

Integrated Airborne Geophysics and Multicriteria Prospectivity Modeling of Pegmatite and Carbonatite Complex in NW Oaxaca, México

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Rare Earth Elements (REEs) are essential to advanced technologies and the global energy transition; however, North American supply remains limited, underscoring the need for new exploration targets. This study assesses the REE potential of the Oaxaquia microcontinent in southern Mexico, a Mesoproterozoic Grenvillian terrane characterized by anorthosite–mangerite–charnockite–granite (AMCG) suites and extensive pegmatite and carbonatite intrusions.

Field observations, petrographic analysis, and ICP-MS geochemistry reveal that pegmatites in northwest Oaxaca are spatially associated with carbonatites and show significant enrichment in total REEs (>2,000 ppm), accompanied by elevated uranium (U), thorium (Th), and potassium (K). These mineralized systems exhibit moderate radioactivity and structural control consistent with regional tectonic fabrics.

High-resolution airborne magnetic and radiometric datasets were integrated with field and geochemical data to improve exploration targeting. Signal enhancement techniques, including the first vertical derivative, the analytic signal, CET grid analysis, and Euler deconvolution, delineate five magnetolithologic domains. Elevated magnetic responses (>400 nT/m) are interpreted as potential intrusive centers, with Euler solutions indicating depths >150 meters. Radiometric signatures, especially potassium/thorium (K/Th) ratios and ternary responses, identify zones of potassic alteration that are spatially coincident with mapped A. A multicriteria targeting approach utilizing the Analytic Hierarchy Process (AHP) was employed to integrate geophysical, structural, and geochemical indicators. The resulting prospectivity model identifies multiple high-priority zones where REE enrichment correlates with geophysical anomalies and structural corridors.

This integrated workflow demonstrates the effectiveness of combining airborne geophysics with decision-support methods to delineate economically significant REE targets, establishing the Oaxaquia terrane as a prospective frontier for critical mineral exploration in North America.