

# **Ensuring a responsible, sustainable, and stable supply of critical minerals: a multidisciplinary approach to identify data gaps and prioritize research**

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Critical minerals (CMs) are minerals or elements with vulnerable supply chains that are essential to the security of a country. An understanding of the environmental behavior and effects of CMs is imperative for their safe and environmentally responsible development. Yet with 50 commodities on the most recent CM list for the United States (U.S.) and similarly high numbers for other countries, *how do we prioritize them for study?* Any prioritization must be thorough and allow for the identification of data gaps and most pressing research needs. Given the urgency for reliable and environmentally responsible supplies of CMs, more guidance for prioritization needs to be available soon. Here we suggest and describe a multidisciplinary approach to prioritize CMs for study.

For CM study prioritization, the entire life-cycle should be considered, and include criteria such as criticality, geochemistry, bioavailability, and toxicity. Metrics for the quantity and content of data available for each CM and criterion must be relatively easy to obtain. For example, databases such as the U.S. Environmental Protection Agency's ECOTOX database can provide data on toxicity in lieu of full literature searches for every CM. In this case, the database shows 29 of the 50 critical commodities having 2 or fewer available acute toxicity values, thus exposing a substantial data gap for toxicity. Such databases do not include 100% of published toxicity data and require updating to remain current; however, they are useful first filters to identify CMs with scarce data and/or the potential for moderate to high toxicity. By developing analogous metrics for the other prioritization criteria, researchers can focus on those CMs that are most critical, mobile in the environment, bioavailable, or toxic, or some combination of these criteria. Such an understanding of data availability is necessary to prioritize timely and thoughtful research to meet the global community's demands for sustainable and environmentally responsible supplies of CMs.