GEOTHERMO-BAROMETRY AND PHYSICO CHEMICAL CONDITIONS OF THE SUHUM BASIN GRANITOID COMPLEX – IMPLICATIONS FROM PETROGRAPHY AND MINERAL CHEMISTRY

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INTRODUCTION

Precambrian terranes, including the Paleoproterozoic Birimian of the West African Craton (WAC) (fig 1a) is crucial in understanding the tectonic evolution of the earth (Amponsah et al., 2023; Kearey et al., 2009; Roverato et al., 2019). Bounded by the Kibi-Winneba belt and the Cape Coast basin to the west, Voltaian sedimentary basin due north and the Pan-African belt to the east (Amponsah et al., 2023; Kwayisi et al., 2025; Kwayisi et al., 2026), the Suhum basin is underlain by four types of granitoids (fig 1b).

The granitoids of the Suhum basin is understudied, with few research works from Amponsah et al., (2023) and Kwayisi et al., (2025, 2026). These few research papers present petrography, whole rock geochemical and isotopic data with limited mineral chemistry data to constrain the geodynamics of the Suhum basin. However, till date, the parameters and conditions of crystallization of the granitoids has not been extensively studied. This paper focuses on using the major and trace element chemistry of amphiboles, biotite and plagioclase to constrain the geothermo barometry (P-T) and physico chemical (fO_2, water content, magma composition) conditions of granitoid crystallization granitoids from the Suhum basin.

GEOLOGICAL SETTING

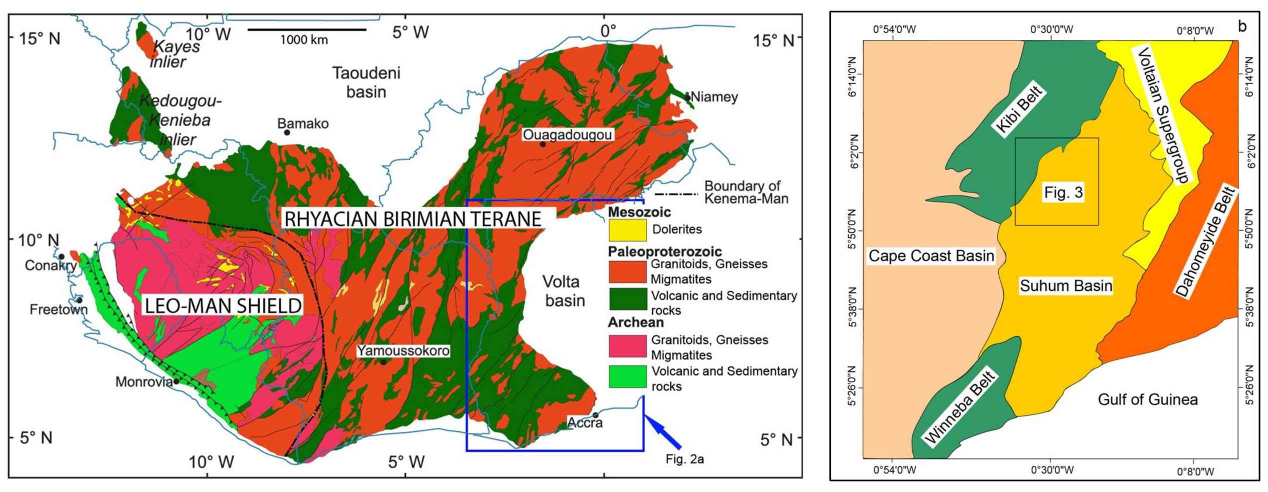
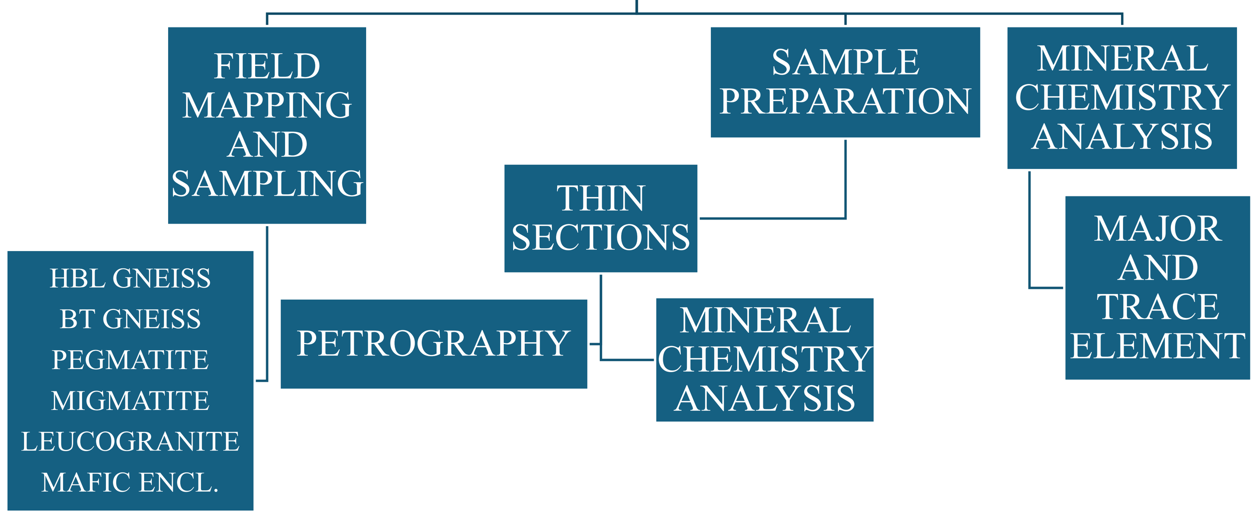


