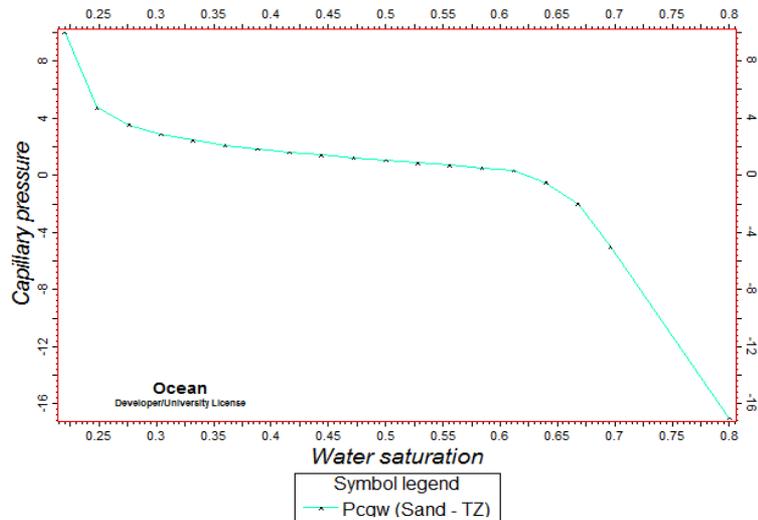
Case with transition zone
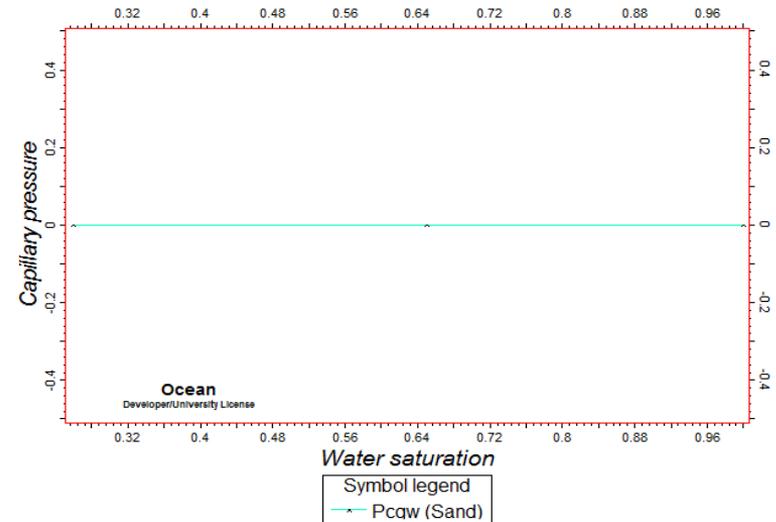
Case without transition zone

VolTerra: Free Oil and Gas Calculations

- From PVT data and an initial condition (a pressure at a given depth)
  - Initial equilibrium is computed
  - Fluids present in the reservoir tend to stratify according to their density
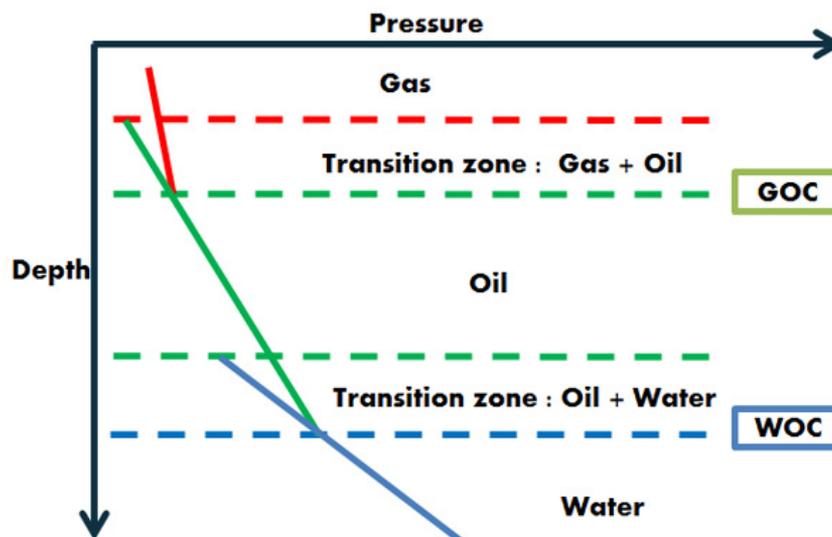
VolTerra: Free Oil and Gas Calculations

