Identifying hosts for non-target uranium and associated radionuclides in copper ores and concentrates

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Mesoproterozoic copper ores in South Australia contain low to moderate concentrations of uranium. Dependent on concentration, the uranium may be an economic by-product, a contaminant, or both. Daughter products of ^{238}U and ^{232}Th decay are also present in the ores. However, due to the distinct physical and chemical properties of each daughter radionuclide, including the short half-life α-emitters, ^{210}Po and ^{210}Pb (hereafter ^{210}RN), these may decouple from the parent uranium to form, or be incorporated into, different minerals. This process may be exacerbated by geological events causing different re-mobilization pathways for different elements. Similarly, parent-daughter separation is also possible during ore processing, and has the potential to create smelter dusts or other processing products enriched in ^{210}RN relative to ^{238}U. There is currently limited available data about mineralogical hosts for ^{210}RN, making prediction of its location in complex, fine-grained ores or concentrates a significant challenge. Information on potential mineral hosts for ^{210}RN is, however, essential to guide attempts to eliminate or reduce unwanted ^{210}RN in copper concentrates and processing wastes.

Concentrations of ^{210}RN are so low (fractions of one part-per-trillion) that their presence in individual minerals cannot be measured directly by conventional microanalytical methods. In order to understand their distribution in millfeed and concentrates, we thus rely on indirect information drawn from assays and RN measurements on bulk material, comprehensive mineralogical characterization at micron scales, and determination of concentrations of proxy elements and isotopes within the crystal lattice of specific minerals. SEM analysis at maximum magnification provides identification of potential sub-μm-sized ^{210}RN-bearing mineral grains, including nanoparticles within sulfides and gangue minerals, and at mineral-mineral boundaries. These data and future FIB-SEM and TEM investigations will assist in building a robust qualitative model for ^{210}RN deportment within ore and an understanding of the different pathways responsible for changes in that deportment as a response to geological events and ore processing.