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Critical Minerals in Porphyry Cu-Mo and other Intrusion-related Deposits of the Western United States

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The U.S. reliance on imported mineral commodities, manifested during the world and cold war eras, has expanded to include 50 largely imported “critical” minerals (CM) deemed vulnerable to supply disruption. In conterminous western states, numerous chalcophile, lithophile, and siderophile CM are variably concentrated in porphyry Cu-(Mo) (PCD) and other intrusion-related deposits.

Production and reserves of Co, Ni, PGE, Sn, and V in these deposits are mostly insignificant to small, equivalent to months or several years of recent annual domestic consumption (2016-2020). Significant inventories (≥ 2 years of consumption) of Al, Sb, potash, and W in unmixed skarn, replacement, vein, and lithocap deposits are ~ 2 to >8 years of consumption, whereas decades of consumption of As, Bi, fluorite, Ga, Ge, and In exist in these deposit types. Based on concentrations of CM in reserves and captive refinery records, the largest inventories of Sb, As, Bi, Re, and Te, and possibly Ga, Ge, In, Sn, Ti, W, and Zr, are in PCD in Alaska, Idaho, Utah, Arizona, and Montana, and in interim products of refineries that processed PCD for recovery of Cu and Mo, and episodically Re and Te.

Recovery of Sb, As, Bi, Re, and Te, and possibly other CM during concentration and refining of Cu and Mo minerals in ores of operating mines and in unmixed reserves is a near-term strategy for reduction or elimination of import reliance. CM, often undetectable in ore, are concentrated (hundreds of ppm to percent) in electrorefining slimes and concentrator tailings, and other than Re and Te, have not been routinely recovered. Because of the large masses of ore processed annually and reserves (hundreds of Mt to Gt), inventories of CM in PCD represent decades to centuries of consumption. However, without recovery processes and mining plans, these inventories do not constitute consumable supplies.