N345: Geomodeling for Unconventional Reservoirs

Instructor(s): Jeffrey Yarus

3 Days	Competence Level: Skilled
Classroom Course	
Computer Usage	

Summary

Business Impact: In order to **increase production** and **drive down the cost** per barrel of oil equivalent (BOE), this course will enable participants to **build reliable earth models** of unconventional reservoirs using **analytics for data insight** and **geostatistics for assessing uncertainty**.

This class addresses the application and integration of data analytics to subsurface geomodeling for unconventional resources, including oil, gas, and geothermal. Deterministic and stochastic methods used to create static models and uncertainty assessment will be reviewed to establish a common knowledge baseline. This is followed by skill development in data analytical methods such as multivariate statistics and machine learning. Topics include kriging, conditional simulation, principal components, cluster analysis, regression, recursive portioning, neural networks, and other practical methods. The class focus is to go beyond traditional static modeling through the integration of geostatistics and data science to produce reliable models for reservoir and completion engineers.

Participants will learn how to create mappable quality indices to optimize successful well placement and formation stimulation strategies. This course pulls together geoscience, engineering, and data science to build synergistic teams, optimize successful drilling programs, reduce uncertainty, and drive down cost per barrel of oil equivalent.

Learning Outcomes

Participants will learn to:

1. QC data for data analytics and geomodeling of unconventional reservoirs.
2. Evaluate workflows developed for geocellular modeling of unconventional reservoirs.
3. Assess critical relationships between petrophysical, geochemical, and mechanical data.
4. Develop spatial models of integrated geomechanical, geochemical, and petrophysical properties.
5. Assess the uncertainty of shale models.
6. Post process static models of unconventional reservoirs for dynamic flow simulation.

Duration and Training Method

A three-day course comprised of classroom lectures with exercises and a computer-based workshop.

Who Should Attend

This course has been designed for mid to senior level geoscientists, and specifically geomodelers. Familiarity with geostatistics and practical geocellular modeling is assumed. Managers and others who have previous experience of building geomodels and wish to develop a better understanding of how to apply modeling techniques to unconventional reservoirs could also benefit from this course.

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Prerequisites and Linking Courses

Skilled Application level course N058 (Reservoir Characterization and Geostatistical Modeling in Field Development) is a prerequisite for this course. Participants familiar with geostatistical principles and practical geocellular modeling, who have equivalent work experience to N058, could also attend this course.

Additionally, participants are expected to have a basic awareness of unconventional reservoirs, as presented in Basic Application level course N313 (Evaluating Resource Plays: The Geology and Engineering of Low Permeability Oil and Gas Reservoirs).

Course Content

This course will address questions about using geocellular models for unconventional reservoirs, such as:

- Are common modeling tools such as kriging and conditional simulation appropriate?
- Is it necessary to model "shale facies" and if so, how do we define them?
- Geocellular grids or meshes; what dimensions, layering types, and granularity are required?
- How to integrate natural fractures - key considerations
- What is the role of micro-seismic data and how can it be used in a geocellular model?
- How can geocellular models be used to improve geosteering and real-time drilling?
- What are the limitations to geocellular grids and stratigraphic layering styles?
- How do geocellular grids of unconventional reservoirs respond in dynamic simulators?

The specific topics to be addressed are:

Day 1

- Introduction
  - Role of 3D geocellular models for unconventional resources
  - Considerations for constructing geocellular grids or meshes for unconventional resources
- Exploratory data analytics for unconventional resources
- Types of variables
- Univariate and bivariate statistics for data quality assessment
- Review of principles of spatial modeling

Day 2

- Review of Kriging and Conditional Simulation
- Review of geomodeling steps and the importance of frameworks and stratigraphy
- Workflows for shale plays and how they differ from conventional plays
- Understanding multivariate analysis techniques and machine learning
- Applications in R and Python
- Post processing - Building probability maps to identify "Sweet Spots"

- What simulation and stimulation engineers would like to get from geomodels
- Real-time drilling and geosteering in unconventional plays

Day 3 - Modeling Workshop

This workshop uses simple exercises on a variety of multivariate techniques in order for participants to better understand the underlying principles. Some of the examples are from unconventional shale reservoirs and some are not. Those that are not, are classic data sets used in texts, classrooms, seminars, and online short-courses and are not necessarily geologic in nature, but clearly illustrate the methods.

Practical computer-based exercises demonstrating Multivariate Data Analytics that form the basis of the workshop include the following:

- Principle Component Analysis
- Factor Analysis
- Cluster Analysis
- CART (a prelude to Random Forests)
- Discriminant Analysis
- Neural nets

The actual number of exercises and methods will vary depending on available time.