The International Association for Structural Geology and Tectonics Conference

DISCOVERY OF LITHIUM-RICH AND VARIOUS RARE METAL-BEARING PEGMATITES IN THE BOUNDIALI AND AGBOVILLE REGIONS OF COTE D'IVOIRE: *PETROGRAPHIC ANALYSIS AND IMPLICATIONS FOR THE GLOBAL ENERGY TRANSITION*

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ex solo ad solem, वसुधैव कुटुम्बकम्
ex solo ad solem, Vasudhaiva Kutumbakam
from the earth to the sun, the world is one family

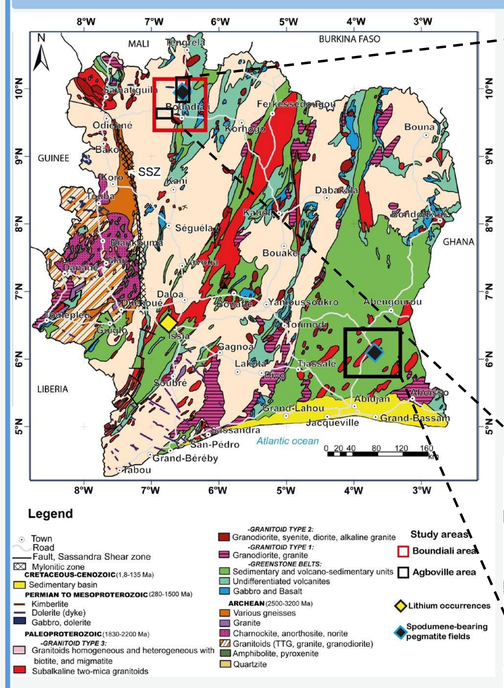
1. INTRODUCTION

Lithium-bearing pegmatites are now a primary global source of Li, alongside Nb-Ta, Cs, Sn, Be and REE, which are critical raw materials for batteries, electric vehicles and the renewable-energy transition.

Cote d'Ivoire's West African Craton hosts numerous Paleoproterozoic (Birimian) pegmatite fields that remain largely undocumented at petrographic scale despite growing exploration interest (ATEX Mining Resources / Firering Holding, SODEMI, KHALEESI licences).

This study provides the first detailed petrographic characterization of two contrasting pegmatite fields (**Boundiali** (NW) and **Agboville** (SE)), establishing mineralogical typologies, alteration histories, and exploration criteria relevant to Li and rare-metal targeting.

2. REGIONAL and LOCAL GEOLOGICAL SETTING



Both study areas lie within the Paleoproterozoic (Birimian) West African Craton, hosted by greenstone belts (amphibolites, schists) intruded by granitoids (granite, granodiorite, monzogranite).

Boundiali (NW Cote d'Ivoire): pegmatites occur in mafic/felsic schists, granite, basalt and amphibolite; NNW–SSE structural trend.

Agboville (SE Cote d'Ivoire): pegmatites hosted exclusively in biotite-muscovite granites, granodiorites and schists; spodumene-bearing bodies follow a NNW-SSE trend.

3. MATERIALS LOCAL METHODS

- Field mapping, sample collection and structural measurements
- Petrography and metallogeny analyses; Optical microscopy (PPL/XPL, reflected light) on polished thin sections
- Pegmatite mineralogical and petrography classification, alteration assessment
- LIBS Analysis (spodumene), Long-wave UV excitation (365 nm) and portable LIBS (SciAps Z-300)
- fluorescence intensity Test, Li grade, and Mn/Fe ratio control in spodumene fluorescence
- Conceptual model for weathering and Mn/Fe control on spodumene fluorescence intensity

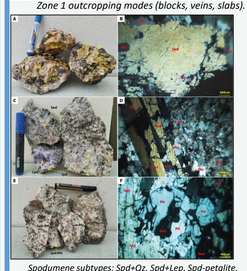
4. BOUNDIALI PEGMATITE FIELD

Subdivided into Zone 1 (ATEX licence, 134.96 km², NW) and Zone 2 (SODEMI licence, 370.87 km², SW), distinguished by mineralogy and host-rock relationships.

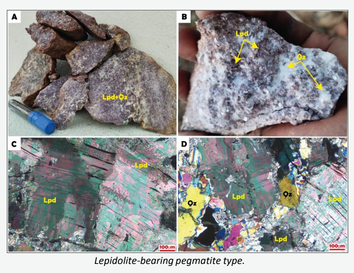
Zone 1 shows a local mineralogical zonation: green mica-albite → muscovite-albite → spodumene–lepidolite–columbite-tantalite core → mirrored sequence northward, ending in spodumene-cassiterite pegmatites.

