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Tectono-Metamorphic Evolution of the Southern Ashanti and Kibi-Winneba Belts in the West African Craton

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INTRODUCTION & METHODS

Objective

Reconstruct the tectono-metamorphic evolution of the southern Ashanti and Kibi-Winneba belts (Ghana) using an integrated multidisciplinary approach.

Geophysical Methods

- Aeromagnetic data: Reduction to Equator (RTE), Analytical Signal (AS), Tilt Derivative (TDR), 1st & 2nd Vertical Derivatives
- Radiometric data: Gamma-ray spectrometry (K, eTh, eU) – ternary composites and ratio images
- Principal Component Analysis (PCA) on K, Th, U bands

Field & Lab Methods

- Structural mapping: 40 stations, dip/dip direction
- Petrography: SEM and REM
- Bulk rock geochemistry: LA-ICP-MS (n = 34 samples)
- Mineral chemistry: Electron microprobe (EPMA)
- Thermodynamic modelling: Theriak-Domino, P-T pseudo-sections

Geophysical Data and Signatures Summary

- Metavolcanics: High magnetic intensity / Low K, medium eTh/eU
- Basin granitoids: Low magnetic intensity / High K, low eTh/eU
- Tarkwaian sediments: Medium magnetic intensity / Medium-high K
- Argillites & schists: Medium-high magnetic intensity / High eU & eTh

