Subtle Potassic Alteration as a Vector for Mineralization in the Silvertip CRD, Northern British Columbia

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Carbonate replacement deposits (CRDs) are significant sources for Pb, Zn, Ag, and potentially In. CRDs represent the distal expression of magmatic-hydrothermal alteration systems where the causative igneous intrusions remain often undiscovered. Exploration efforts are often hampered due to a lack of visible alteration phases in the carbonates hosting the ore lodes and rely primarily on systematic mapping of variations in δ13C and δ18O isotopic compositions. Isotopic variations can extend well beyond calc-silicate skarn alteration due to the relatively fast propagation velocity of isotopes compared to silicate- or sulfide-forming reactions. In many CRDs, siliciclastic shales form the hanging wall, representing an impermeability layer to the mineralizing fluid, promoting lateral fluid migration and formation of subhorizontal, tabular ore bodies (mantos). Mantos often occur along the contact between carbonates and siliciclastics. Locally significant mineralization can occur in the hanging wall, usually as high-angle veins.

The Ag-Pb-Zn±Cu Silvertip deposit in northern British Columbia, Canada, shows near-vertical, fault-related (chimneys), and manto-style mineralization hosted by the Middle Devonian McDame limestone. The Late Devonian Earn Group shales at Silvertip overlie the McDame Group. We show that subtle potassic alteration can be tracked in the Earn Group when carefully accounting for base metal enrichment due to redox processes in black shales. The potassic alteration correlates spatially with δ34S values in CRD-related sulfides centering around 0 ‰ in the Earn group, δ18O values from carbonate veinlets approximating 11 ‰, and mineralization containing increasing amounts of chalcopyrite and bursaite (Pb5Bi4S11(Ag)), the latter exsolving native bismuth.

These results indicate a progressively dominant magmatic fluid and an increasing water/rock ratio, likely linked to closer proximity to the fluid-releasing intrusion. In the absence of volcanic or intrusive rocks, subtle chemical variations detectable with a p-XRF handgun can help identify potassic alteration and define fluid-flow paths toward a magmatic-hydrothermal fluid source.