Zone 1 outcropping modes (blocks, veins, slabs).

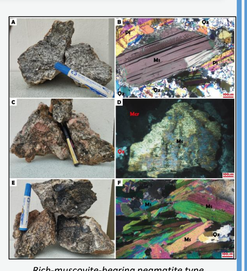
Type Zone 1	Key assemblage
Spodumene-bearing (3 subtypes)	Spd+Ms+Qz+Alb ± Lep ± Ptl; coarse to fine spodumene, SQI/SQS textures
Lepidolite-bearing	~80 modal% Lep + Alb + Qz; pink-violet radiating flakes
Rich muscovite-bearing	Greyish Ms clusters, partly chloritized, deformed cleavage
Basic quartz-feldspar-Ms	~90% Qz-Fsp, minor Ms/Grt/Fe-Ti oxides
Green-mica-bearing	~80% green mica + Qz; discordant to N10 foliation



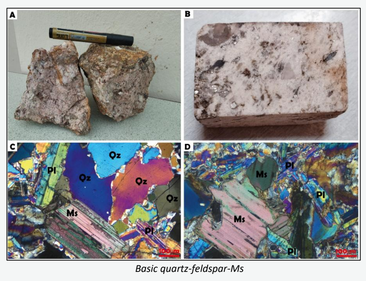
Spodumene subtypes: Spd+Qz, Spd+Lep, Spd-petalite.



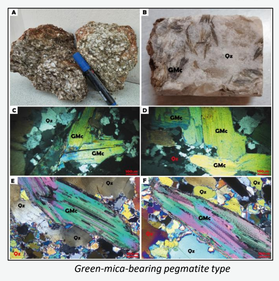
Lepidolite-bearing pegmatite type.



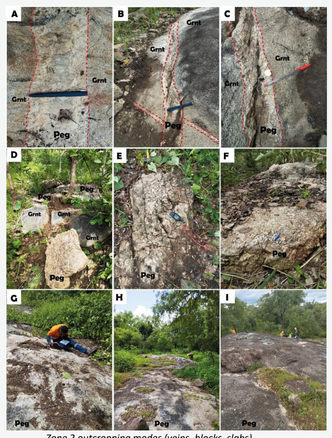
Rich-muscovite-bearing pegmatite type.



Basic quartz-feldspar-Ms

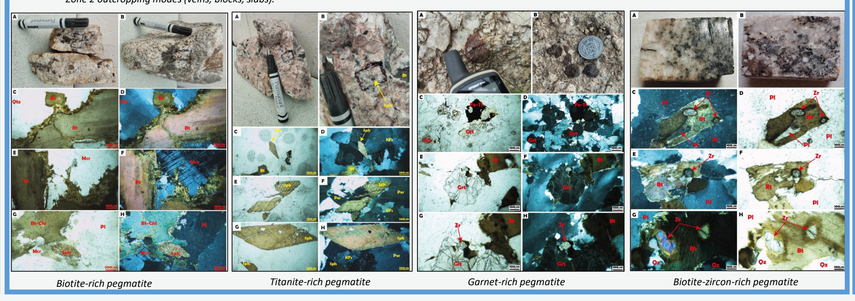


Green-mica-bearing pegmatite type



Zone 2 outcropping modes (veins, blocks, slabs).

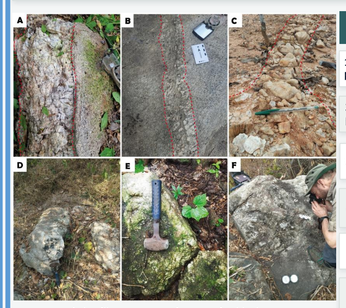
Type Zone 2	Key assemblage
Biotite-rich	Bt + KFs composition
Titanite-rich	Sph + Per + KFs composition
Garnet-rich	Grt + Bt + Zr composition
Biotite-zircon-bearing	Zr inclusions in Bt, dark PPL aureoles



Biotite-rich pegmatite | *Titanite-rich pegmatite* | *Garnet-rich pegmatite* | *Biotite-zircon-rich pegmatite*

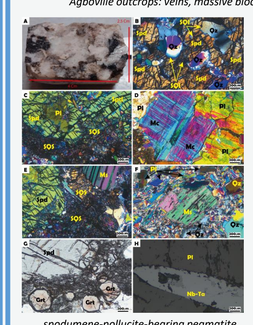
5. AGBOVILLE PEGMATITE FIELD

Hosted within biotite-muscovite granites, granodiorites and schists. Six petrographic groups defined from mica type, structure and rare-metal content. Zone 2 spodumene bodies follow a NNW-SSE trend.

