APPLİCATİON OF GERT NETWORK PLANNİNG İN THE GEOSTATİSTİCAL SİMULATİON PROJECTS MANAGEMENT STRUCTURE – CASE STUDY: DALİ CU-AU PORPHYRY DEPOSİT

S. Talesh Hosseini[1], A. Moradzadeh[2*] and O. Asghari[3]

1. PhD student, School of Mining, College of Engineering, University of Tehran, Tehran, Iran
2. Prof. School of Mining, College of Engineering, University of Tehran, Tehran, Iran
3. Associated Prof. School of Mining, College of Engineering, University of Tehran, Tehran, Iran

Abstract: In exploratory projects, the number of collected data is much smaller than the area of investigation, thus finding a robust tool for deposit spatial modelling that accords to the limited collected data is very important. According to the characteristics of the studied deposit, different geostatistical simulation algorithms were presented with the ability to generate different models of the deposits to solve this problem. The existence or absence of highly skewed exploratory collected data in study area is one of the reasons for using sequential indicator simulation method or sequential Gaussian simulation method. In this article, according to the type of study activities, graphical evaluation and review technique (GERT) programing network was used for exploration projects management and creation of a suitable pattern for use of sequential gaussian simulation and sequential indicator simulation. To implement the possible activities of the designed network, geochemical data of Dali Cu-Au porphyry deposit was used. Comparison results of SIS simulation on gold data (highly Skewed) with results of SGS simulation on copper data (lowly skewed) indicates the high correlation of these two elements and the existence of a Cu-Au porphyry deposit along the NE-SW direction in the northern Dali area. The adaptation of the survey results with geological evidences proved work steps.

Keywords: Geostatistical Simulation, Sequential Indicator Simulation, Sequential Gaussian Simulation, GERT Programming Network, Dali Cu-Au Porphyry Deposit

1- INTRODUCTION

The approaches of geostatistical estimation and simulation are very important in studying deposit characteristics. In the pre-feasibility stage of a deposit, for example, recoverable reserves must be estimated through approximation of the ore grade and/or metal content of all blocks with grades higher than a given economic level. Therefore, selecting the best technique with the most effective output for high-grade situations of an ore is important for the precise reproduction of grade curve, and the economic study of each and every deposit. Geostatistical simulation approaches eliminate the problems of the Kriging technique, and the variability of the concentrations in the area will be easily recognized using a series of taken points. These methods were introduced in 1970 by Journel, and are now used in various industries including mining, oil, and environment. The existence or absence of highly skewed exploratory collected data in the studied area is one of the reasons for using sequential indicator simulation method or sequential Gaussian simulation method. The sequential Gaussian simulation (SGS) method is among the most important and most widely used geostatistical simulation methods, which is nowadays used to simulate many geological parameters such as mineral grade, porosity, and permeability. Sequential indicator simulation (SIS) is in essence the same as the sequential Gaussian simulation (SGS), except that instead of simulating a Gaussian variable, an indicator variable or an indicator transform of a continuous variable is simulated. The sequential indicator simulation technique uses indicator Kriging to calculate the local probability distribution. This technique needs the input of a semivariogram model for each cutoff defined by the user. As in indicator kriging, one can select to input for all cutoffs the semivariogram model for the cutoff conforming to the median of the data, with some loss in precision. Both sequential indicator and sequential Gaussian simulation need some choices to be made about the tails of the distributions. Because the number of grid nodes to be simulated out numbers the number of input data in most conditions, information delivered by the input data is usually inadequate to yield sensible values at the tail ends. In this article, according to the kind of study activities, of the graphical evaluation and review technique (GERT) programing network was used for managing exploration projects and creating an appropriate model for use of sequential Gaussian simulation and sequential indicator simulation. GERT can be an influential tool for the systems analyst since it has all the advantages associated with networks, and provides an exact evaluation of certain types of networks. GERT has wide application possibilities, as indicated by the numerous researches, and also has characteristics which make it useful as a teaching mechanism. To implement the possible activities of the designed network, geochemical data of Dali Cu-Au porphyry deposit was used. Comparison results of SIS simulation on gold data (highly Skewed) with results of SGS simulation on copper data (lowly skewed) indicates the high correlation of these two elements and the existence of a Cu-Au porphyry deposit along the NE-SW direction in the northern Dali area. The adaptation of the survey results with geological evidences proved work steps.

