

Integrated Mineral Systems Approach for Target Generation in the Kunene Craton-Margin (Namibia): Implications for Ni–Cu–PGE and Sediment-Hosted Cu–Co Exploration

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Mineral exploration is increasingly challenged by declining discovery rates and the need to target concealed mineral systems. This study presents an integrated, mineral systems-based approach applied to the Kunene craton-margin setting (northern Namibia), aimed at improving target generation for Ni–Cu–PGE and sediment-hosted Cu–Co mineralization.

The workflow integrates multi-disciplinary geoscientific datasets, including regional geology, structural interpretation, multi-element geochemistry, and potential field geophysics (magnetic and gravity data). Rather than focusing on isolated anomalies, the approach emphasizes system-scale understanding, including metal source, transport pathways, depositional traps, and preservation conditions.

Structural analysis identified major crustal-scale lineaments and deformation corridors controlling magmatic intrusions and fluid flow. Geochemical datasets were statistically evaluated to define element associations and coherent anomaly clusters consistent with the proposed mineral system. Geophysical data were used to detect subsurface mafic–ultramafic bodies and structural discontinuities, providing critical constraints on the lithospheric architecture.

All datasets were integrated within a GIS-based multi-criteria framework to produce a prospectivity map and hierarchical ranking of exploration targets. The results highlight several high-priority zones characterized by strong convergence of structural, geochemical, and geophysical indicators.

This study demonstrates that exploration effectiveness can be significantly improved by transitioning from anomaly-based targeting to a mineral systems approach focused on data integration, uncertainty management, and geological coherence. The methodology is transferable to other underexplored regions, particularly in craton-margin settings, and provides a robust framework for decision-driven exploration in the search for critical mineral resources.