Application of SPDE method to a continental-fluvial uranium ore body and comparison with classical methods

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ABSTRACT

Big data management is currently a concern for most businesses and the mining industry is no exception. To boost productivity, a risk analysis associated with mineral resource estimation is often required and an assessment of the uncertainty is compulsory. Conditional simulations bring an appropriate answer but the traditional methodologies (e. g. Turning Bands Model) may lead to a prohibitive computing time and the need to choose a moving neighbourhood, which is a conundrum.

Most of the Geostatistical standard procedures suffer from severe limitations in the presence of large data sets and numerous target sites. The Stochastic Partial Differential Equation (SPDE) approach offers an innovative way of calculating Kriging and Geostatistical Simulations, which departs from the traditional geostatistical workflow by working directly on the precision matrix (inverse of the covariance matrix) instead of the dense covariance matrix. This precision matrix is directly computed from the model by using the link between a certain class of random functions and solutions of Stochastic Partial Differential Equations (SPDE) [Whittle, 1954] [Lindgren, 2011] and by approximating the solution with the finite elements method.

The SPDE approach leads to a very significant gain in performance of Estimation and Conditional Simulations. It enables us to deal with large set of inequalities through an efficient Gibbs sampling procedure. As it can handle a huge amount of data, it gets rid of concepts such as the Moving Neighbourhood. The algorithm initially developed for 2D dataset was recently adapted for 3D context. This approach naturally allows us to use varying anisotropies in a global consistent model by making variable the operator involved in the stationary SPDE.

This paper first summarises the key points of the methodology and its implementation in 3D. Then, the SPDE method is applied to a uranium ore body to compare these results with the ones obtained by the “classical” methods.