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Re-evaluating the Mineral Potential of the Boulder-Basin District, Montana: District-Scale Geochemical Insights from Archived Samples in Support of Earth MRI

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Historic sample collections housed at state geological surveys preserve valuable critical minerals information from mining districts across the United States. When paired with modern analytical techniques, these samples can provide new insights into mineral systems that were only partially understood during early exploration. As part of the Earth Mapping Resources Initiative (Earth MRI) and National Geological and Geophysical Data Preservation Program (NGGDPP), this study evaluates the mineral potential of the Boulder-Basin District in southwestern Montana through geochemical analysis of archived samples in collections at the Montana Bureau of Mines and Geology (MBMG).

The district lies within the well-mineralized Boulder Batholith, a Late Cretaceous intrusive complex known for hosting polymetallic vein systems and porphyry-style mineralization, including the world-class Butte District. Mining began in the late 1800s and focused primarily on E-W striking gold-silver and base-metal veins, particularly near the town of Basin. Historic samples in the MBMG collections provide an opportunity to study mineralization from these mines that are now largely inaccessible.

Archived rock samples housed at the MBMG were selected for geochemical analysis through the NGGDPP, and mineralogical analysis at Montana Technological University labs. The MBMG collection includes over 20,000 specimens; 350 were identified as potential candidates for analysis, and 124 samples were ultimately submitted for whole-rock geochemistry by ICP-MS. Small samples (<300 g) unsuitable for destructive analysis were prepared as polished mounts for SEM analysis.

The resulting dataset shows consistently high metal and critical element content, with elevated copper, zinc, manganese, silver, barium, iron, and lead. Localized molybdenum enrichment identifies the presence of molybdenite-bearing zones within the district. These results demonstrate how archived geological collections can generate new exploration datasets decades after initial sampling and highlight the importance of long-term sample preservation for refining mineral system interpretations and supporting future exploration efforts.