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Geochemical and mineralogical characterisation of REE-bearing mine tailings in a neutral drainage environment, Northern Sweden

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The demand for critical raw materials (CRM) is expected to increase mining activities in the near future, with subsequent increased production of mining waste. Mine waste may pose environmental risks, due to potential contamination, if not managed properly. While research has focused on acid mine drainage (AMD), less is known about the geochemistry of metals in neutral pH conditions. Furthermore, research on the behaviour of rare earth elements (REEs) in mine waste is limited, despite being classified as emerging contaminants of concern.

This study examines the distribution and mobility of CRM, such as REEs and cobalt, in tailings from the LKAB Kiruna iron ore deposit in northern Sweden. LKAB is considering several changes in the mine waste management practices due to i) need for more efficient waste handling and ii) the potential extraction of REEs from waste stream generated during iron ore beneficiation. Therefore, a comprehensive understanding of the current stability of CRM in tailings is necessary to develop effective mine waste management strategies to prevent the release of non-traditional pollutants into the environment.

Tailings subsamples from a 10-meter-long vertical tailings core were subjected to optical microscopy, XRD, SEM, and whole rock geochemistry. Groundwater samples from the drilled location were also analysed using ICP-SFMS. By examining morphological changes of minerals with depth and location within the water-saturated active tailings storage facility (TSF), the impact of pH and redox conditions was determined, and weathering processes that have occurred during ca. 50 years of storage in neutral (pH 8-9) anoxic conditions were evaluated. The tailings were enriched in P, F, Fe, Si, S, and REEs (La and Ce). Significant correlations were observed between Ca, P, ∑REE, and As throughout the profile, as well as S and Co. The groundwater concentration of ∑REEs, As and Co were low (average: 0.30, 0.22, 1.51 µg/L, respectively). These preliminary findings indicated that CRM in the present tailings are immobile. Further studies will evaluate how the planned changes in the mine waste practices might impact the mobility of the elements.