- Compute the pressure of each phase

  - $\frac{dP_o}{dh} = \rho_o(P_o, R_s) \times g, \qquad \frac{dP_g}{dh} = \rho_g(P_o, R_v) \times g, \qquad \frac{dP_w}{dh} = \rho_w(P_o) \times g,$

- Compute saturation from capillary pressure between phases

  - $P_{cog} = P_g - P_o, \qquad P_{cow} = P_o - P_w, \qquad P_{cgw} = P_g - P_w$

- Volume of free oil and gas in this cell is

  - $STOIIP^i = \frac{S_o^i V_i \varphi_i}{B_o^i}$

  - $GIIP_{free}^i = \frac{S_g^i V_i \varphi_i}{B_g^i}$

1. **Start the process**
2. **Import data using the blue arrow**
3. **Run the calculation**
4. **Visualize the results**

Case Study

- Synthetic geological model composed of 32.000.000 active cells
- Average cell dimension : 15m x 15m x 1.2m
- 315 layers
- 5 zones
- 4 lithofacies
- Porosity modeling conditioned to the 3D facies realization
- Fluid model : Light Oil + Gas

Case Study

Facies
- Clay
- Sand
- Silt
- Fine Silt

Porosity
- 0.2500
- 0.1750
- 0.1000
- 0.0250
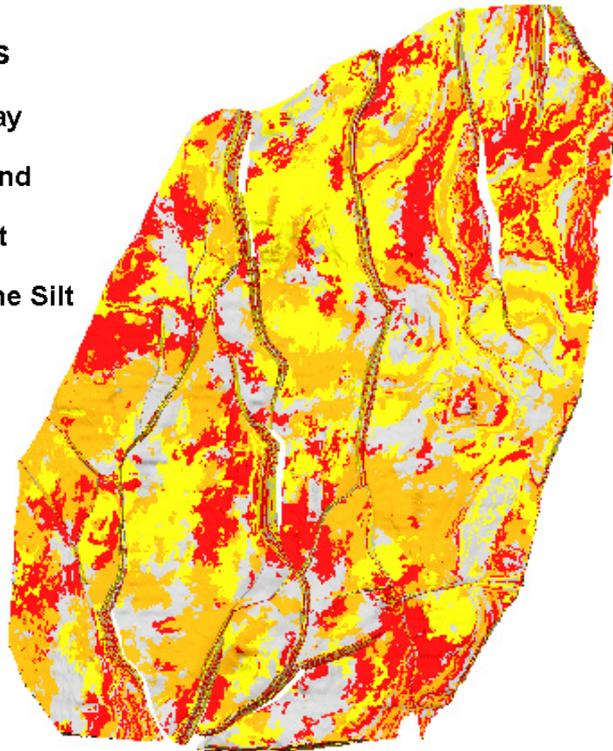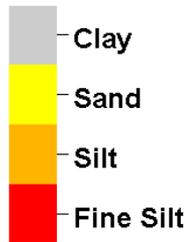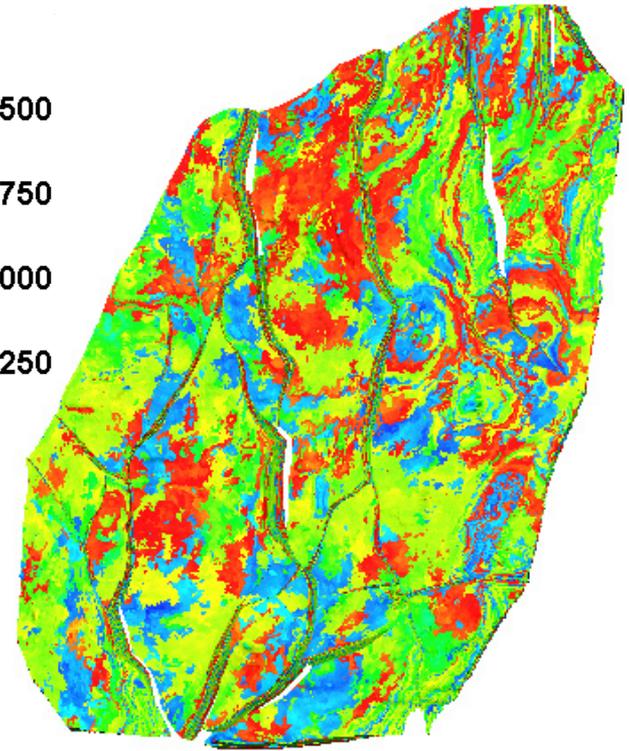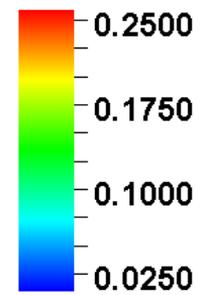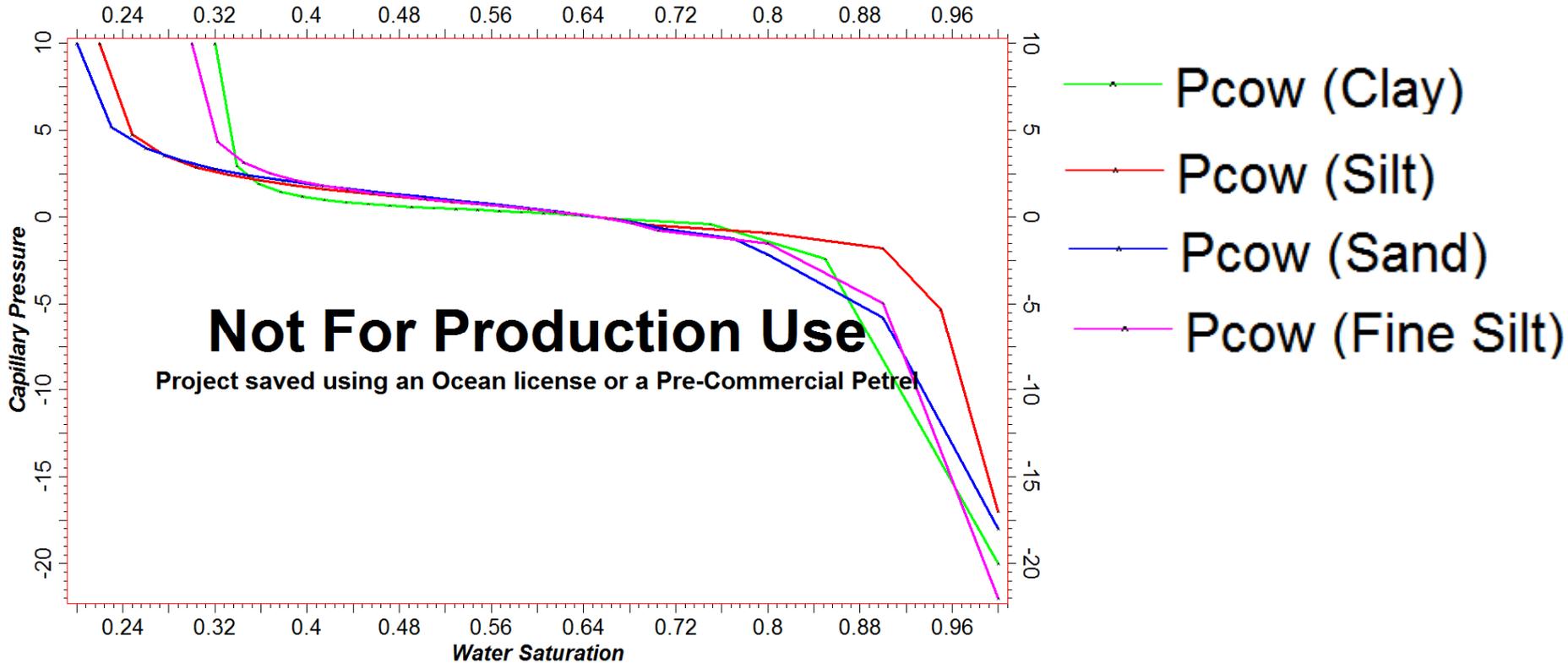
Case Study