2-METHODS

2-1- Sequential Simulation

Sequential simulation is a stochastic modeling process that is based upon the input data that creates numerous realizations. The algorithm begins with a randomly selected location, and developments sequentially across the grid showing the area to be simulated. The order of this advance is not identified by concept, but a random sequence is usually tailed. At each location, the computer program explores for points in an operator identified neighborhood; these points can include both data input to the program, and data that have been simulated in earlier steps. A probability distribution is computed from these points using one of methods. How one computes this probability distribution distinguishes between types of sequential simulation, two of which are sequential indicator and sequential Gaussian simulation. Gaussian simulation is an algorithm that sequentially simulates the nodes, and the simulated values are used as the conditioning data. Gaussian standardized values are necessary to be used in the Gaussian simulation method. Therefore, it is necessary to transform the data into the Gaussian space. Unlike all estimation approaches based on moving average, geostatistical simulation is measured as an algorithm to adjust the smoothing effect of such techniques. In the simplest expression, this algorithm starts the simulation from a random point and will continue randomly to simulate all points of a block. Simple Kriging estimation helps to create a local distribution function. Then a value is selected from the distribution and is assigned to the point as a full-scale. This operation is repeated as long as all the spots on this route are simulated. In the simulation of a region one will be faced with many realizations that are different from the other ones, because except for the areas that have been sampled, the rest are facing with uncertainty. Therefore, each realized case can be a product of simulation. The main objective of the simulation process can be seen as restoring the changes of the original data space. The SIS is an invaluable tool for providing spatial models by combining the sequential paradigm with the indicator formalism to simulate nonparametric categorical or continuous distributions. Such spatial models contain all data in a neighborhood, including the main data and all previously simulated values. The sequential indicator method uses indicator Kriging to compute the local probability distribution. This method requires input of a semivariogram model for each cutoff specified by the user. As in indicator Kriging, one can select to input for all cutoffs the semivariogram model for the cutoff corresponding to the median of the data, with some loss in accuracy. In simulating petro physical variables such as permeability, one is interested in extreme values, and usually wants to provide accurate spatial models for the extremes in order to best capture the effect of permeability barriers or high-permeability zones on fluid flow through a reservoir. The time required to model semivariograms for the tails is possibly worth the effort.

2-2- Graphical evaluation and review technique

Graphical Evaluation and Review Technique, GERT, is a net analysis method used in project organization that lets probabilistic action both network logic and estimation of activity duration. . GERT is mostly used on project activities that are only done in part, as well as those activities that may be performed more than once (loop).

3- FINDINGS AND ARGUMENT

The algorithm of graphical evaluation and review method for selection of simulation approach is illustrated in Figure 1.

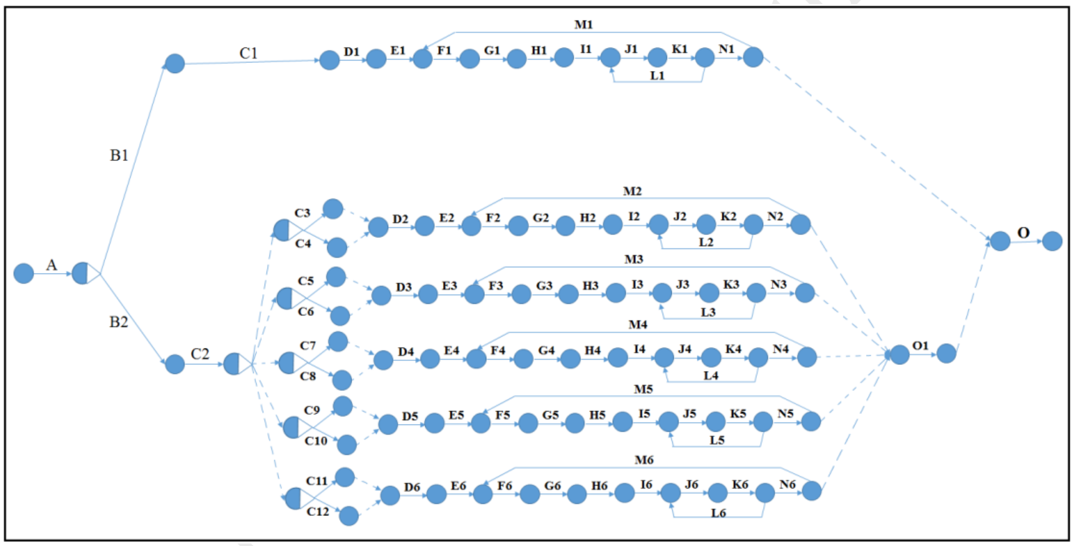

Figure 1- Algorithm of GERT network for selection of simulation method

The results of sequential Gaussian simulation method are shown in Figures 2 and 3 for copper element in Dali Cu-Au Porphyry Deposit. Also, the results of indicator Kriging and sequential indicator simulation method are shown in Figure 4 for Gold element of Dali Cu-Au Porphyry Deposit. Copper and gold in the NE-SW direction of the region show enriched values. This can prove that these two elements were the mineralization elements, and the correlation coefficient between the data of these two elements was very high.

