

Mine Level Isotopic Fingerprinting of Gold

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With sustained high gold prices, mining activity has increased globally, including operations linked to labor exploitation and violence. In response, a growing body of research has applied geochemical and statistical approaches to help determine the provenance of gold and support efforts to reduce the presence of illegally mined conflict minerals in the supply chain. A combination of scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDS), electron probe microanalysis (EPMA), and laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) have been used to measure the trace element composition of natural gold. These data form trends in spatial distribution of trace elements in gold, but do not statistically differentiate samples at the deposit scale. Here, we use copper (⁶³Cu, ⁶⁵Cu), silver (¹⁰⁷Ag, ¹⁰⁹Ag), and lead (²⁰⁴Pb, ²⁰⁶Pb, ²⁰⁷Pb, ²⁰⁸Pb) isotope compositions of 200 gold samples from around the world with known provenance to test the hypothesis that isotope ratios of $\delta^{63}\text{Cu}$, $\delta^{109}\text{Ag}$, 208/204Pb, 207/204Pb, and 206/204Pb, can be used to fingerprint the source of gold from individual deposits.

Gold samples were dissolved via complete acid digestion, analyzed using liquid ICP-MS to determine trace element concentrations, separated using column chromatography, and analyzed using multi-collector (MC)-ICP-MS to determine stable Cu, Ag, and Pb isotope abundances. The concentration data will be compared to published LA-ICP-MS data. The isotope data will be statistically analyzed using principal component analysis (PCA) to determine if the isotope ratios are statistically unique and can be used to fingerprint the mine origin of gold. If successful, this study will aid in the development of a global library of the isotope composition of gold that has direct implications for tracing gold in the supply chain and decreasing the supply of illegally mined gold. Isotopic fingerprinting of gold in stream sediments also has the potential to be used as a pathfinder tool for gold exploration.