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3D stochastic inversion of gravity data of Lalor volcanogenic massive sulphide, Manitoba, Canada

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The objective of this study is to present an algorithm for 3D stochastic inversion of gravity data, which takes into account the geological model. The obtained model is expected to permit the application of Bayesian SGS approach for metal grade estimation and compare the results with those retrieved using conventional least-squared regularized inversion. The proposed approach includes sets of geological models adjusted to the actual data without any matrix inversion as usually done in conventional approaches. The stochastic inversion seeks the conditional probability density parameters of the measured data and the known constraints of the model, unlike the conventional inversion where a single optimal model is sought.

In this study, we propose a stochastic inversion method in which, the geological model of the study area is used as a training image to generate multiple scenarios by implementing multiple point simulation. In an optimization process to obtain a satisfactory match to sets of observed data, different stochastic realizations with the same overall statistical properties are iteratively linearly combined through gradual deformation. Then, we perform forward modeling on these constrained combined models to obtain measured gravity data, assuming the physical properties of each unit in our models are constant. The results are compared by the observed data to have the minimum misfit possible between the measured and observed data in order to validate the initial geological model
The methodology is applied to Lalor volcanogenic massive sulphide (VMS) deposit, which is located near Snow Lake, Manitoba, Canada. The deposit is one of the largest metal deposits within Flin Flon Greenstone Belt having 25Mt reserves. There are three mineralization zones in the deposit including zinc zones, gold zones and a gold-copper zone. An analysis of physical rock properties was conducted to determine the relationship between the petrophysical, geophysical and geological data. The analysis shows the relationship between metal grades and physical properties such as the concentration of iron and the density. These non-linear relations will be used in estimating the metal grades.

The model built with our method considers the uncertainty and makes it possible to integrate geophysical and geological data to be used later for estimating the grades.