

Enhancing Geological Model Development through Machine Learning Integration in Mapping Workflows: A Case Study of the Bendigo Zone, Victoria, Australia

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Summary

This study presents two proof-of-concept case studies conducted in the Bendigo region of Victoria, Australia, showing the successful integration of machine learning (ML) techniques into surface mapping workflows for enhanced structural and lithological geological model development. In the first case study, geological structural features, such as faults, were inferred by employing Subspace K-Nearest Neighbors (KNN). This approach used geophysical and geological mapping data, integrating magnetic and gravity data, and field mapping observations. The Subspace KNN algorithm identified geological structure features associated with fault zones and effectively captured their complex relationships, i.e., cross-cutting relationships and fault-fold interactions. The second case study focuses on lithology inference from geophysical data using unsupervised ML clustering techniques, specifically Self-Organizing Map (SOM), with an iterative post-clustering review. By applying the SOM clustering algorithm to magnetic, gravity and radiometric survey data, a lithological map was inferred based on the categorized clusters. SOM clustering suggested distinct lithological clusters based on their geophysical characteristics. Subsequent cross-correlation with a comprehensive rock sample database validated and refined these clusters, aligning them with existing geological understanding for a more robust interpretation. The two presented proof-of-concept studies exemplify the potential of ML in geological mapping and 3D modelling and lay a foundation for future research in refining ML applications.