

Rapid Characterization of Mine Waste and Tailings Using Radiometric Surveys From Airplanes, Helicopters, and Drones

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Waste and tailings from older mine sites may contain extractable mineral resources, but a key challenge to their evaluation is compositional heterogeneity, which can be difficult to characterize through sample analyses alone. Here we use airborne radiometric methods (gamma-ray spectrometry for K, Th, and U in the upper ~0.5 m) at multiple scales to assist rapid characterization of mine waste features. Recent airplane and helicopter radiometric surveys, such as those collected through the U.S. Geological Survey Earth Mapping Resources Initiative, resolve features at scales of several hundred meters and have shown K, Th, and/or U anomalies over certain waste and tailing piles. Some anomalies correlate with commodities of interest, such as Th with rare earth elements. Finer-scale resolution can only be achieved with lower sensor heights and narrower line spacing, so we deployed a recently developed lightweight Csl radiometric sensor on board a small uncrewed aircraft system (sUAS), i.e. drone. This system was flown at heights of 2-3 m over several mine waste, tailings, and stock piles from copper and silver mines in southwestern New Mexico that were also part of an extensive geochemical sampling campaign by the New Mexico Bureau of Geology and Mineral Resources. The drone radiometric system showed 2-10 m-wide zones where K, Th, or U were elevated 2-10 times the surrounding material. Radioelement variability across different sUAS surveys correlated reasonably well with average geochemical values for each feature, but at individual sample locations the sUAS data only sometimes correlated with sample geochemistry. This is probably because the samples showed significant chemical variability at scales < 1 m, whereas the sUAS surveys supplied averages over several meters. This system thus contributes locally composited, semi-continuous geochemical information that cannot be obtained via sampling and maps local anomalies that may be of interest for further examination.