SIMULATION OF CORRELATED VARIABLES

A Comparison of Approaches with a Case Study from the Yandi Channel Iron Deposit

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ABSTRACT

Conditional Simulation of correlated assay variables is a subject of significant recent and current development. The objective of this thesis is to evaluate the available approaches in this area for mining applications. BHP Billiton's (BHPB) Yandi Channel Iron Deposit (Yandi CID) in Western Australia was selected for these tests.

The Yandi CID is 150 km by road North of the town of Newman in the Pilbara region. This channel iron deposit (CID) infills the meandering tertiary palaeochannels of Marillana Creek, which are 450m - 750m wide and approximately 100m deep in the centre. The deposits outcrop as a series of low mesas beside the present day creeks and were divided into three areas (Western, Central and Eastern) within which individual mesas are numbered. A North-South trending part of the channel (mesas C4, and part of C5) is the focus of this study. Drilling of the C4 and C5 mesas is on grids varying from 25m x 50m to 100m x 100m.

Although the Yandi CID is mined for iron ore, the concentrations of the contaminants Al_2O_3, SiO_2 and P_2O_5 are economically critical. The loss on ignition (LOI), while not strictly speaking a contaminant, is also an important product characteristic for iron ore customers. The correlations between the assay variables and their relative abundances vary from sample to sample. For resource modelling, individual samples were grouped together into domains of similar geological and geochemical character. The 'Main Ore Zone' of the Yandi CID was the domain selected for study in this thesis. Detailed univariate, bivariate and multivariate analyses were used to characterise this domain before proceeding to the simulation study.

The Conditional Simulation methods evaluated in this thesis are all Gaussian-based and they include Conditional Co-Simulation using the Linear Model of Co-Regionalisation and two other, alternative multivariate simulation methods, which use Min/Max Autocorrelation Factors or the Stepwise Conditional Transform to de-correlate assay variables before performing independent Conditional Simulation. Twenty simulations were generated for each of these simulation methods. It was found that Conditional Co-Simulation best reproduced the characteristics (histograms, variogram, scatterplots etc) of the declustered drill hole data. Whilst simulation using Min/Max Autocorrelation Factors generally produced acceptable results, the method did not adequately reproduce the variance of the assay variables. The univariate statistics, histograms and experimental variograms were acceptable for simulations generated from the Stepwise Conditional Transform. Bivariate statistics, cross-variograms and scatterplot reproduction for the Stepwise Conditional Transform were unacceptable. This method produced inferior results because there were insufficient samples to obtain a reliable transform of the third assay variable in the transformation sequence.

None of the abovementioned simulation methods provides good reproduction of all the scatterplots. This is due to the presence of clay pods, which cause some scatterplots to display two trends. These clay pods contain higher percentages of SiO_2 and Al_2O_3 than the surrounding material (known as CID). The clay pods are generally smaller than the drill-grid dimensions and thus their locations are generally unknown. The locations of the clay pods were simulated via Indicator Conditional Simulation. Condition Co-Simulation was then performed separately for the clay pods and the CID. This significantly improved the reproduction of the correlation coefficients, the scatterplots and visually the simulation was more geologically realistic. This Indicator Conditional Simulation of clay pods followed by Conditional Co-Simulation of assay variables is the recommended approach for simulation at the Yandi CID.

DECLARATION

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Signed:

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