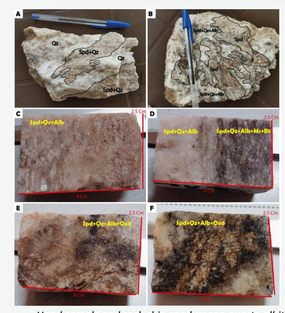


Agboville outcrops: veins, massive blocks.

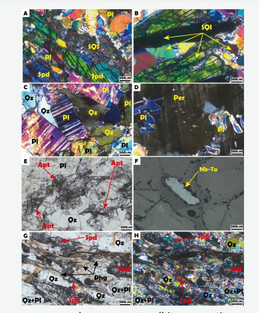
Type	Key assemblage
1. Spodumene-bearing	AGB 51: pollucite + Nb-Ta oxides + Grt; AGB 52-54: SQI/SQS, phengite at contacts
2. Tourmaline-bearing	Schorl + apatite ± Nb-Ta oxides; phengite confirmed (EMPA)
3. Two-mica	Ms-Qz-Alb to Bt-Ms granite-pegmatites; Fe-biotite (AGB 1)
4. Green-mica zones	Overmicaceous quartz hills (AGB 46/49/50)
5. Deformed / contact	Foliation, mineral stretching, sigma-Ms porphyroclasts
6. Graphic-texture	Qz-microcline runic intergrowth, no rare metals (AGB 6C)



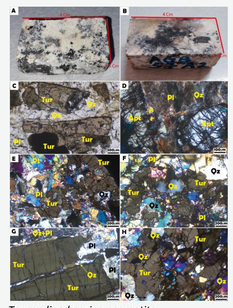
spodumene-pollucite-bearing pegmatite



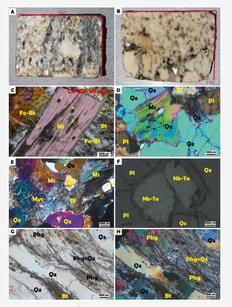
Hand sample and rock chip spodumene-quartz-albite pegmatites



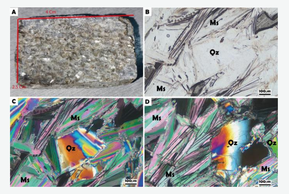
spodumene-quartz-albite pegmatites



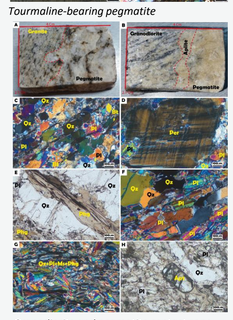
Tourmaline-bearing pegmatite



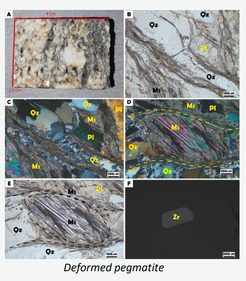
Two mica-bearing pegmatite



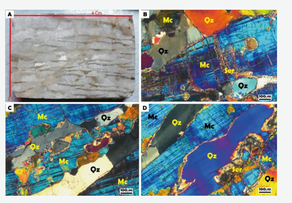
Green mica-bearing pegmatite



Granodiorite and pegmatite contact zone



Deformed pegmatite



Graphic textureg pegmatite

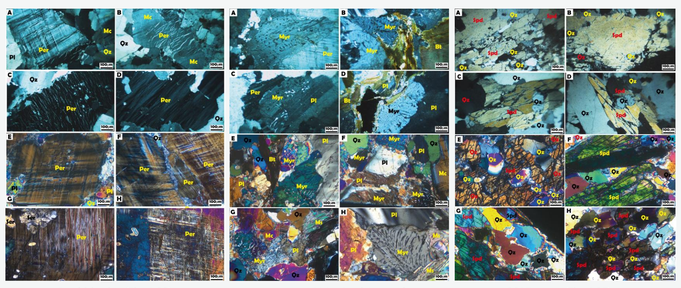
NB: Most evolved pegmatite of the dataset: spodumene + pollucite ($CsAlSi_2O_6$) + columbite-tantalite + albite + quartz + garnet + apatite.

Pollucite confirmed independently by SEM-EDS across 5 acquisition zones — the only confirmed pollucite occurrence in either field, marking an exceptionally fractionated, Cs-enriched pegmatite melt.

