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**A Machine Learning-based Framework for Prospectivity Mapping of Critical Minerals**

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There has been a significant decline in the discovery of critical mineral deposits over the last two decades, and exploration geologists have begun to apply new technologies to increase the success rate of exploration projects. One of these technologies is artificial intelligence, particularly machine learning, which has been successfully applied in different fields to address a variety of problems. A range of methods has been developed for mineral prospectivity mapping. With the increase in computer power, the application of machine learning for providing accurate prospectivity maps has gained traction for exploration geologists to take full advantage of numerous datasets. This study proposes a machine learning-based framework for generating prospectivity maps of critical minerals. This framework benefits from different machine learning methods for various purposes, including an improved generative adversarial network to overcome the class imbalance problem of the training dataset, an autoencoder neural network to reduce the dimension of feature space, and the combination of a positive and unlabelled learning method and random forest as the main classifier for predicting probability values at target points. We evaluated the efficiency of our proposed framework by creating a prospectivity map of mafic-ultramafic intrusion-hosted nickel mineralization in the Gawler craton, South Australia. Various exploration datasets were used as input features, including geological, geochemical, and geophysical data. We used known mineral occurrences as positive samples and created different sets of random samples throughout the study area as unlabelled samples. Based on our results and different evaluation metrics, the model's performance is stable, and its accuracy is higher than the map generated by a conventional approach using a standard random forest classifier. Our prospectivity map shows a strong spatial correlation between high probability values and known mineral occurrences and predicts a number of potential greenfield regions with as yet undiscovered deposits.