Figure 1: a) simplified geological map of sWAC (after Agyei-Duodu et al., 2009), b) geological map of the Suhum basin (after Kwayisi et al., 2026)

METHODOLOGY



RESULTS

BIOTITE

	Hbl Gneiss (n=22)	Bt Gneiss (n=4)	Pegmatite (n=3)	Migmatite (n=16)	Leucogranite (n=24)	Mafic encl. (n=11)
avg.∑REEs	1.40	3.91	0.82	1.09	4.36	0.44
avg.Eu/Eu*	0.73	0.25	1.05	0.96	1.18	0.02
avg.La_N/Sm_N	1.56	2.34	0.49	0.63	1.37	0.09
avg.Gd_N/Yb_N	1.06	2.27	0.18	1.77	1.96	0.43
avg.Fe#	0.70	0.73	0.81	0.63	0.76	0.59

Table 1: Average trace element ratios of biotite

HORNBLENDE

	Hbl Gneiss (n=15)	Migmatite (n=12)	Leucogranite (n=6)	Mafic encl. (n=12)
avg.∑REEs	81.99	114.78	189.76	141.86
avg.Eu/Eu*	0.70	1.04	0.72	0.64
avg.La_N/Sm_N	0.34	0.22	5.12	0.53
avg.Gd_N/Yb_N	1.83	1.93	3.13	2.28
avg.Mg#	0.51	0.54	0.56	0.61

Table 2: Average trace element ratios of hornblende

PLAGIOCLASE

	Hbl Gneiss (n=21)	Bt Gneiss (n=3)	Pegmatite (n=3)	Migmatite (n=13)	Leucogranite (n=21)	Mafic encl. (n=7)
avg.∑REEs	1.87	3.02	2.96	2.02	2.66	1.59
avg.Eu/Eu*	10.74	4.25	12.88	13.46	8.11	0.78
avg.La_N/Sm_N	5.21	8.74	6.16	4.11	7.05	0.61
avg.Gd_N/Yb_N	0.88	0.73	3.39	0.38	1.36	2.32
avg.An	23.81	22.41	19.74	24.52	18.81	21.56

