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Mapping Critical Minerals in Mineral Systems with the Critical Minerals in Ores (CMiO) Database

George N. Case[1], Evgeniy Bastrakov[2], Garth Graham[3], Albert Hofstra[3], David Huston[2], Christopher Lawley[4], Vladimir Lisitsin[5], Bronwen Wang[1]
1. U.S. Geological Survey, Alaska Science Center, Anchorage, AK, USA, 2. Geoscience Australia, Canberra, ACT, Australia, 3. U.S. Geological Survey, Geology, Geophysics, and Geochemistry Science Center, Denver, CO, USA, 4. Geological Survey of Canada, Ottawa, ON, Canada, 5. Geological Survey of Queensland, Brisbane, QLD, Australia

Base- and precious-metals are the primary focus of most mineral systems, yet many critical minerals (CMs) occur as co- or by-products. Understanding the distribution of CMs in mineral systems is crucial to determine if they are concentrated in ores, waste, or unmined parts of the system. The Critical Minerals in Ores (CMiO) database, compiled by Geoscience Australia, the U.S. Geological Survey, and the Geological Survey of Canada as part of the Critical Minerals Mapping Initiative, contains high-quality, geospatial geochemical data from ore deposits around the world. Each deposit has been classified using a consensus nomenclature, facilitating global comparisons.

Preliminary investigation of porphyry and iron oxide-Cu-Au/iron oxide-apatite (IOCG/IOA) systems highlights differences in CM abundance within mineral systems, and spatial variations within individual deposits. The database confirms that porphyry Cu ± Au ± Mo systems are enriched in rhenium (Re), platinum (Pt), palladium (Pd), selenium (Se), and tellurium (Te). In the Pebble Cu-Au-Mo porphyry deposit (Alaska, USA), Re and Se abundances are broadly coincident with the East and West Cu-Au-Mo orebodies, while Te enrichment is highest immediately outside of the orebodies. A similar pattern is observed in the CuMo porphyry deposit (Idaho, USA), in which mineralization is zoned from Mo-Cu in the core to peripheral Te. Iron oxide-Cu-Au systems are enriched in a broader range of CMs that include cobalt (Co) and light rare earth elements (LREEs). Overall, cobalt is enriched in magnetite-dominant IOCG systems such as Ernest Henry and the E1 Group (Queensland, AUS), whereas LREEs are enriched in IOA and hematite-dominant IOCG systems like Olympic Dam (South Australia, AUS). However, IOA mineralization beneath or adjacent to Cu-Au orebodies in both types of IOCG systems can also be enriched in LREEs. The results demonstrate the utility of the CMiO for characterizing CM distribution in ore deposits.