

## **The Lure and Liabilities of Co-Production**

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Many of the metals used in industry today are obtained as by-products (sometimes also described as co-products or companion products) from the extraction of primary minerals such as iron, nickel, copper, zinc and lead. Despite the importance and occasional dominance of co-production in the supply chains of many metals, however, very few mines identify themselves as multiproduct operations. The main examples of multiproduct facilities are coltan mines, producing niobium and tantalum, and rare earth mines, producing several individual rare earth elements or mixtures of them. These are cases in which each of the product streams contributes a significant fraction of the mine's revenues. In the more typical case, a copper mine, for example, may generate molybdenum and tellurium as by-products but the quantities of the by-products are small and they generate only a small fraction of the mine's revenues.

For many critical or potentially critical materials, the quantities present as companion elements in ores of other primary metals can be large enough to meet global needs. It is therefore attractive to consider co-production as a means of ameliorating shortages of critical materials.

We consider a few simple case studies to identify the advantages and disadvantages of pursuing a co-production strategy versus creating single-product facilities, with the goal of identifying key technical questions and research needs.

While the analysis necessarily varies case by case, some consistent features emerge in the competition between the business cases for co-product and single-product facilities. Co-production has a number of advantages from a cost perspective, but also involves a distinct set of risks that have to be evaluated for each case. We will identify and list the items that need to be considered in evaluating co-production opportunities.

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