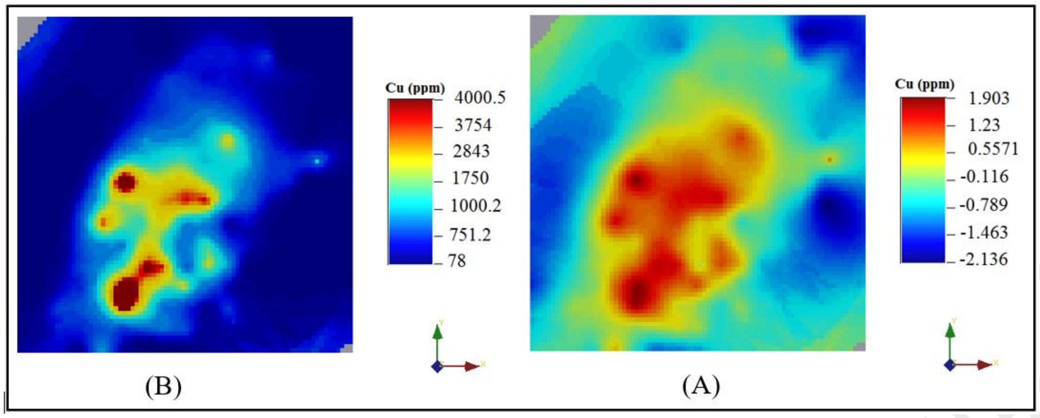

Figure 2- Maps of Kriging method for Cu element in (A) normal condition (B) real environment condition

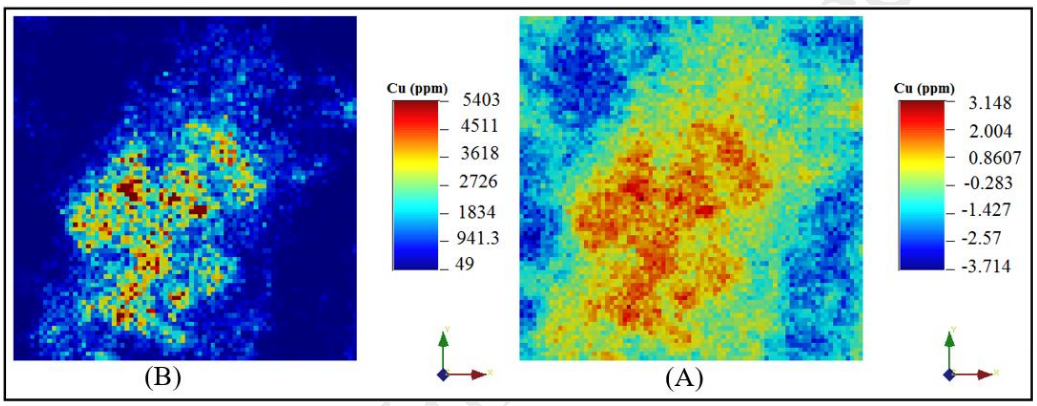

Figure 3- Maps of sequential Gaussian simulation for Cu element in (A) normal condition (B) real environment condition

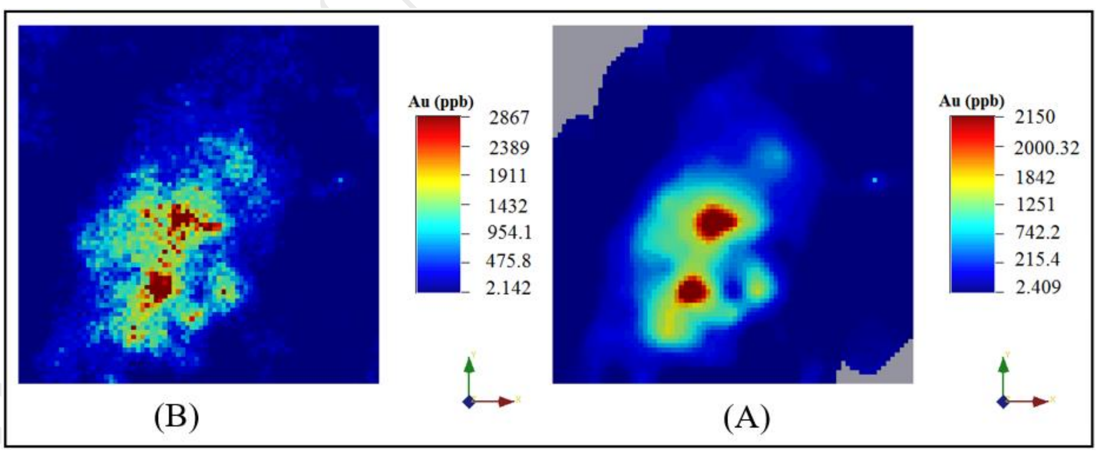

Figure 4- Maps of Au changes using (A) Indicator Kriging (B) Sequential indicator simulation

4- CONCLUSIONS

Due to the small size of the sampled area compared to the whole studied area, it is recommended to use the geostatistical simulation methods that are capable of predicting the best and worst events. Among these methods are the SGS and SIS method as the most efficient and flexible

methods that examine all the possible scenarios. The existence or absence of highly skewed exploratory collected data in the studied area is one of the reasons for using sequential indicator simulation method or sequential Gaussian simulation method.
In this article, according to the type of study activities, graphical evaluation and review technique (GERT) programing network was used for exploration projects management and creation of a suitable pattern for use of sequential Gaussian simulation and sequential indicator simulation. To implement the possible activities of the designed network, geochemical data of Dali Cu-Au porphyry deposit was used. The results of the sequential indicator and Gaussian simulations are compatible to a considerable extent, and both results represent significant mineralizations of copper and gold, especially in the NE-SW direction of the deposit. Since the case study is a porphyry type deposit, this increase is sporadic.

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