Towards an understanding of the mineralogical deportment of ^{210}Po and ^{210}Pb in geological samples

N.J. COOK[1,2*], D. SCHMANDT[1], M. ROLLOG[1,3], D. LANE[2], C.L. CIOBANU[1], K. EHRIG[4], S. GRANO[2]

[1]School of Chemical Engineering, Univ. of Adelaide, Adelaide, SA 5005, Australia (*Correspondence: Nigel.Cook@adelaide.edu.au)
[2]Institute of Minerals and Energy Research, University of Adelaide, Adelaide 5005 SA, Australia
[3]School of Physical Sciences, University of Adelaide, Adelaide 5005 SA, Australia
[4]BHP Billiton Olympic Dam, Adelaide, SA 5000, Australia

There is scant published information on the mineralogical deportment of ^{210}Po and ^{210}Pb in geological samples. This knowledge is a critical first step for identifying the hosts for ^{210}Po and ^{210}Pb in U-bearing copper ores, copper concentrates and other products of mineral processing. We have undertaken an extensive review of published information on the distributions of ^{210}Po and ^{210}Pb in geological and related anthropogenic materials. Insights from the concentrations and distributions reported from volcanic, hydrothermal, sedimentary (marine, lacustrine, deltaic and fluvial) environments, soils, peats and coals, provide valuable insights into the transport mechanisms and reasons for decoupling of ^{210}Po and ^{210}Pb from parent uranium. Data on ^{210}Po and ^{210}Pb distributions in a range of anthropogenic materials, including products of uranium mining, phosphate production, oilfield scales, smelter slimes, fly ash, mineral sands etc., equally provide a range of valuable indirect data that can help define a likely list of potential hosts.

Data from a wide range of sources points to ^{210}Po and ^{210}Pb being potentially hosted within: galena (PbS), sulphates such as barite and anglesite, phosphates, and carbonates. A potentially significant role for Bi-, Se- and Te-bearing compounds, e.g. clausthalite (PbSe), altaite (PbTe), Pb-Bi-sulphosalts and Bi-chalcogenides) cannot be ruled out. Evidence for the retention of radiogenic Pb within parent U-minerals leads us to also consider whether ^{210}Po and ^{210}Pb may potentially occur locked within the structure of U-phase. Last but not least, indirect evidence from environmental studies raises the possibility that ^{210}Po and ^{210}Pb may complex with some macromolecular organic compounds, and may also occur as nanoparticles absorbed onto the surface of clays, Fe-oxides, and possibly also carbonates.

Despite the likely complexity and diversity of ^{210}Po and ^{210}Pb distribution in most samples, such information can guide our multi-disciplinary approach to identifying the most significant mineralogical hosts.