Table 3: Average trace element ratios of plagioclase

DISCUSSION

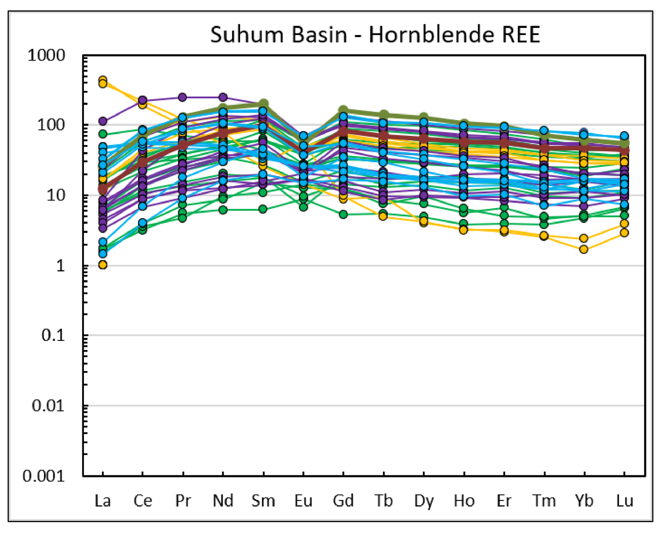


Fig 2: Chondrite normalized REE plot of hornblende

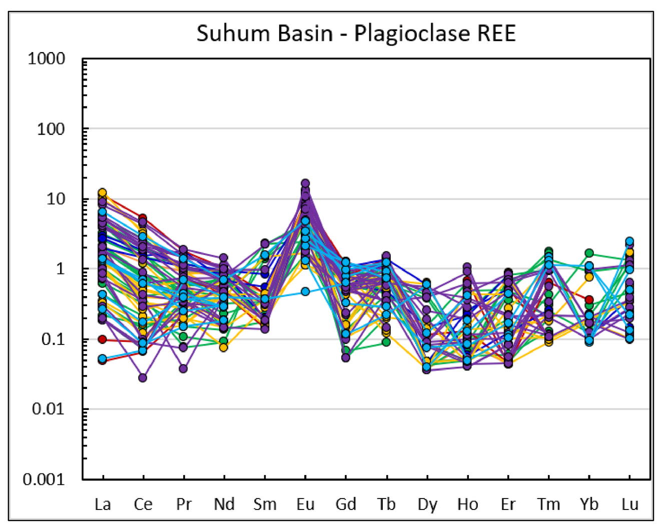


Fig 3: Chondrite normalized REE plot of plagioclase

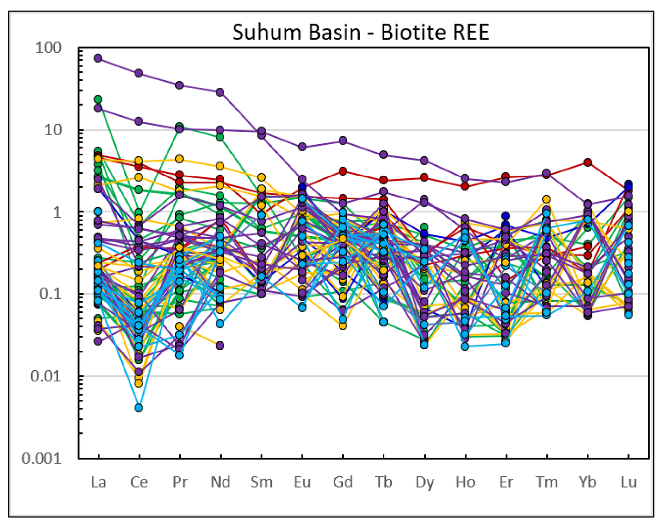


Fig 4: Chondrite normalized REE plot of biotite

CLASSIFICATION

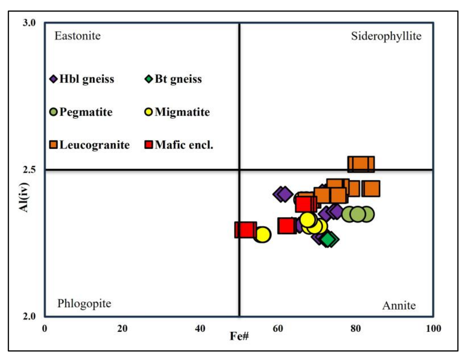


Fig 5: Fe# vs Al^{IV} classification diagram of biotite