Case Study - Results

- STOIIP : $\qquad$ $3.2 \ 10^8 \ sm^3$
  - STOIIP in oil: $\qquad$ $3.2 \ 10^8 \ sm^3$
  - STOIIP in gas: $\qquad$ $0 \ sm^3$
- GIIP : $\qquad$ $7.3 \ 10^{10} \ sm^3$
  - GIIP in oil: $\qquad$ $4.3 \ 10^{10} \ sm^3$
  - GIIP in gas: $\qquad$ $3.0 \ 10^{10} \ sm^3$
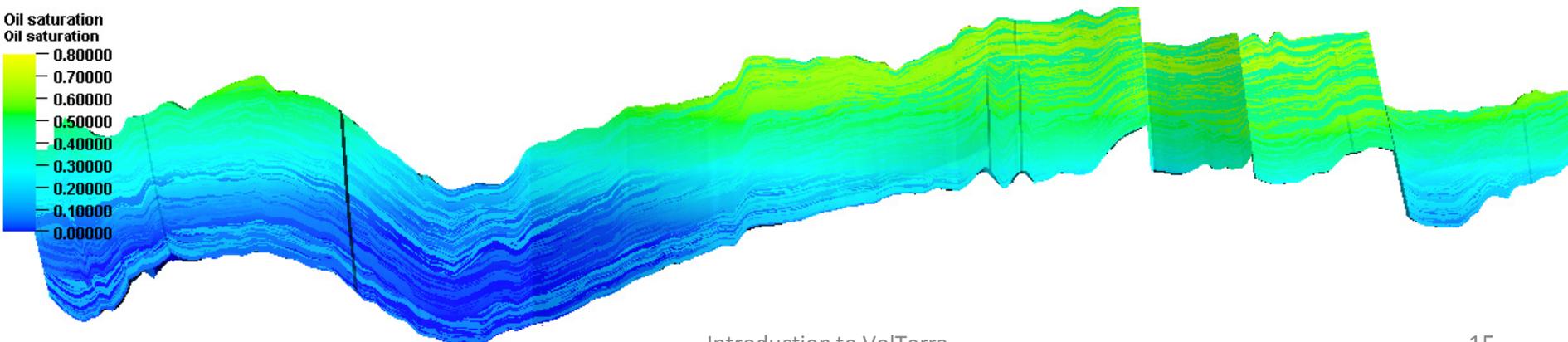
Conclusions

- VolTerra method provides an exact calculation of initial fluids in place
  - On high resolution geological model
  - Without reservoir simulator
  - The calculation speed allows uncertainty estimations
    - 15 minutes for 32 millions cells (Intel Core i5 CPU 2.53GHz)
- Calculations are performed for Black-Oil model
  - With constant or variable bubble point and dew point
- Uncertainty analysis can be done using Petrel workflows
- A full Word report (Data and results) is provided on a click

Licensing & Evaluation

- www.ocean.slb.com

- Free evaluations (14 days)
- 8,000 $ (12 months)
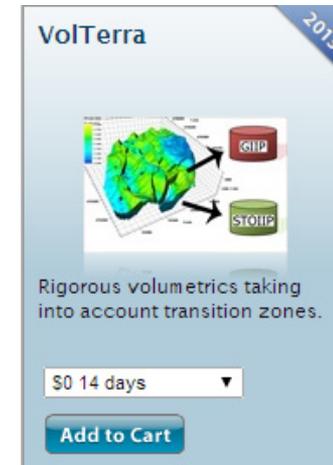
Energy Environment Expertise

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