6. Comparative overview

Feature	Boundiali	Agboville
Lepidolite / cassiterite / petalite	Present	Absent
Pollucite ($CsAlSi_2O_6$)	Absent	Present (AGB 51)
Phengite (EMPA-confirmed)	Absent	Widespread
Fe-biotite + muscovite (EMPA)	Absent	Present (AGB 1)
Biotite-dominant pegmatites	Zone 2 only	Absent
Tourmaline as major group	Host-rock only	Major widespread group
Host-rock range	Schist, basalt, amphibolite, granite	Granite/granodiorite only

7. ALTERATION TEXTURES

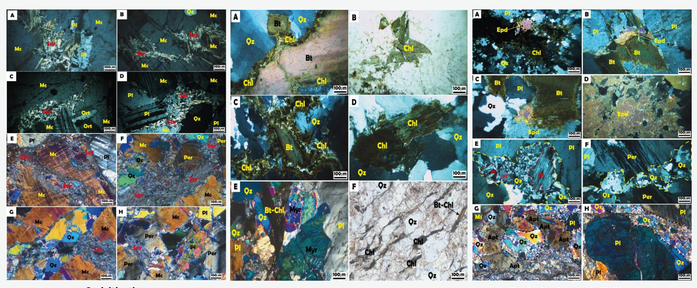


Perthitization (Fig. 4.32) — Albite exsolution lamellae (flame to stringer) within K-feldspar host.

Myrmekitization (Fig. 4.33) — Vermicular quartz vermicules within sodic plagioclase at K-feldspar margins.

SQI Texture (Fig. 4.35) — Spodumene crystals systematically intergrown with directional quartz ribbons.

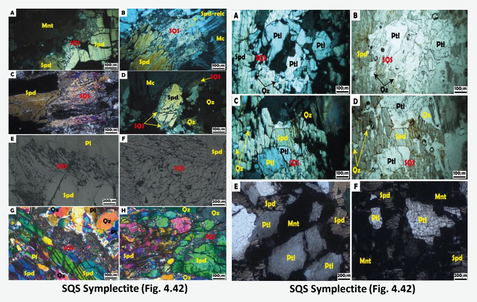
Magmatic / deuteric



Sericitization | **Chloritization** | **Epidotization and silicification**

>90% of Boundiali pegmatites show sericitization; chloritization; epidotization; silicification.

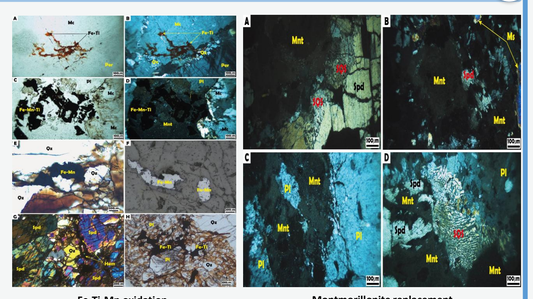
Hydrothermal



SQS Symplectite (Fig. 4.42) | **SQS Symplectite (Fig. 4.42)**

Garnet, titanite, tourmaline; SQS Type 1 (both fields) and Type 2 with relic petalite (Boundiali only); phengite and pollucite (Agboville only)

Metasomatic



Fe-Ti-Mn oxidation | **Montmorillonite replacement**

Fe-Ti-Mn oxidation in both fields; montmorillonite replacement of spodumene/plagioclase — Boundiali only.

Supergene

8. COMPLEMENTARY STUDY: UV FLUORESCENCE & LIBS GEOCHEMISTRY OF SPODUMENE

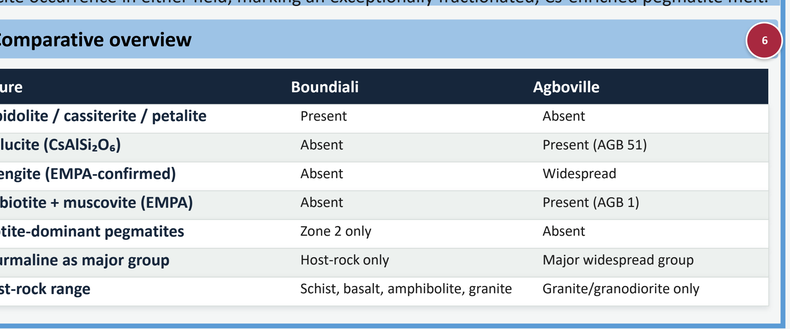
Long-wave UV excitation (365 nm) and portable LIBS (SciAps Z-300) were used as rapid, field-deployable screening tools on spodumene from Boundiali and Agboville, to Identify spodumene mineral within quartz-feldspar assemblage, correlate relative fluorescence intensity to the weathering state of spodumene minerals, and test whether fluorescence intensity can serve as a proxy for Li grade.

