

Geochemical Exploration for Oxide Copper in a Regolith-Dominated Terrane Using pXRF Analyses of Soil

Michael F. Gazley,^{1*} Louise A. Fisher,¹ Walid Salama,¹ and Lindsay Bonnett²

¹CSIRO Mineral Resources Flagship, Kensington, Western Australia 6151

²CST Minerals Lady Annie Pty. Ltd., PO Box 2029, Mount Isa, QLD, 4825, Australia

*E-mail, michael.gazley@csiro.au

Thick cover attenuates or adds complexity to the geochemical signature of mineral deposits beneath it, and is a major impediment to mineral exploration in regolith-dominated terranes. Large geochemical datasets can be effectively collected from a range of sample media using portable X-ray fluorescence (pXRF) technology to enhance the ability of an explorer to operate effectively in terranes of this nature. The work presented here is such an example with a focus on exploration for Cu oxide deposits around Lady Annie Copper mine, ~120 km NW of Mount Isa, Queensland, Australia.

It is well established that pXRF can produce reliable and robust data when appropriate workflows are followed, with very good correlations to laboratory data collected on the same samples. A <1 mm fraction was taken for soil and <2 mm fraction for lag samples sieved in the field, before being oven dried at ~100°C for ~1 hr, before being presented to the pXRF unit in a sample cup with a mylar film. An Olympus Innov-X Delta pXRF unit was used with a high-count rate detector and analysis times of 30 seconds per beam in geochem mode. Matrix-matched standards were incorporated into the sample stream at a frequency of five every 40 samples, along with blanks, duplicates, and replicates. The data were post-processed with correction factors calculated from the standards included in each sample batch. The pXRF data showed good correlation with laboratory data with discrepancies of $\pm 10\%$ for Cu and Zn and R^2 of >0.95 . While Pb data typically had a very good R^2 of >0.97 , the pXRF analyses were almost 70% lower than the laboratory data. This was found to be a result of peak pile-up and additions in the spectra for samples with Fe-rich matrices. Other elements of interest, such as Fe, Al, Ti, Ca, Mn, Rb, Sr, and Zr all performed favorably in comparisons with lab data, with R^2 typically >0.8 and variation $<20\%$ from the laboratory data; much of this deviation from the laboratory data can be explained by further examination of the matrix of the samples and emphasizes the need for site specific standards in a QAQC process for pXRF analysis.

Variable erosion has resulted in variable completeness in the regolith profile. This provides a challenge for explorers as the lateritic duricrust that would cap a complete sequence is high in Cu and other mobile metals; the underlying kaolinitic saprolite is substantially depleted in these metals. If the kaolinitic saprolite is exposed at surface, any soil sampling of this media will result in low concentrations, even though they may overlie an oxide orebody. As we demonstrate here, utilizing other elements that are collected in a pXRF analysis, alongside the elements of interest (e.g. Cu, Zn, Pb), proxies such as Ca/Al can provide insights to effectively level these data. The importance of this is evidenced by the Cu surface anomaly not being located overtop of the Ant Hill deposit, but rather on its flank. Once normalized to regolith profile location, this anomaly straddled the deposit.