ALTA 2022 26
20-27 May | Perth, Australia | Online

SYNCHROTRON ANALYSES: ADDING VALUE TO CHARACTERISATION OF NICKEL AND OTHER CRITICAL ENERGY-METALS IN MINERAL ORE AND MINING WASTES

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ABSTRACT

Good decisions about tailings re-processing or their environmental risks rely on the best information regarding metal solubility, toxicity, and association with mineral or organic phases. To this aim, understanding the chemical form of metals such as Ni, Cu or Cr is crucial.

Typical analyses of ores and tailings provide information about concentration (e.g. ICP-OES, XRF) and mineralogy (X-ray diffraction). However, when materials are complex, contain co-occurring metals, or include poorly crystalline phases, these methods can be insufficient to form the comprehensive view required. ANSTO's Australian Synchrotron has a range of x-ray spectroscopy tools that in addition to identifying elements, can determine the chemical form and state of many metals at trace (ppm) levels in complex materials with minimal or no sample preparation. X-ray and infrared microscopy allows us to map elemental distribution, oxidation states and organic species in heterogeneous samples with micron-level resolution.

We show how synchrotron tools can readily reveal the oxidation state and speciation of nickel in mining waste – complex and dynamic materials different from the original ore with chemistry that continues to be altered via weathering reactions during storage. As an example, nickel originally associated with sulphide or silicate minerals is quickly mobilised into new secondary mineral phases. This insight is key in better understanding environmental risk and opportunities for nickel recovery.

We also show how we can see organic phases interacting with minerals, metal co-location in complex materials, and the presence of trace mineral phases, using examples from our suite of synchrotron techniques. Finally, we touch on our newest, cutting-edge capabilities and how these will benefit the mining and metallurgical industry.

Keywords: synchrotron, mine tailings, trace metal geochemistry, X-ray spectroscopy, microscopy, critical metals, tailings reprocessing, environmental risk