A Workflow to Assess the Critical Mineral Potential of Tailings: Case Study from the Red Dog Mine in Northwest Alaska, USA

Nina Zaronikola[1], Joseph Trouba[1], Elizabeth A. Holley[1], Priscilla P. Nelson[1], Erik Spiller[1], Robin Bullock[2], James Frost[3], Michael Gonzales[3], Lance Miller[4]
1. Colorado School of Mines, Golden, CO, USA, 2. Montana Technological University, Butte, MT, USA, 3. Teck Resources Limited, Anchorage, AK, USA, 4. NANA Regional Corporation, Kotzebue, AK, USA

The elements Co, Ga, Ge, In, Te and V are essential for green energy technologies and are among others characterized as “critical minerals” by the USGS due to their widespread application in global and domestic industries, relatively low abundance, geographic dispersion, and the potential for supply shortfalls. The goal of our project is to identify new approaches for responsible supply of these commodities.

We conducted an assessment of critical mineral recovery potential at the Red Dog Mine, located in the DeLong Mountains, northwestern Alaska. In 2021, Red Dog produced 607,000 tonnes of Zn contained in concentrate. The Red Dog deposit is a black shale-hosted, sedimentary exhalative Zn-Pb deposit (SEDEX) deposit. It is suggested that trace elements, like Ga, Ge, and In along with other critical elements often found in association with zinc could occur as impurities in sulfide minerals (e.g., sphalerite) in various type deposits, including SEDEX deposits.

Here we present an interdisciplinary workflow that we have developed to assess the potential for critical mineral recovery from tailings, using Red Dog as a case study. First, we obtained materials indicative of Red Dog Mine’s tailings. This was followed by mineralogical and chemical characterization of the tailings, using optical microscopy, SEM, ICP-OES, and LA-ICP-MS elemental mapping to determine critical element content and their host mineral phases. Based on mineralogical characterization, we performed a metallurgical study investigating potential physical separation and hydrometallurgical processes for critical element recovery and enrichment. New fundamental knowledge generated from such workflows will help predict the economic recovery of critical minerals from tailings at sites worldwide.