Advances in Geologic and Resource Modelling Methods for Locally-Varying Controls on Orogenic Gold Mineralisation

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Keywords: Orogenic Gold, Local Controls, Domain Definition, Machine Learning, Enhanced Ordinary Kriging, Python-based Resource Estimation

ABSTRACT

Orogenic gold deposits can display complex, non-stationary ore geometries reflecting factors such as host rock heterogeneity, progressive deformation, and multiple mineralisation events. Recent advances in modelling and estimation methods help to represent such local controls on mineralisation at the Palaeoproterozoic (circa 1788 Ma) Oberon gold deposit (Tanami, Northern Territory). Currently in the pre-feasibility study stage, the deposit exhibits a complex geometry that manifests as an elongate, doubly-plunging dome of metasedimentary and intrusive rocks.

Lithostratigraphic domains are defined by interpreting conventional drill core logging data supplemented by natural gamma and multi-element geochemical data. Unsupervised machine learning algorithms, including K-means and density-based clustering, refine and validate these domains. Mineralised domains are characterised by planar envelopes of stockwork-type veins or disseminated sulphides, aligning with limb or axial-planar geometries. Gaussian mixture models of Au leverage As and S data to help define latent Au thresholds for the mineralised domains. Secondary indicators, such as vein density and alteration intensity, are encoded based on indicator thresholds and aggregated to a secondary indicator score to support the definition of the mineralised domains. Local, high-grade ore shoots reflect the hinge of the dome, smaller nested folds, and lithologic contacts. Such trends define anisotropic variogram models within the principal planes of mineralisation. Python-based resource estimation software and workflows utilise locally varying anisotropy for experimental variography and local capping methods for calibrated Ordinary Kriging.

The results of this case study highlight the benefit of supplementing conventional geological approaches to domain definition with high-quality, high-dimensional datasets, which provide the basis for domain validation and refinement using unsupervised machine learning algorithms. The application of domaining strategies, variogram methods, and capping techniques tailored to honour local plunge controls and local search neighbourhoods enhance the strength of the Ordinary Kriging estimator in its ability as a non-stationary estimation algorithm.