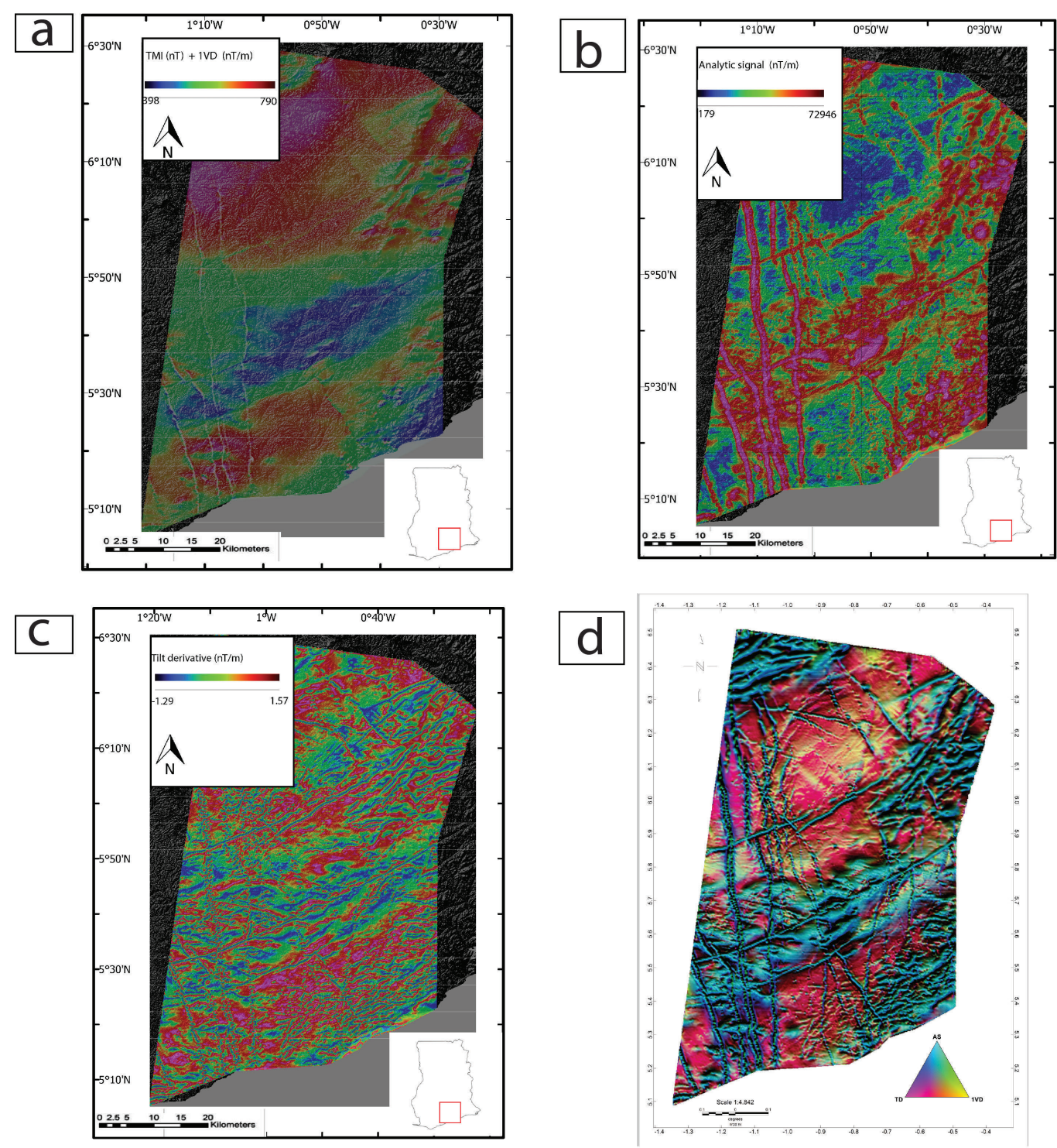


Figure A1: Aeromagnetic ternary image (AS-TDR-1VD) showing NE-SW trending lineaments, high-intensity anomalies (metavolcanics), and low-intensity zones (granitoids & basins)

