ABSTRACT

Geographic Information Systems (GIS) provide a good framework for solving classical problems in the earth sciences and engineering. This thesis describes the geostatistics associated with creating a geological model of a petroleum reservoir using a variogram-based two-point geostatistical approach. The geology of the field features a conventional heterogeneous sandstone formation with uniformly inclined rock strata of equal dip angle structurally trapped by surrounding geologic faults. Proprietary electrical well logs provide the resistivity and spontaneous potential at depth intervals of ten feet for the thirteen active wells in the field. The dimensions and shape of the reservoir are inferred from geological reports. An isopach map was georeferenced, digitized and used to generate a three-dimensional point-set grid illustrating the boundaries and the volumetric extent of the reservoir. Preliminary exploration of the input data using univariate and bivariate statistical tests and data transformation tools rendered the data to be statistically suitable for performing ordinary kriging and sequential gaussian simulation. The geological and statistical characteristics of the field indicate local stationarity thus ensuring that interpolation is appropriate to employ. Three variogram directions were established as part of the variogram parameters and then a best-fit statistical function was defined as the variogram model for each of the two electrical log datasets. The defined variogram was then used for the kriging algorithm. The data points were interpolated across the volumetric reservoir resulting in a 3D geological model displaying the local distribution of electrochemical properties in the subsurface of the field. Data is interchanged between separate modeling programs to illustrate the interoperability across different software. Validation of the predictive geostatistical models includes performing a leave-one-out cross-validation for each borehole as well as computing a stochastic model based on the sequential Gaussian simulation algorithm, which yielded multiple realizations that were used for statistical comparison. The reservoir characterization results provide a credible approximation of the general geological continuity of the reservoir and can be further used for reservoir engineering and geochemical applications.