The Successful Application of Stream Sediment Geochemistry as an Exploration Tool for As-Bi-Co-Cu-Fe-Ni Mineralisation in Volcano-Sedimentary Settings

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Cobalt (Co) is essential in the development of batteries for carbon-neutral technologies, such as plug-in hybrid electric vehicles. Despite this criticality, primary sources of Co are limited, typically sourced as a by-product within other critical and base metal deposits across a range of metallogenetic conditions. Understanding Co ore formation styles and developing rapid-assessment exploration workflows, making use of low-cost, high-reward tools, is crucial to the identification of future new deposits. Within this remit, we utilize the UK Geochemical Baseline Survey of the Environment (G-BASE) stream sediment geochemical data set to demonstrate its successful applicability as a lithogeochemical mapping and exploration tool for As-Bi-Co-Cu-Fe-Ni mineralisation in the UK Lake District.

Using a combined unsupervised-supervised statistical approach, we reduced the dimensionality of the G-BASE data, resulting in geochemical maps that correlate strongly with regional, 50k-scale geological boundaries for each of the major lithological groups: Skiddaw Slates, Borrowdale Volcanic Group (BVG), and Ordovician-Devonian Plutonics. These maps provide average lithogeochemical values for major and trace elements. Using these, we identified combined anomalies for As-Co-Cu-Ni, correlated these with available exploration-related data, identifying 10 prospective areas for Co-bearing mineralisation, four of which align with previously recorded Co mineralisation.

Upon visiting six of the prospective sites, base metal sulphides were identified as disseminations in quartz-chlorite veins or the local volcano-sedimentary host rocks. Bulk geochemical concentrations of host rock and vein material were then measured. Comparison of these values with the modelled G-BASE values indicates relatively similar concentrations of major and trace elements, with slight overestimations of Bi, Co, Cu, Pb, S, and Zn in the model but still within acceptable boundaries. Furthermore, detailed mineral characterisation of three sites (Scar Crags, Dale Head North, Ulpha) link the mineralisation to "Five-Type" vein systems, demonstrating the applicability of this workflow to exploration in similar, more economic regions globally.