

Structural and Geophysical Controls on Rare-Element Pegmatite Emplacement in the Alto Ligonha Province, Mozambique

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Rare-element pegmatites of the Alto Ligonha Pegmatite Province (northeastern Mozambique) represent one of the most important LCT-type pegmatite systems worldwide, hosting economically significant mineralization of Li, Ta, Nb, and Be. Despite their importance, the structural controls and geophysical signatures governing their emplacement remain insufficiently constrained, limiting the effectiveness of exploration strategies in the region.

This study presents an integrated approach combining field structural data, remote sensing (SRTM), and airborne magnetic data to investigate the tectonic framework controlling pegmatite emplacement in key areas of Nacala Velha and surrounding regions. Structural mapping reveals that pegmatite bodies are preferentially emplaced along ductile shear zones and brittle–ductile transition structures, with orientations consistent with regional tectonic fabrics associated with the Neoproterozoic evolution of the Mozambique Belt.

Magnetic data highlight regional structural lineaments and crustal discontinuities controlling pegmatite distribution, enabling the identification of favorable mineralized corridors. SRTM data contribute to lineament extraction and morphostructural characterization, reinforcing the interpretation of tectonic structures that acted as pathways for magma ascent.

The integration of structural, magnetic, and remote sensing datasets allows the development of a predictive exploration model for rare-element pegmatites in the Alto Ligonha Province. This model emphasizes the role of crustal-scale structures and their reactivation in controlling pegmatite emplacement and mineralization processes.

The results contribute to a better understanding of the geodynamic evolution of LCT pegmatites and provide a robust framework for identifying new mineralized targets, supporting more efficient and sustainable exploration of critical raw materials in Mozambique.