Theory and Applications of Geostatistics concepts for Reservoir Characterization

Course Description

This course provides a comprehensive step by step overview of the methodology for generating 3D geological models. Geostatistics is an increasingly important tool for developing and understanding reservoir description. The importance of geostatistics is related to the quality of how petrophysical properties and lithology can be distributed in the reservoir. This course addresses workflows for modern 3D reservoir modeling.

The course is aimed for strengthening the participants' mathematical skills by offering tools applicable to reservoir characterization to have a better understanding of the 3D modeling process, their limitations and advantages.
This course provides detailed discussions of the core of geostatistics that includes data stationarity, spatial relationship (variograms), estimation techniques (kriging and cokriging), as well as Sequential Indication Simulation (SIS), and sequential Gaussian Simulation (SGS). This course is applicable only for conventional reservoirs.

Who Should Attend?

This course is designed for professionals with background in petroleum engineering or earth sciences (petrophysics, geology, geophysics).

What You Will Gain:

1. Understand the importance of the geostatistics in reservoir characterization.
2. Learn the geostatistics concepts required to understand commercial software to build 3D reservoir models
3. Understand the concepts of structure, facies and property modeling
4. Understand the use of variograms for petrophysical properties and lithology facies distribution

5. Learn how to perform oil in place calculations.
6. Learn how to upscaling geological models for reservoir simulation.
7. Learn when to use the different techniques of stochastic simulation

Training Methodology

The training course will combine lectures (5%) with workshop/work presentations (40%), interactive practical exercises and case studies (40%), supported by video material, software and general discussions (15%).

Course Content

The role of the geostatistics in reservoir characterization

- Introduction to geostatistics
- Definition, application and goals of geostatistics.
- Geostatistical modeling workflow.

Univariate data analysis

- Descriptive statistics
- Inferential statistics
- Exercise of univariate analysis (paper)
- Exercise of univariate analysis (Petrel software)
    - Import data: well head, well paths, stratigraphic markers, fault sticks, seismic horizons, facies logs, porosity and permeability
- Gaussian Transformation.
- Exercise (Gaussian Transformation).

Estimation methods

- Estimation methods.
    - Closed neighborhood.
    - Inverse distance.
    - Minimums squares.
    - Exercises of estimation methods (hand calculations and software-based calculations).

Geostatistical tools

- Proportion analysis.
    - Vertical Proportion curve analysis
    - Facies proportion matrix.
    - Vertical Proportion Facies exercise (hand calculations and software-based calculations)
- Variograms
    - Variogram parameters
    - Theoretical Variograms

  - Experimental variograms
  - Fitting a variogram model
- Exercises (hand calculations and software-based calculations)
- Variogram analysis.

Interpolation methods, Kriging

- Kriging, definition
- Comparison of Kriging methods with other interpolation methods.
- Simple Kriging
- Ordinary Kriging
- Other Kriging methods
- Kriging Exercise (hand calculations and software-based calculations)

Co-Kriging

- Analysis for choosing a multivariate distribution method
- Definition and classification of Co-Kriging methods.
- Co-Kriging applications: structural modeling, sedimentological modeling, petrophysical property modeling
- Exercises (using Petrel software)

Stochastic simulation of sedimentary facies.

- Estimation vs. Simulation
- Sequential Indicator Simulation (SIS)
- Pluri-Gaussian Simulation (PGS)
- Truncated Gaussian simulation (TGS)
- Object-Based Simulation
- Exercise (Generation of facies model).

Property modeling (Porosity, Permeability, and Saturation)

- Sequential Gaussian Simulation.
- Exercise: Build shale models, porosity, permeability and water saturation.

OOIP calculations and Uncertainly analysis.

- Geostatistics and volumetric method.
- Determination of OOIP/OGIP.
- Exercise: uncertainly analysis of oil water contact and its impact on OOIP
- Visualization of results.
- Uncertainly analysis of facies modeling.