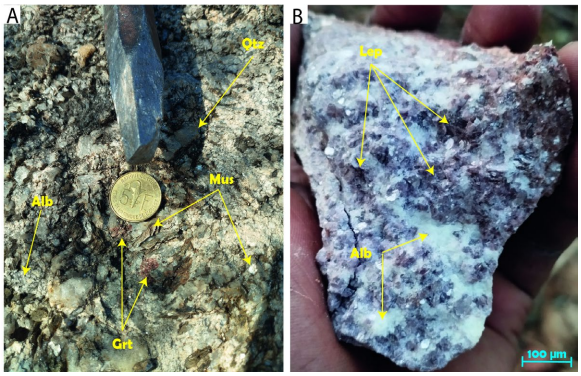
Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.29011



Lithium and rare metal enrichment in the pegmatites of Boundiali, Côte d'Ivoire: petrogenesis, structural controls and implications for the energy transition

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Technological development through global energy transition is one of the most important aspects of the 21st century and driving an increasing demand for critical raw materials, particularly lithium and tantalum, essential for battery technology and renewable energy storage. Sustaining this demand necessitates knowing the geological formations potentially favorable for these materials: pegmatites representing a primary source. In Côte d'Ivoire, pegmatite occurrences have been the subject of limited studies. Fifteen (15) zones of interest have been identified, of which only those in the Issia locality formed from differentiated residual fluids related to the crystallization of the Issia peraluminous granite, have undergone rigorous study, revealing columbite-tantaliferous deposits with limited lithium enrichment. Recent petrographic investigations in the Boundiali region identify various rare-metal-rich pegmatites which highly prospective, particularly for lithium mineralization. These pegmatites intrude birimian (Paleoproterozoic) formations, either within parametamorphic units (mainly amphibolites) or in granitic bodies. Thin section analyses highlighted five main types of pegmatite: spodumene-bearing pegmatites, lepidolite-bearing pegmatites, green-mica-rich pegmatite, garnet-rich pegmatite, and barren pegmatite. The mineral assemblages and textural features suggest a complex geological history involving (i) **magmatic crystallization (quartz,** feldspar, spodumene, and muscovite minerals**), followed by (ii)** regional metamorphic decompression, and metasomatic fluid interactions **including** chemical exchange between spodumene and fluids, leading to the formation of SQUI texture (vermicular intergrowth with small quartz crystals), and myrmekite textures, (iii) hydrothermal alteration such as sericitization, and montmorillonite replacement **and (iv) surface weathering evidenced by** eucryptite indicating potential lithium mobility, and hematite and rutile formation**.** The abundance of metasomatic features (sericitization, myrmekite, SQUI texture) underscores the role of fluid recirculation and rare metals redistribution (Li, Be, and Cs). Structural analysis of outcrops and thin sections reveals significant tectonic control on pegmatite emplacement. The presence of folding, stretching, and sigmoidal feldspar structures indicate a senestral shear zone, likely associated with regional tectonics. These likely provided a pathway for fluid flow enhancing metal enrichment and pegmatites evolution.