A 3 Day workshop on Geostatistical Reservoir Characterization

Who should Attend:

Reservoir engineers, geophysicists, geologists, mining engineers. geoscientists and others involved in reservoir modeling of lithofacies, porosity and permeability and reservoir management.

Introduction:

This course will cover basic theoretical and practical understanding concepts in geostatsitics and application to petroleum reservoir characterization using a variety of data such as core data, log data, 3D Seismic, production history etc. This course will introduce hands-on sessions for solving practical field problems using GSLIB Software. Many oil industries have started realizing the overall benefit of this technology recently. It is an introductory course with emphasis on the principles and practice of integrated studies and uncertainty analysis.

Statistical and geostatistical methodologies are increasingly being utilized in petroleum industries to quantify and measure geological and geophysical properties. A 3 day course is designed to provide integrated approach of spatial data analysis, spatial correlation with seismic data together with 3 D geostatistical modeling and reservoir simulation for the natural resources without entering into mathematical details. An optimizing oil recovery from limited and sparse well is critical and requires good understanding of geostatistical methodologies to establish and quantify spatial correlation between wells with help of seismic data. How to integrate all information from exploration phase (geological, seismic and sparse well data) and exploitation phase (production, well test and tracer data) is critical and challenging to geoscientists. Due to recent advances in geostatistical and computational power, one can apply the geostatistical tools with easily available public domain software to perform advanced 3D geostatistical modeling to optimize hydrocarbon resources. The course will focus on concepts and methods to manage resource risk in order to improve critical business decision. Time will be allocated in each day in the last house for participant questions and discussions. The course will cover geostatistical interpolation (kriging, etc.), heterogeneity modeling, uncertainty quantification (simulation, etc.), and data integration (cokriging, external drift, geostatistical inversion, etc.). A number of case studies are presented, covering examples from various parts of the world.

Course Outline:

Day 1

<u>Morning Session: (Exploratory Data Analysis and Classical Statistics)</u>

10 – 11am	What is reservoir characterization and modeling? What is reservoir heterogeneity?/ Scales of heterogeneities What is geostatistics/Why learn Geostatistics/probability plot, mapping of spatial

	data
11 – 11.10am	Coffee Break
11.10 – 1pm	Data analysis, QC and Preparation/Data analysis and QC tools/Applications Regionalized variable, introduction of variogram, elementary Statistical Analysis / Data Cleaning Declustering for Representative Statistics Coordinate Transformation / Geometric Modeling Model the Spatial variability of a reservoir attributes using variogram. Stationarity and domaining.
1 – 1.45pm	Lunch

Afternoon: (Spatial statistics)

1.45 – 3pm	What is kriging?/Different types of kriging/Applications and limitations of kriging Experimental covariogram/Experimental Variogram Estimation and concepts, properties/behavior at origin/omnidirectional variogram/horizontal and vertical variogram/ Interpretation and Modeling/Cross Variogram estimation and modeling /integrate data from alternate sources for reservoir parameters estimations/wells designing/Anisotropy, geometric and zonal anisotropy.
3 – 3.20pm	Coffee
3.20 – 5.30 pm	Modelling: theoretical (mathematical) model of variogram, fitting models to experimental variogram geometric and zonal anisotropy/ anisotropic ellipse/Introduction to GSLIB: data file format, parameters files/ computation workshop about data statistical analysis. Indicator Variogram estimation and modeling, kriging weight, Computer Case Study

Day 2 (<u>Various Geostatistical interpolation techniques)</u>

10 – 11am	Ordinary Kriging, change of support, volum-variance relationship.
11 -11.20	Coffee
11.20 -1pm	Quantifying Uncertainty with Ordinary and Indicator Kriging
1 -1.45pm	Lunch
1.45 – 3pm	Conditonal Simulation/Seqiuential approaches Cross Validation
3 -5.30pm	Introduction of GSLIB and computer case study

Day 3 (Stochastic Simulation Techniques)

10 – 11pm	Introduction of various simulation methods for continuous and categorical parameters
11pm – 11.20pm	Coffee
11.20 – 1pm	Apply stochastic simulation algorithms used for modeling reservoir description/ Basic concepts, simulation methods, uncertainty, Simulation techniques: Gaussian and simulated annealing/Sequential Indicator Simulation (SIS)
1 – 1.45pm	Lunch
1.45 – 3pm	Simulation with Multiple Variables/Change of Support Effect/Uncertainty and Risk Analysis/Post simulation tasks: uncertainty quantifications, probability maps.
3 – 3.20pm	Coffee Break
3.20 – 5.30pm	Probabilistic techniques for measuring the uncertainty associated with the reservoir descriptions / Decision Making in Presence of Uncertainty/ Multidisciplinary Data Integration/ Computational workshop about simulation methods Introduction of GSLIB software

Day 4, Risk Management – Uncertainty Quantification

Morning Session

10 – 11am	Confidence Intervals
11 – 11.20am	Coffee Break
11.20 – 1pm	Monte-Carlo Methods – Simulation Optimization
1 – 1.45pm	Lunch
1.45 – 3pm	Risk Assessment/Optimization
3 – 3.20pm	Coffee Break
3.20 – 5.30pm	Applications and Introduction of GSLIB software.

MATERIAL NEEDED – Participants must bring a scientific calculator and a ruler and are encouraged to bring a laptop computer with a spreadsheet program.

Benefits:

- Know when geostatistical tools applied to quantify the connectivity of reservoir lithofacies, porosity and permeability;
- Know and experience the utilization of the geostatistical software of Stanford University
- Practical expertise through computational workshops
- Make decisions on when and where to apply reservoir description and modeling to support reservoir management,
- Understand the methodology of integrated studies
- Select the appropriate reservoir description and geostatistical modeling tools
- Analyze and QC data for reservoir modeling,
- Understand variogram analysis, kriging and stochastic simulation, integrated studies, uncertainty analysis; and
- Recognize the limitations and opportunities for reservoir modeling.