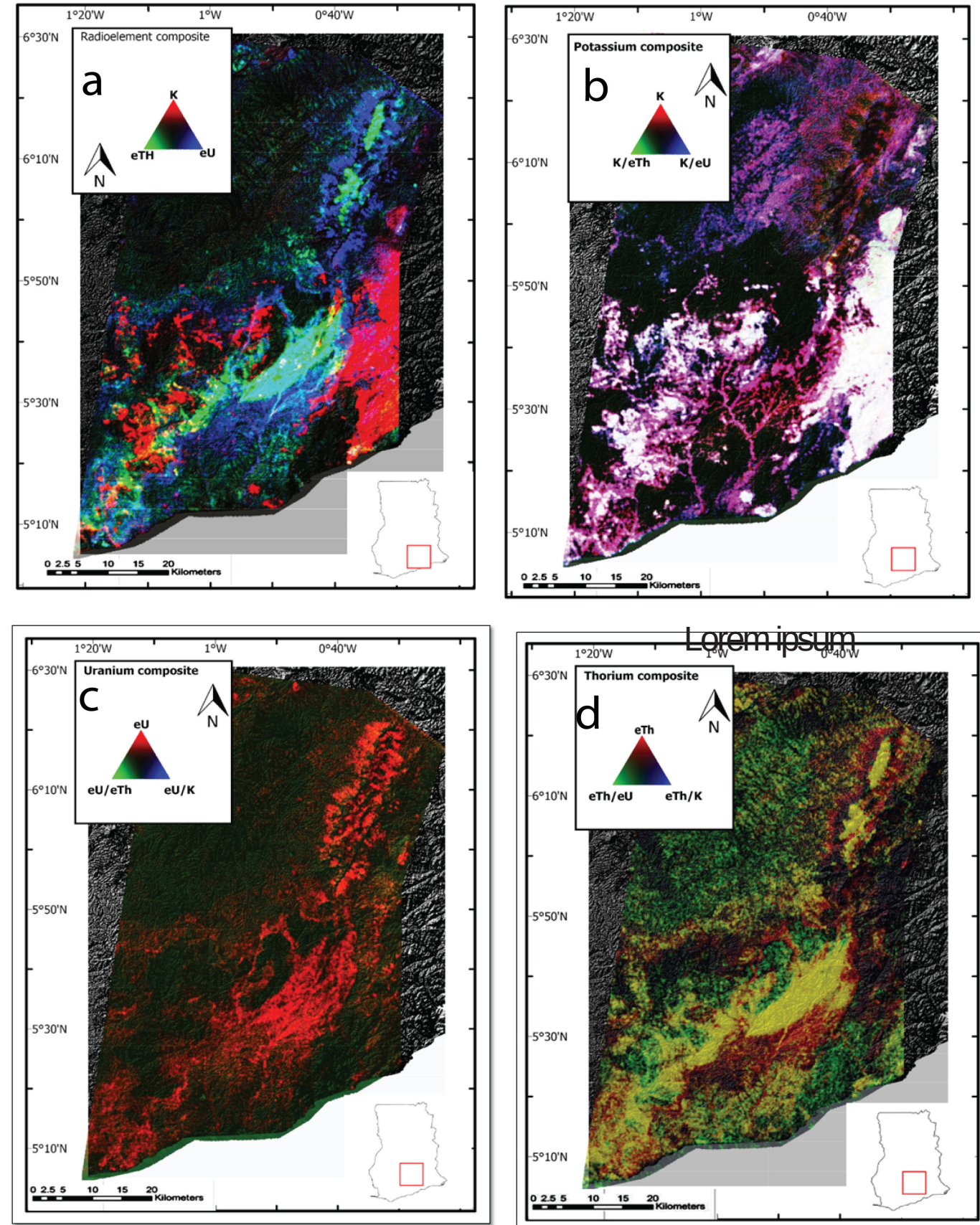
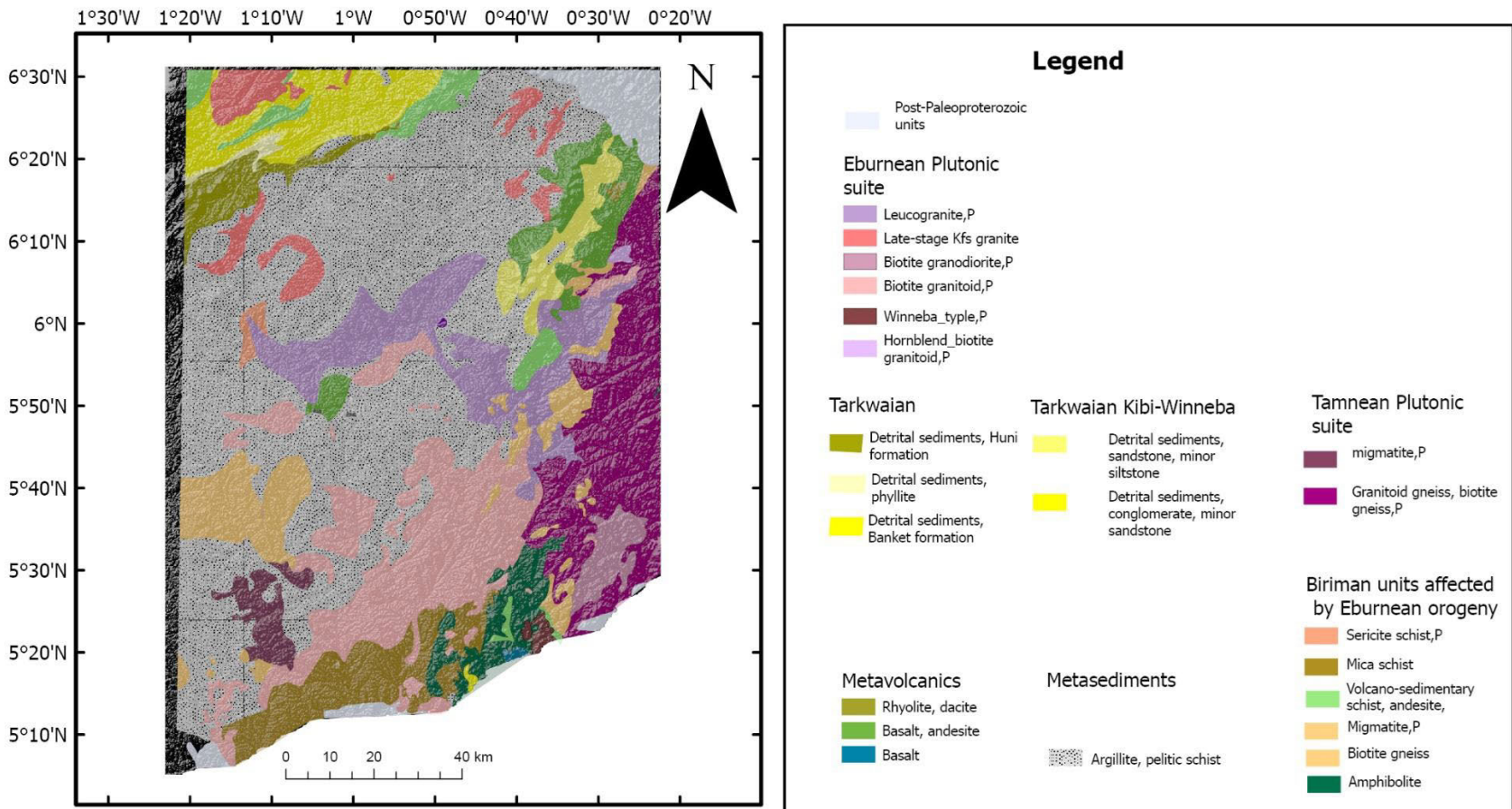


