

Introducing Graph Neural Networks (GNNs), Solving the Fluid Flow Conundrum, Modelling Mineralization and Evaluating the Economics of Mining Mineral Deposits

Matthew Hoffer¹, Daniel Mogilny², Haozhe (Marko) Huang³, **Matthew Hoffer**⁴

¹GeoMet AI, Brisbane, Australia, ²GeoMet AI, Toronto, Canada, ³GeoMet AI, Toronto, Canada, ⁴GeoMet AI, Chicago, USA

Machine Learning (ML) is creating value in all facets of the mining industry. The authors introduce Graph Neural Networks (GNNs) a specialized deep learning architecture designed to process data structured as graphs - nodes and edges - rather than standard grids (images / convolutional neural networks CNNs). GNNs are becoming more widely recognized as one of the most powerful forms of ML in large part through GraphCast by Google DeepMind and more specifically research work into weather forecasting and hurricane tracking. We will introduce the GAUGE system, a set of GNN tools and demonstrate how they are applied and the economic considerations necessary for determining when GNNs may be the right solution to de-risk challenging economic mine related modelling problems.

The authors present the results from the mineral resource modelling of an epithermal gold deposit in Papua New Guinea and demonstrate how statistically significant non-linear correlated elements are used as direct inputs to the resource and geometallurgy models. They assist in the mining and milling of orebodies, thereby predicting the behaviours of mining blocks and comparing the GAUGE system with classical geostatistical techniques, such as kriging.

This work unravels how the fluid flow conundrum of modelling mineralization and weathering as fluids frozen in time, provides a technological benefit. Issues addressed are: 1) existing techniques for finding correlations between assayed elements do not fully reflect the complex geology of the deposit 2) non-linear correlations that are difficult to model as simple mathematical functions are in fact representative of complex geological patterns in a deposit and 3) non-linear correlated assayed data fed as inputs increases the performance of the resource and geometallurgical models as reconciled through blind tests. It's further demonstrated that the GAUGE system provides an enhanced de-risking tool for economic modelling by generating more accurate block models and drill patterns.