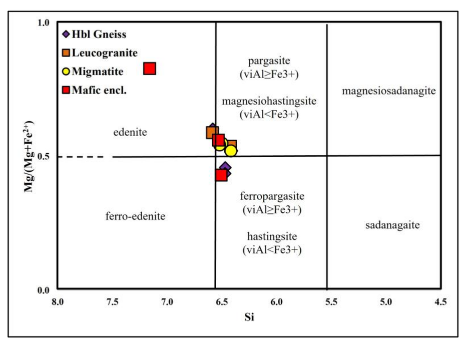


Fig 6: Si vs Mg# classification diagram of amphibole.

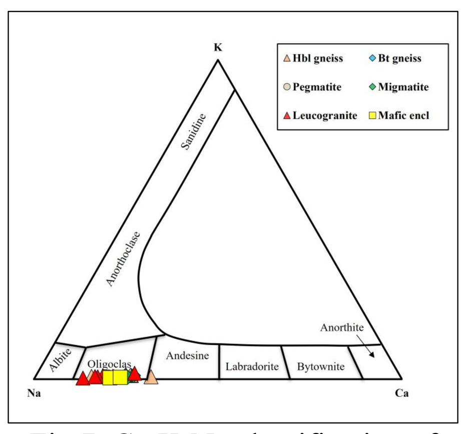


Fig 7: Ca-K-Na classification of plagioclase.

P-T CONDITIONS, fO_2

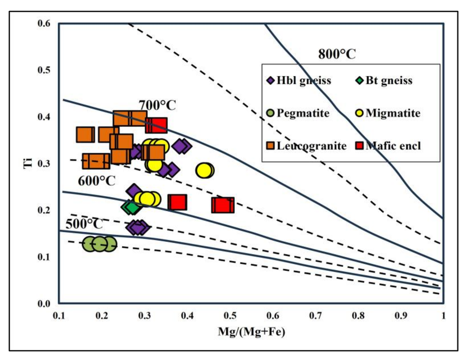


Fig 8: Mg# vs Ti temperature diagram of biotite

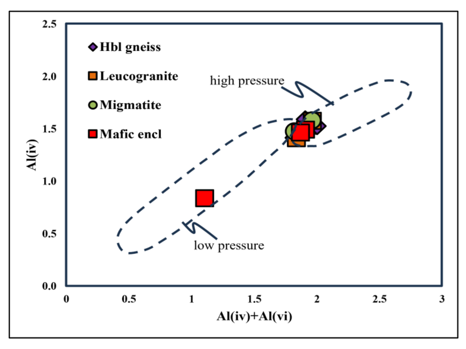


Fig 9: Al_{tot} vs Al^{IV} pressure diagram of amphibole.

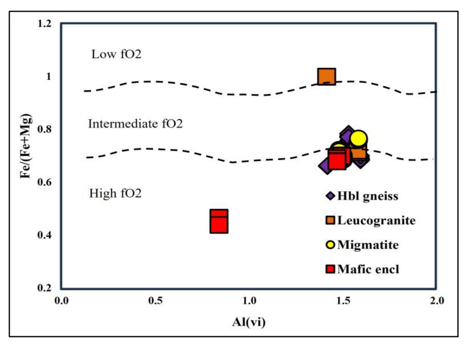


Fig 10: Al^{VI} vs Fe# oxygen fugacity diagram of biotite.

