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Idaho's Proterozoic-Hosted Copper-Cobalt Belt: Characteristics, Challenges and New Geologic Insights

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The Idaho Cobalt belt (ICB) is a 60-km-long, northwest-trending belt of sedimentary rock-hosted copper-cobalt (Cu-Co) occurrences in the Lemhi subbasin of the Mesoproterozoic Belt-Purcell basin in Idaho. The ICB hosts the only primary cobalt resources in the US and is somewhat similar to the African Copper belt, though known ICB deposits are much smaller. Mineralization is strata-bound within siltites, quartzites, and argillites of the 1.4 Ga Apple Creek Formation. Cobaltite and chalcopyrite at the Blackbird Mine are associated with biotite-rich zones. To the southeast at Iron Creek, cobaltiferous pyrite is associated with magnetite, biotite, and chlorite. Genetic interpretations are complicated by three overprinting periods of intrusion, metamorphism, and deformation: bimodal magmatism at 1370 Ma, a poorly known "Grenville" event at ca. 1200 Ma, and widespread Cretaceous magmatism. The southeast end of the belt is less affected by Cretaceous overprinting. Slack suggested that chalcopyrite and cobaltite at Blackbird were variants of IOCG-type deposits and related to the 1370 Ma plutonism, compatible with U-Pb ages on xenotime. Ongoing geologic mapping by the Idaho Geological Survey is aided by new USGS-funded airborne geophysics. Recent work on the Iron Creek deposit includes LA-ICP-MS analyses of magnetite chemistry to assess its origin, hyperspectral scanning, and geochronology and petrographic studies. Hyperspectral drill core scanning of the fine-grained rocks suggests Co-Cu zones are associated with Fe-rich chlorite alteration. Magnetite and Co-bearing pyrite formed prior to the tight folding and stretching deformation and predate or are coeval with metamorphic biotite having a minimum age of 938 Ma ($^{40}Ar/^{39}Ar$). Magnetite compositions are compatible with an IOCG origin, though the metals may have been enriched earlier in the basin's evolution. The ICB is illustrative of the many challenges to critical mineral extraction, including economics and ESG issues.