Applying Machine Learning Methods to XRF Data to Quantify the Acid-Generating Potential of Waste and Other Intrinsic Rock Properties

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MineSense Technologies equips shovels and loaders with XRF sensors to provide real-time bucket measurements of material as it is being excavated. The primary purpose of the measurements is to predict the grade of material in each bucket. These grade predictions are integrated with the mine's fleet management system to provide synchronous ore sorting to optimize recovery and reduce the quantity of waste processed by the mill — adding both economic and environmental value. Further investigation of these XRF spectra using key mine data sets and the application of techniques from machine learning has led to the discovery of relationships between extracted features of the spectra and other intrinsic rock properties. A noteworthy example is the classification of NAG and PAG waste, which can be used to sort trucks for optimal waste management with significant downstream environmental implications. Another is the classification of material by copper mineral speciation, which is consequential for mill processing performance. These associations are identified by engineering problem-specific feature sets, leveraging physical and geological knowledge as a starting basis to extract informative predictor variables from the XRF spectrum that are both directly and indirectly related to elemental composition. Care must be taken to account for confounding factors such as the spatiotemporal correlation of these properties, and these models can be validated by measuring the relationships between predictions and relevant mill processing KPIs downstream. Here we discuss the methodology used in developing and validating a rock property prediction model with XRF data, as well as the broader implications for sustainable mining.