MAGMA SOURCE AND EVOLUTION

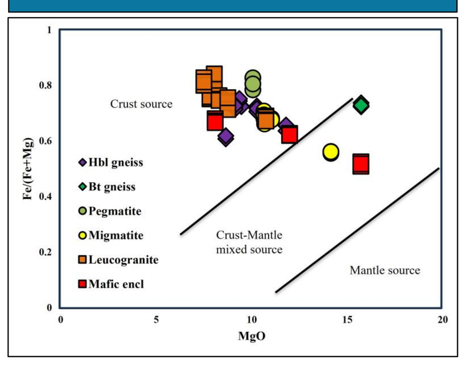


Fig 11: MgO vs Fe# magma source diagram of biotite

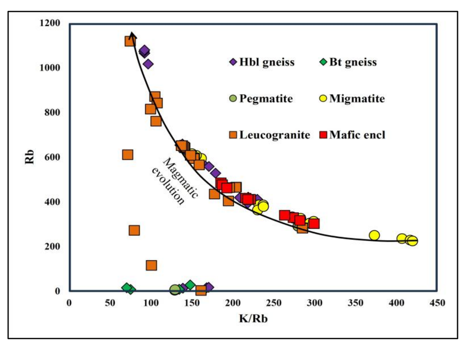


Fig 12: K/Rb vs Rb magma evolution diagram of biotite

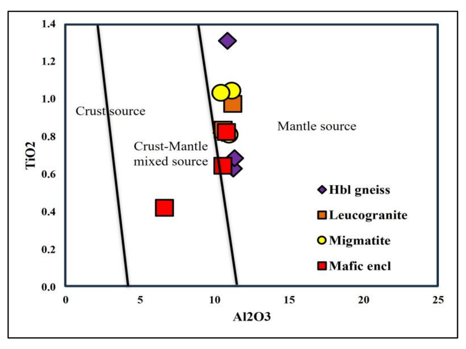


Fig 13: Al_2O_3 vs TiO_2 magma source diagram of amphibole

MAGMA SERIES

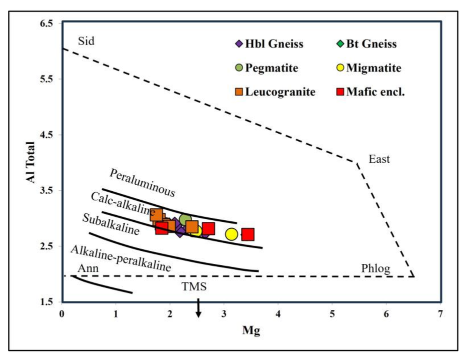


Fig 14: MgO vs Fe# magma series diagram of biotite

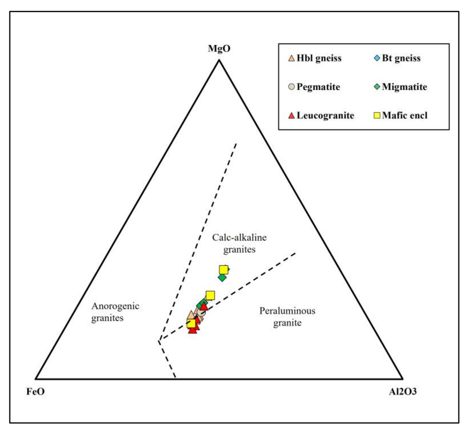


Fig 15: FeO-MgO-Al_2O_3 ternary diagram of biotite

CONCLUSION

- Facies from the Suhum basin granitoid primary contains calcic amphiboles, with magnesio-hastingsite and ferro paragasite being the dominant type with Mg# ranging from 0.41 to 0.83. primary and re equilibrated biotite from the granitoid complex exhibits Fe# ranging between 0.51 to 0.84, closely aligning with the annite field. In the typology diagram based on biotite composition, they plot in calc-alkaline granites. The feldspar composition is primarily oligoclase with An contents ranging between 13.13 to 31.39.

Together, the chondrite normalized REE patterns indicates the order of fractionation where;

- early plagioclase fractionation produced positive Eu anomalies in plagioclase influenced by the moderate An concentrations in a predominantly Ab rich plagioclase mineral. This lead to a complementary Eu depletion in the residual melt.
- Hornblende subsequently incorporated much of the remaining REEs, particularly the LREE. Although showing notable negative Eu anomaly, Eu concentration is moderately enriched. The moderate level of enrichment of Eu in hornblende can be attributed to a possible co-equilibration of hornblende with plagioclase influencing the concentration of Eu in hornblende due to Ca-Eu substitution in hornblende.
- while biotite crystallized during later stages from an evolved melt with relatively low REE abundances.

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