Petroleum Geostatistics using Systat

Introduction

Application of geostatistics in the geosciences continues to expand from its origins in the mining sector and now includes significant applications in the environmental, petroleum and geotechnical sectors. In practice, application of geostatistical theory requires an integrated toolbox of statistical, geostatistical, geological, spatial analysis and visualization techniques.

In recent years, there has been a rapid development in geostatistics in the oil industry, comparable to that of mining geostatistics in the sixties. It is now of common use in a large number of companies from the exploration to the production stages. The reasons for this success are to be found in the significant contributions made by geostatistics to the analysis of spatial data.

Since the late eighties research and applications in geostatistics have shifted from mining to petroleum engineering. Geostatistics aims at producing models for Petroleum Reservoirs that are so-called maximally data charged. The aim is to generate a set of (equally probable) reservoir models of rock properties (Permeability, Porosity), usually defined on a fine grid of pixels that honor two important, yet different types of information. First, this set of reservoirs should depict a geological structure that agrees with the geologist's interpretation. Secondly, the models should honor the available data. The data exhibits a wide range of scale and precision. There are the direct observations of rock properties at wells and there are measurements that relate indirectly to the rock properties (Seismic, well test, production data). [***Source:*** http://pangea.stanford.edu/~jcaers/intro.html]

Research in petroleum geostatistics

Geostatistics involves studying phenomena correlated in time and space by means of a statistical tool: the theory of regionalized variables. Many phenomena in time or space can be modeled by means of geostatistical tools in the oil and gas industry, such as:

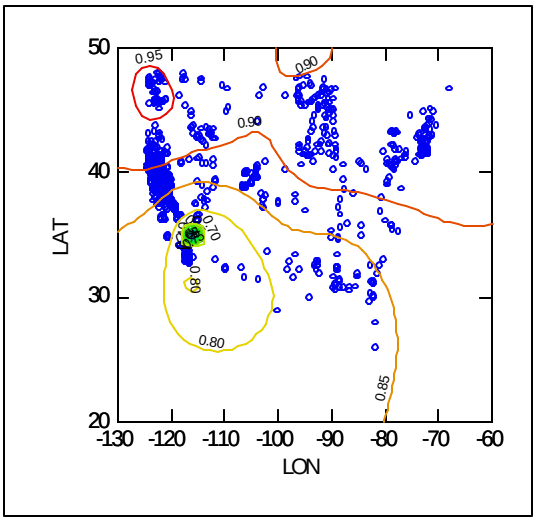
- Geometrical modeling
- Reservoir characterization - Reservoir characterization technology has dramatically changed over the last decade. The application of 3D seismic interpretation and sequence stratigraphic principles, coupled with geostatistical modeling has not only improved strategies for development of mature fields, but also for field development during the early stages where limited data are available. Both situations require different workflows, particularly when implementing geostatistical methodologies.
  Characterizing mature reservoirs generally requires the use of larger data sets (more wells and production data) and capturing more subtle observations resulting from a long history of analysis and production. In such cases, geostatistical methods can be used to accurately capture the observed complexity (heterogeneity) and provide appropriate upscaled models to be used in flow simulation. During early development stages, it is necessary to rely more heavily on remote data such as seismic, which generally supplies accurate information regarding horizontal continuity, but lacks critical vertical information. Under these conditions, geostatistical methods can be used to integrate data whose volume support are inherently different, and predict vertical detail throughout the reservoir.
- Reservoir engineering
- Seismic information
- Etc.

So what really is geostatistics?

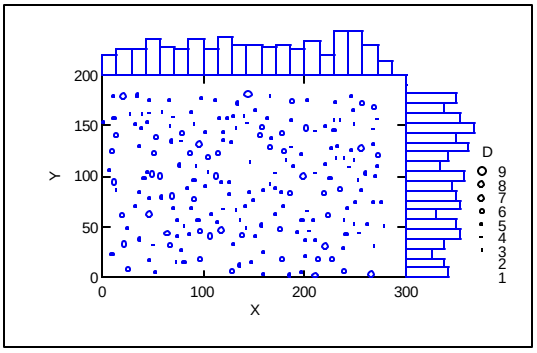
Geostatistics is really spatial statistics applied to the petroleum reservoir modeling, mining engineering or hydrogeological modeling disciplines. That is, geostatistics involves the analysis and prediction of spatial or temporal phenomena, such as metal grades, porosities, pollutant concentrations, price of oil in time, and so forth. The prefix geo- is usually associated with geology, since geostatistics has its origins in mining. Nowadays, geostatistics is just a name associated with a class of techniques used to analyze and predict values of a variable distributed in space or time. Such values are implicitly assumed to be correlated with each other, and the study of such a correlation is usually called a "structural analysis" or "variogram modeling." After structural analysis, predictions at unsampled locations are made using "kriging" or they can be simulated using "conditional simulations". [***Source:*** http://www.ai-geostats.org/Geostats_FAQ/Syed/introduction.html]

Spatial statistics using Systat

Spatial statistics involve a variety of methods for analyzing spatially distributed data. Systat Spatial Statistics covers two principal areas: fixed-point methods (kriging and Gaussian simulation) and random-point methods (nearest-neighbor distances, polygon area/volumes, quadrat procedures).



Spatial statistics compute a variety of statistics on a 2-D or 3-D spatially oriented data set. Variograms assist in the identification of spatial models. Kriging offers 2-D or 3-D kriging methods for spatial prediction. Simulation realizes a spatial model using Monte Carlo methods. Finally, a variety of point-based statistics are produced, including areas (volumes) or Voronoi polygons, nearest-neighbor distances, counts of polygon facets, and quadrat counts. Graphs are automatically plotted and summary statistics are printed for many of these statistics.



Apart from the above, Systat also offers a bouquet of multivariate data analytical methods useful in petroleum geostatistics. They include principal components analysis, discriminant analysis, canonical correlation analysis, cluster analysis and correspondence analysis.

The description above just gave a bird's eye view of Systat's capabilities. But Systat provides a powerful statistical and graphical analysis system in a graphical environment using descriptive menus and simple dialog boxes. Simply pointing and clicking the mouse can accomplish most tasks. Systat's command language provides functionality not available in the dialog box interface in addition to complete coverage of menu-based functionality. Robust algorithms from leading statisticians give meaningful results-even with extreme data. Matrix procedure allows you to use matrix algebra to specify statistical analyses and perform data management tasks.

Conclusions

Geostatistics is a rapidly growing area in engineering, the earth sciences, and applied mathematics. The field is devoted to the application of statistical techniques in the study of spatially variable phenomena. Although geostatistics was first developed to improve ore reserve estimation in a mining context, it has grown in application to many other areas of the earth sciences.

Whether you are looking for an all-in-one tool, or an advanced addition to your statistical library, you'll never have to worry about finding the right statistic or perfect graphic for the specific needs of your research then Systat is the answer to your research problems.