

Determining Economic PGE Mineralization Using Base Metal Ratios: A Machine Learning Approach

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Mineralization vectors such as specific element suites, alteration indices, and metal ratios, are amongst the most useful of geochemical exploration techniques and have led to the discovery of many kinds of ore deposits from epithermal gold to porphyry copper. Platinum-group element (PGE) exploration, however, lacks definitive mineralization vectors. Here, 1029 whole rock samples from 54 unique PGE occurrences and deposits across the world were compiled and used to inform machine learning models. Our models produced decision trees that predict economic (≥ 0.8 ppm Σ PGE) samples using base metal ratios alone. A total of 1,620 models were run, with the best operating at 72.8%, 72.2%, and 81.8% accuracy on training, cross-validation, and external validation sample sets for a total weighted accuracy of 80%. This decision tree indicates that high Cu/Pb (> 1480.3) correlates with economic PGE mineralization at 84% accuracy ($n = 129$) and low Cu/Pb (< 66.7) are predominantly subeconomic at 80% accuracy ($n = 412$). Intermediate Cu/Pb, 66.7 – 1480.3, are less distinguishable unless they also exhibit low Pb/S ($< 9.1E-05$), in which case they are subeconomic at 92% accuracy ($n = 36$). Our machine learning model indicates Cu/Pb to be the most predictive ratio of economic PGE mineralization and presents an approach for evaluating PGE prospectivity in formerly overlooked terranes or areas without PGE assay data. Furthermore, our methodology may be used for other commodities or deposits to identify mineralization vectors and geochemical exploration targets.