COURSE

INTRODUCTION TO APPLIED GEOSTATISTICS

BY: Dr. REINALDO J. GONZÁLEZ

This course is intended for reservoir engineers, geologists, geophysicists and other different geoscientists with an interest in the various geostatistical techniques utilized in the reservoir modeling of lithofacies, porosity and permeability (which in turn form the basic inputs into many reservoir simulations), but have a limited background in statistics and/or geostatistics.

The course introduces the basic geostatistical techniques for reservoir modeling from the theoretical and practical viewpoints. At its end, each participant should be able to describe situations where the application of geostatistical could assist with reservoir management; know the kind of geostatistical tools applied to quantify the connectivity of reservoir lithofacies, porosity and permeability; know how the constructed heterogeneous reservoir models are constrained by well and seismic data; understand the limitations of the resulting numerical models and model-building tools; and experience the utilization of the geostatistical software of Stanford University. Without scruples, more emphasis will be made on applied aspects of the techniques than in its theoretical postulates.

GENERAL OBJECTIVE:

At the end of this training, participants will be able to apply some geostatistical tools for generating reservoir descriptions coming from simple situations. This course addresses problems and available solutions emerging of reservoir characterization tasks. Focus will be made on practical and effective solutions today applied in the oil industry and also the learning of practical expertise through computational workshops.

SPECIFIC OBJECTIVES:

At the end of this training, the participant will be able to:

1. Apply statistical tools for exploratory data analysis
2. Model the spatial variability of a reservoir attribute using variograms
3. Estimate attribute values using the geostatistical technique named *kriging*
4. Integrate data from alternate sources to tasks of reservoir parameters estimation
5. Apply some stochastic simulation algorithms used for modeling reservoir heterogeneities
6. Use probabilistic techniques for measuring the uncertainty associated to the reservoir description tasks.

- **RÉGIME:**   theoretical - practical

- **DURATION:**   32 hrs. (can be abbreviated for shorter duration)

- **DIRECTED TO:** professionals dedicated to reservoir characterization tasks, i.e., reservoir engineers, geologists, petrophysicists, geophysicists, etc. concerned in a functional and practical introduction to geostatistical tools and their application in reservoir heterogeneities modeling.

- **PARTICIPANT´S CONDITIONS:** professionals linked to reservoir description tasks with or without previous statistical background**.** Computer experience (PC or WS) is recommended.

- **INSTRUCTOR:** Dr. Reinaldo González is a Senior Consultant of Advanced Resources International (ARI), a firm focused in emerging resources and new technologies for facing present energy industry times. He is an applied mathematician working on petroleum engineering solutions. He has more than 18 years experience in the oil industry and over 25 years of academic experience (including 8 years as independent consultant and Venezuela's nationwide geostatistics instructor for PDVSA). His areas of expertise encompass statistical and mathematical modeling, geostatistical and data-driven methods for reservoir characterization, risk analysis, and the application of advanced mathematical solutions to oil industry problems. Mr. Gonzalez has several publications about applied mathematics to petroleum industry problems.

ACTIVITIES SCHEDULE

- **Day 1** . . . . **Classical Statistics**

Introduction: What is geostatistics? course objectives, participant's expectations.
Univariate Data Analysis: traditional statistics tools for univariate description – histograms, summary statistics, probabilistic distribution functions, graphic resources.
Bivariate Data Analysis: traditional statistics tools for bivariate description – crossplots, conditional distributions, quantil graphics, regression, covariance and correlation.
Introduction to GSLIB and SGeMS software: data file format, parameter files, practice.
Computational workshop about data statistical analysis.

- **Day 2** . . . .**Spatial Statistics**

Spatial Statistics: difference between spatial and classic statistics, spatial depending crossplots, variogram concepts, practical interpretations.
Variography: experimental variogram, properties, importance, behavior at origin, omnidirectional variogram, horizontal and vertical variogram, indicator variogram, the use of variograms in the description of geological factors.
Modeling: theoretical models of variogram, fitting models to experimental variograms, geometric and zonal anisotropy, anisotropy ellipse, stratigraphic coordinates.
Structural Analysis: alternative tools for the measuring of the attribute spatial variability, heterogeneity scales, variograms superposing, nested structures.

Variogram analysis using GSLIB and SGeMS: selecting parameters for the experimental variogram, finding anisotropy axes, applications.

- **Day 3** . . . . **Estimation**

Estimation Methods: global and local estimation, the geostatistical method called *kriging*, introduction to ordinary kriging, influence of the variogram model on the estimated values.
Kriging Varieties: incorporating supplementary information to the estimation, integration of seismic data, kriging with an external drift, collocated cokriging, indicator kriging, case studies.
Computational workshop about kriging methods using SGeMS.

- **Day 4** . . . .**Stochastic Simulation**

Stochastic Conditional Simulation: basic concepts, simulation methods, uncertainty, multiple heterogeneous descriptions of a reservoir, comparing estimation and simulation methods.
Simulation Techniques: sequential Gaussian simulation, sequential indicator simulation, annealing simulation. Applications. Case studies.
Post simulation tasks: uncertainty quantification, probability maps; optimum, central and pessimistic scenarios.
Computational workshop about simulation methods using SGeMS.
Closing Activities: course overview, questions and discussion session, certificates.