In situ mapping of radionuclides in Olympic Dam copper concentrates by nanoSIMS

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The Olympic Dam iron oxide-copper-gold-uranium deposit, South Australia, not only contains significant copper, gold and silver resources, but is also the world's largest uranium resource. Complex ore processing strategies endeavour to extract target metals and separate them efficiently from unwanted components. Of particular interest during copper concentrate production are the ^{238}U decay chain radionuclides (RNs) ^{226}Ra, ^{210}Pb, and ^{210}Po, which have maximum concentration requirements far below minimum detection limits for most *in situ* analytical techniques. Fine- to ultrafine-grained ore textures prohibit conventional mineral separation and bulk activity measurements, hindering identification and targeting of RN host minerals for removal.

The CAMECA nanoSIMS platform provides the capability to map RN distributions *in situ*, at sub-micron spatial resolution, within individual minerals. Sample grains collected from various stages of processing were embedded in epoxy resin, polished, and mapped for up to 21 isotopes. Evaluation of the 4000+ resulting isotope maps has provided a wealth of information regarding the deportment of radionuclides in the deposit and throughout the processing stream. Uranium-bearing phases (uraninite, coffinite, uraniferous thorianite, euxenite) tend to retain all daughter isotopes, albeit to varying degrees. Phosphates (xenotime, apatite, monazite) readily incorporate Th, and usually retain the rest of the decay chain. Sulphates (baryte, anglesite, aluminium-sulphate-phosphates) can uptake substantial amounts of ^{226}Ra and ^{210}Pb, especially during acid leaching. Other minerals, including hematite, fluorite, rutile, molybdenite and covellite have been identified as potentially

significant reservoirs of RNs at Olympic Dam. Recognition of the carrier phases for specific radionuclides facilitates their targeted removal.