Mineralogy Characterization by X-ray Energy Dispersive Spectrometry, X-ray Diffraction, and X-ray Fluorescence Spectrometry Applied to Ore Processing

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Mineralogical characterization is critical to the optimization of extraction circuits, as mineralogy determines the chemical and physical behavior of the ore as it is processed, and thus the final extractability of the target metal. While bulk mineralogy is important, target metals (e.g., Au) are frequently in low abundance mineral phases necessitating the concurrent identification and quantification of trace mineral phases. In this study, we sampled three different ore extraction circuits (Au, Cu, and Au/Ag-Te) throughout the extraction processes at different stages starting with the mill feed. We analyzed the samples with four mineralogical characterization methods to compare their utility across the varied mineralogical assemblages and grain sizes these samples presented. Each analytical approach—Thermo Noran System 7 (NSS) Compass Energy Dispersive Spectrometry (EDS) phase identification package, Thermo NSS EDS automated feature sizing analysis, bulk mineralogy results from powder X-ray Diffraction (XRD), and calculated mineralogy from bulk X-ray Fluorescence (XRF) spectrometry elemental abundances—yielded broadly similar results for each sample. However, there are critical differences between the techniques. Low abundance mineral phases are identified by EDS methods and sometimes XRF, but not bulk XRD. Comparing EDS feature sizing results of two samples, both with ~50 ppm Te via XRF, one from the Au mill and one from the Au/Ag-Te mill, yield different Te deportments. Feature sizing shows that the Te in the Au extraction sample is found primarily in tetradymite (Bi_2Te_2S), while insufficient Te-rich minerals are found in the Au/Ag-Te sample, hinting that the Te may be present as a trace constituent in another mineral phase. Iterating between all techniques yielded the greatest utility in identifying and quantifying mineral phases. These techniques complement one another and together provide a more complete mineralogical characterization, which is essential in assessing the deportment of trace elements during ore extraction processes.