

Enhancing Intrusive Modelling with Data-Driven Spatial Continuity Mapping: Application at Bingham Canyon, Utah

Mario Zelic¹, Jen Ellis², Alexander Wilson³, Kathryn Gall⁴

¹Rio Tinto, Copper Technical, , Australia, ²Rio Tinto, Kennecott Copper, Salt Lake City, United States, ³Bentley Systems, , Canada, ⁴Bentley Systems, Perth, Australia

This study introduces how Spatial Continuity Mapping (SCM), an unsupervised machine learning approach, improves geological modeling of intrusive units at the Bingham Canyon Mine, Utah. Traditional modeling methods often rely on manual interpretation and isotropic implicit algorithms, which can introduce subjectivity and fail to capture complex local geometries. SCM addresses these limitations by analyzing downhole drilling data to identify and quantify 3D spatial continuity trends, expressed as local anisotropy ellipsoids.

The workflow begins with preparing input data, categorical lithology logs converted to binary classifications and composited to 3-ft intervals. SCM is used to select analysis centers within the feature of interest and constructs continuity envelopes through inside-out aggregation of nearby samples. Each envelope is converted into an ellipsoid representing local anisotropy, including orientation, axis ranges, and confidence scores. Collectively, these ellipsoids form a Locally Varying Anisotropy (LVA) field across the deposit.

SCM-guided interpretations suggest that intrusive bodies, Monzonite (MZ), Porphyritic Quartz Monzonite (PQM), Quartz Monzonite Porphyry (QMP), and Latite Porphyry (LP), exhibit strong structural control and tabular geometries, contrasting with the traditional stock-like representation. LP intrusions appear predominantly sill-like, aligned with stratigraphic contacts, while PQM and QMP show steep dips influenced by major faults such as Copper Center and Giant Chief. MZ intrusions display sub-vertical trends along WSW, NNW, and NE fault systems, indicating emplacement within a complex strike-slip and extensional regime.

While SCM requires dense, high-quality data and should complement traditional interpretation, its ability to extract spatial trends directly from drilling data represents a major step toward more accurate, auditable geological models. These models provide a robust foundation for resource estimation and geotechnical analysis in structurally complex deposits.