Evaluating Circular Economy Solutions for Critical Minerals Supply

B Currie[1]

1. Business and Project Development Manager - Metals, Sedgman, Brisbane Queensland 4010.
   Email: Bernadette.currie@sedgman.com

Keywords: secondary processing, circular economy, hydrometallurgy, critical mineral byproducts

ABSTRACT

The net zero energy transition is driving the demand for specific critical metals, which also presents an opportunity to define emerging supply chains. Elements as Cobalt, Rhenium, Scandium, Selenium, Indium, Cadmium, Tellurium, Gallium, Molybdenum and Rare Earths are typically associated with the mineralogy of base metal ore deposits (Cu, Zn, Al, Ni), and where primary mining is or has already been undertaken, these valuable byproducts in the feed ore were historically not targeted, with some reporting to the concentrate or product and others discarded in mine waste.

Secondary processing, concurrent to primary mining or at the end of asset life, poses a unique opportunity to expand domestic resource extraction and processing capacity of critical metals. Currently, proposals to reprocess fresh / historical tailings or smelter-refinery waste streams (to chase a byproduct not originally pursued) are generating commercial interest. This paper explains how options for a 'circular economy' solution to critical mineral supply may be made viable.

One of the key benefits of secondary mining, is reduced impacts to ecosystems, offsetting those caused by primary mining. Additionally, cashflow can be generated from recouping the residual value of the original elements that remain due to poor past plant performance, a 'throughput over recovery' operating philosophy, or intermittent periods of high losses. However, realising value by simply directing mine waste material back to an existing or a re-start of a former processing facility has already been tested, and shown in most cases to fail. There was a physical / mineralogical reason material was originally rejected, and development of a new flowsheet is likely required. The challenges facing new plants to accomplish the reprocessing aim include: marginal economic recovery, flowsheet complexity, challenging material selection, legacy environmental liabilities, land rights and permitting issues, extensive test work or piloting requirements, long development timelines and stringent product specifications.

Also, the positive impact of reprocessing from a waste reduction perspective is low, as it does not typically materially reduce final waste volumes. For most commodities mined from secondary sources of ore, only partial grams per ton are extracted and the volume of waste generated may increase due to requirements for neutralisation or detoxification. The waste reduction opportunity for reprocessing is realised from alternate treatment of tailings or sludge once handled, which in some cases can be enabled by the cashflow derived from sale of recovered primary and byproducts.

Increased production of critical minerals, the raw materials of low-emission energy generation and storage technologies, is needed to meet sustainability targets. Options for 'circular economy' supply solutions may be viable, but these uses are highly dependent on the host mineralogy, mine waste or tailings characteristics and the will of operating miners to explore secondary prospectivity in their commodity pipelines and asset portfolios.

A logistical, technical, environmental, and economic evaluation of secondary processing approaches is key for successful, implementable outcomes. This paper outlines theorical case studies from magmatic or volcanogenic massive sulfide deposits containing significant enrichments of critical elements and reviews applicable recovery approaches, explaining the advantages, disadvantages, and cost considerations of each. The outcome sought through secondary byproduct recovery is improved utilisation of finite mineral resources and increased volume of specific minor metals and metalloids to responsibility meet demand.