

# SEG 2022 Conference: Minerals For Our Future

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## **New Investigations of the REE-Nb Carbonatite Deposits of Southern Ravalli County, Montana, USA**

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With funding from U.S. Critical Materials and the U.S. Army Research Lab, Montana Tech has begun a comprehensive investigation of the REE-Nb carbonatite dikes of southern Ravalli County, Montana. The district contains a large number (> 40) of thin (< 4 m), discontinuous carbonate bodies hosted by deformed and metamorphosed meta-igneous rocks (amphibolite, meta-gabbro, felsic augen gneiss) previously dated to circa 1.4 Ga. The meta-igneous complex and associated REE-rich carbonatite bodies extend into eastern Idaho, and are on strike with the Lemhi Pass Th-REE district, circa 100 km to the southeast. The meta-igneous complex is bordered to the north by relatively unmetamorphosed siliclastic sedimentary rocks of the Belt and/or Lemhi Supergroups; however, no carbonatite bodies are known to exist in the meta-sediments. The meta-igneous complex may represent a flare-up associated with the onset of Mesoproterozoic rifting. Geochemistry of channel samples (n = 40) shows a possible evolution from early magnesio-carbonatite (dolomite + apatite) to later calcio-carbonatite (calcite + barite + Mg-riebeckite), with enrichment in light REE (up to > 10 wt%  $\Sigma$ REE) and Nb (up to 0.2% Nb) in the form of monazite, ancylite, allanite, columbite, and a host of minor phases. Sparse sulfides include pyrite, pyrrhotite, chalcopyrite, Co-Ni-As sulfides, and molybdenite, the latter of which has been submitted for Re-Os dating. The surrounding mafic country rock is locally altered to coarse phlogopite ("glimmerite"). Carbonate isotopes are consistent with a magmatic origin for the dolomite-rich carbonatites, and possible involvement of high-temperature meteoric waters for the more mineralized calcio-carbonatites. More C-O-H-S stable isotope work is in progress, as well as detailed mineralogy, trace element geochemistry, field mapping, and geochronology. Other partners in this project include the U.S. Geological Survey, the Montana Bureau of Mines and Geology, and the Idaho Geological Survey.