Subsurface Data Analysis, Geomodeling and Geostatistics

Discipline: **Geostatistics/Geomodeling**

Length: **3 days**

Instructor

David Garner has more than 30 years of technical experience in industry with over 20 years in applied geostatistical studies in petroleum and mining. He has published and presented over 25 papers, many of which were peer-reviewed. Currently, he is a consulting geomodeling advisor and trainer and an associate of Geovariances in Fontainebleau, France. Previously Mr. Garner held positions in Halliburton as a Chief Scientist in R&D, as a Specialist in Statoil's Heavy Oil Technology Centre-Unconventionals R&D, as Senior Advisor Geologic Modeling for Chevron Canada Resources, and Reservoir Characterization Specialist at ConocoPhillips Canada. He was president of TerraMod Consulting for 6 years applying geostatistics and geomodeling techniques mainly for large international reservoir studies and mining resources. As a volunteer, Mr. Garner currently serves as a co-chair for the CSPG Geomodeling Technical Division committee and is chair for the upcoming Gussow conference, Closing the Gap III Advances in Geomodeling for Petroleum Reservoirs to be held in October, 2018. He was general chair for the CSPG 2011 and 2014 Gussow conferences., co-editor of the special edition December 2015 BCPG on Geomodeling Advances and the 2013 **CSPG Memoir 20**. Other courses taught are Fundamentals of Geostatistics, All You Need to Know about Geostatistics, Deconvolution Theory, and Introduction to Geophysics

COURSE DESCRIPTION

Geomodeling is a critical discipline within subsurface teams. Geomodeling practice is varied in the hydrocarbon industry with a need for fundamentals training to improve understanding of methods, common practices, quality and standards, irrespective of vendor software used. The Geomodel is used to render the geologic interpretations into a digital format suitable for decision making processes, such as economic resource assessments, forecasting production, well planning, and uncertainty analysis. Geomodeling practice uses diverse information to provide images of reservoir heterogeneities critical to better understand the physical hydrocarbon extraction processes.Geostatistics is the mathematical engine of spatial data analysis and geomodeling. Solid grounding in Geostatistics is a prerequisite to become proficient as a Geomodeler and problem solver within subsurface teams. Dominant uses of geostatistics in the industry are data analysis, mapping, integrating diverse variables, building geomodels, and resource evaluation. Uncertainty is a fundamental topic because underlying applications are stochastic and data provide a sparse or imprecise sampling of reservoirs. Geostatistical basic theory and best practices are explained along

with a variety of practical tips. Uses of probabilistic results are discussed. Context for the subsurface team is given through workflow descriptions and case studies. Exercises are designed to reinforce the theory and lecture through the hands-on learning. The advanced exercises are scripted to allow flexibility to experience the impact of parameter choices on model outcomes without getting bogged down in the software during a short course. The Isatis Geostatistics toolkit is used for exercises since it is a flexible software where basic techniques are transferable.

LEARNING OUTCOMES

An introductory grounding in geomodeling thought process, in basic geostatistical theory and best practices, tools of the trade for using geomodeling or mapping, understanding the application of geostatistics in the context of the hydrocarbon industry, and subject knowledge to improve team communication. Improved understanding of the uses and limitations of geostatistics and geomodeling. The course manual is reference material.

COURSE CONTENT

Module 1 (computer exercises)

Introduction: Geomodeling and the Subsurface Team -What is Geostatistics?

Essential statistics and terminology

Purpose: Background for exploratory data analysis, preparing for mapping and model building

- Regionalized Variables: Data Types, definitions
- Univariate Statistics: Measures of position, spread, and shape; proportions, stationarity, proportional effect
- Box plots, Q-Q plots
- Bivariate Statistics: Covariance and correlation
- Quantifying Variability/Spatial Continuity: Variograms- experimental, anisotropy; hand calculations; variogram maps; Behaviour, impact of outliers and calculation tips
- Variogram Models: illustrations; nested, issues, fitting tips and tricks

Module 2 (computer exercises)

Geostatistical Estimation

- General estimation techniques
- Kriging: simple and ordinary; Kriging by hand with a variogram model; Kriging weights, Cross validation, stationarity
- Multi-variate: Co-Kriging; collocated co-Kriging; Kriging with External Drift (universal Kriging)
- Trends in data: handling non-stationarity
- Case examples with mapping
- Geostatistical Depth conversion brief introduction, e.g., for model framework
- Multi-variate Special: Principal Components analysis; seismic attributes; statistical plays

Module 3 (computer exercises)

Simulation

- Simulation versus Estimation concepts

- Conditional Simulation; random walk and search neighbourhood
- Sequential Gaussian Simulation processes
- Petrophysical Trends and secondary data
- Post-processing topics: probabilities and uncertainty; volumetrics; avoiding bias in estimates
- Post-processing special topic: Checking results direct forecasting without simulation
- Case History

Module 4 (computer exercises)

Facies Simulations

- Stochastic Methods summary
- Stratigraphic coordinate systems
- Facies trend modeling: 1D to 3D proportions; integration of seismic attributes
- Object methods-summary
- Pixel methods: Illustrated description of algorithms for Truncated Gaussian (TGS), Truncated Pluri-Gaussian (PGS), Sequential Indicator (SIS), Multiple Point (MPS)
- Trends and locally varying azimuths: Application

Module 5 (Lecture)

Generalized Subsurface Workflows and Workflow Elements

- Case History
- Compiling and checking the input databases, data types, e.g. well markers, logs, seismic.
- Defining the structure and stratigraphic framework; grids and model sizing
- Facies inputs: Diverse Sources; Visual versus Electrofacies; Issues, scale, preparation, checking
- Facies trend modeling: Building 1D to 3D proportions; integration of seismic attributes
- Topics on Petrophysical modeling of porous media and fluids: Porosity, water saturation methods, permeability, mechanical; scale and specific rules
- Upscaling and Downscaling practices: Rules of thumb (du nez), issues and checks
- Post-processing: net pay, connectivity, summarizing uncertainty

Who should attend: Technical people working on subsurface reservoirs in multi-disciplinary teams growing geomodeling practices. This includes geomodelers, geologists, geophysicists, petrophysicists, reservoir engineers, new hires and technical managers.

Computer requirements: Windows based laptop. The Isatis Geostatistics Toolkit Software from Geovariances will be provided for the course exercises and will be installed on attendees' laptops before or at the start of the course.

Course setting: Offices

Exercises: Several on each main topic. There is an integrated probabilistic volumetric study, and four different facies simulation methods. Exercises are intended to reinforce concepts, best practice and improve understanding of applications.

Prerequisites: None specifically, but generally practical experience with integrated subsurface teams using geostatistical geomodeling would be helpful. Openness to seeing mathematical theory and intense exercises with explanations of concepts.