Key result:

- Long-wave UV excitation is a very effective tool for spodumene identification and they alteration state;
- Li does NOT correlate with fluorescence: weakly fluorescent BND 18F has higher Li (0.466%) than strongly fluorescent BND 42 (0.128%). Fluorescence tracks the Mn/Fe ratio instead (Mn^{2+} = activator, Fe = quencher), which falls with weathering.

BND 42 & AGB 52 under daylight vs. 365 nm UV: bright, uniform orange-red fluorescence (RFI 80–95%), Mn^{2+}-activated, low Fe.

AGB 51 *under daylight vs. 365 nm UV:* Bright yet Slightly Dull fluorescence (BSD-fl) *(RFI* 50% to 79%), *Mn^{2+}-activated, low Fe.*

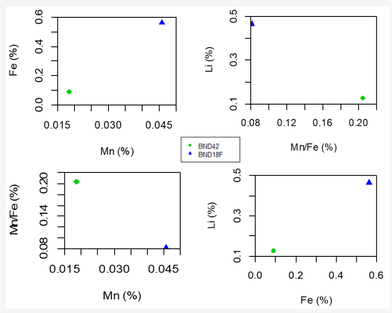


AGB 53A, BND 18F, and AGB 53B *under daylight vs. 365 nm UV: bright*Average fluorescence (Afl) and Weak fluorescence (Wfl) *(RFI* 20% to 49%).

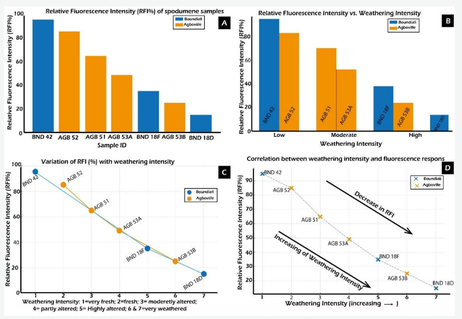
BND 18D under daylight vs. 365 nm UV: bright, very weak (vWfl) to weak (Wfl) fluorescence intensity

LIBS major/trace data, BND 42 vs. BND 18F

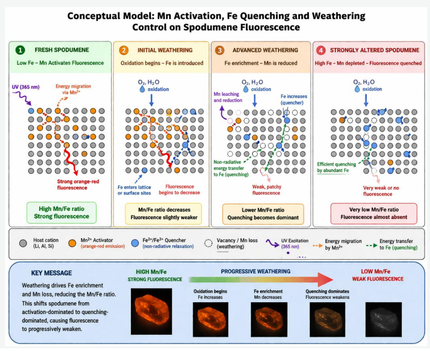
Elements	BND42 (%)	BND18F (%)
Li	0.128	0.466
Be	0.005	0.001
Na	2.16	0.163
Mg	0.037	0.017
Al	5.85	7.73
S	1.06	1.47
K	1.12	0.74
Ca	0.684	0.131
Ti	0.022	0.0306
Mn	0.0184	0.0457
Fe	0.09	0.563
Ba	0.06	0.0016
Si	64.5	41.6
Cu	0.166	0.164
Ni	0.112	0.099
C	0.099	0.052
Zn	0.0227	0.152
Cr	0.00187	0.000195
Pb	0.00247	0.0105



LIBS binary plots (BND 42 vs. BND 18F): higher Fe and lower Mn/Fe in BND 18F decouple Li enrichment from fluorescence intensity.



Graphical summary of the inverse relationship between Relative Fluorescence Intensity (RFI, %) and weathering intensity across the seven spodumene-bearing pegmatite samples from the Boundiali (blue) and



9. CONCLUSION

The Boundiali and Agboville pegmatite fields record both shared and contrasting petrogenetic histories within the same Birimian craton. Each field is characterized by a distinct mineralogical signature and rare-metal enrichment trend: NYF affinity in Boundiali Zone 2, Li-Sn-Cs-Nb-Ta-REE enrichment in Boundiali Zone 1, and Li-Cs-Nb-Ta-REE enrichment in Agboville. Based on these mineralogical assemblages, the Agboville pegmatites, defined by a spodumene-pollucite-CGM association, can be classified as "true LCT" pegmatites (van Lichtervelde et al., 2025), whereas the Boundiali field comprises both NYF-type and "basic" LCT-type pegmatites.

Together, these results establish the first systematic petrographic framework for rare-metal pegmatite exploration in Côte d'Ivoire.

Structural Geology in a Changing World: Tectonics, Resources and Sustainable Transitions