Rapid Cu-Porphyry Indicator Mineral Characterization by µXRF: A Case Study Investigating Benchtop-µXRFs as a Prospective Automated Indicator Mineral Analytical Tool

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Developing rapid and cost-effective methods for characterizing indicator minerals is beneficial to the minerals exploration industry facing the challenge of exploring for deposits buried under sedimentary cover. Porphyry indicator minerals from stream sediment samples proximal to the Lorraine alkalic copper deposit in northern British Columbia, Canada, were characterized by scanning electron microscopy and benchtop micro-X-ray-fluorescence (µXRF) at the Mineral Deposit Research Unit, University of British Columbia. The aim of this analysis was to identify and characterize indicator minerals common to copper porphyry deposits and develop improvements to existing methods. Several different mineral sample preparation, analytical instrumentation, and mineral identification techniques were tested and compared. Scanning electron microscope characterization of heavy mineral concentrates fines (50-250 µm) proved to be an effective, but timely and costly, quantitative indicator mineral method. Indicator minerals' modal mineralogy, grain counts, grain size, grain shape, inclusions, and association were determined. Benchtop µXRF characterization of porphyry indicator minerals was found to be a promising tool to aid in exploring for porphyry copper deposits under sedimentary cover. Several key porphyry indicator minerals were readily visually identified by µXRF chemical maps (apatite, zircon, rutile, magnetite) in the prepared heavy mineral concentrates fines. Mineral identification was also rapidly derived from unquantified µXRF counts data of compositionally distinct indicator minerals using simple and interpretable unsupervised machine learning methods. Finally, random forest supervised machine learning methods were found to have the potential to assist in quantitative porphyry indicator mineral identification by µXRF, addressing difficulties in identifying minerals by µXRF due to multi-mineral mixed pixels.