Figure A2: Radiometric ternary maps showing high K (pink/red) in granitic domains, low K but medium eTh/eU in metavolcanics, and high eU/eTh in Cape Coast basin



Revised geological map of the Kibi-Winneba belt and its adjoining basins based on geophysical data interpretation, field observations and re-existing data.

STRUCTURAL ANALYSIS

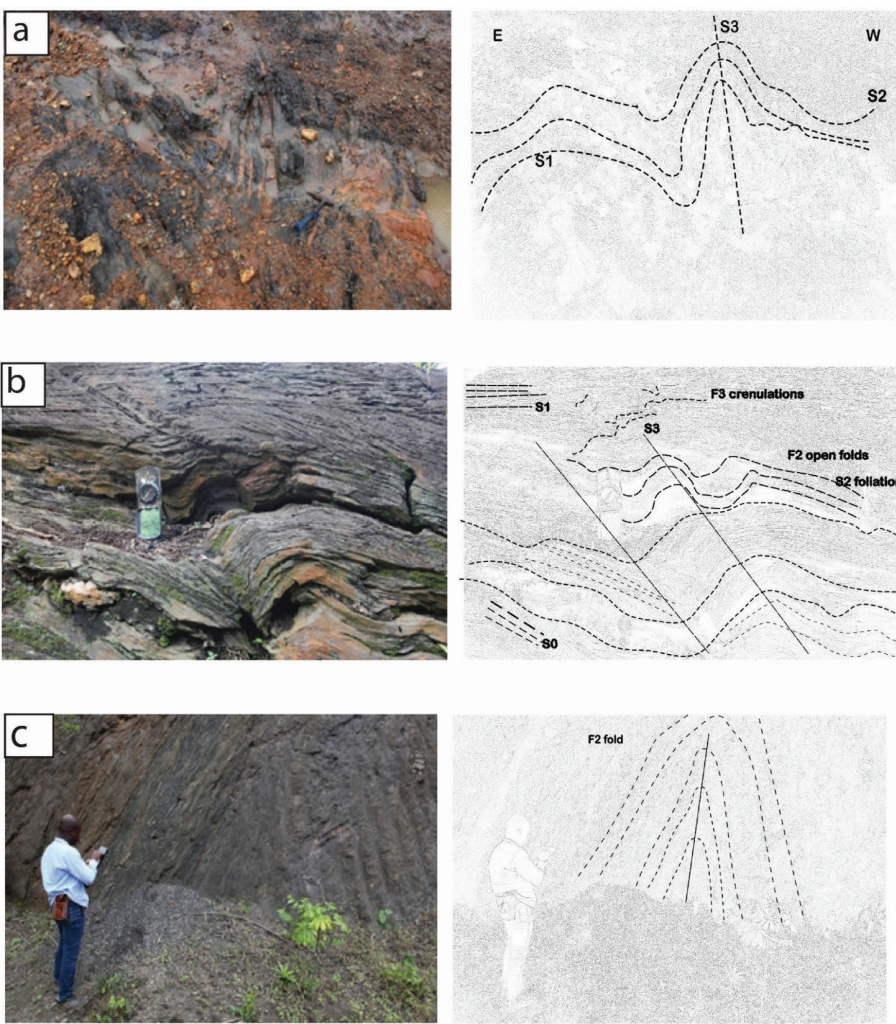


Figure B1: a) Foliations observed in argillites from the Cape Coast basin. b) Contoured stereographic pole plots of foliation planes (S2) associated with D2 deformational events c) F2 fold observed in the NKW belt

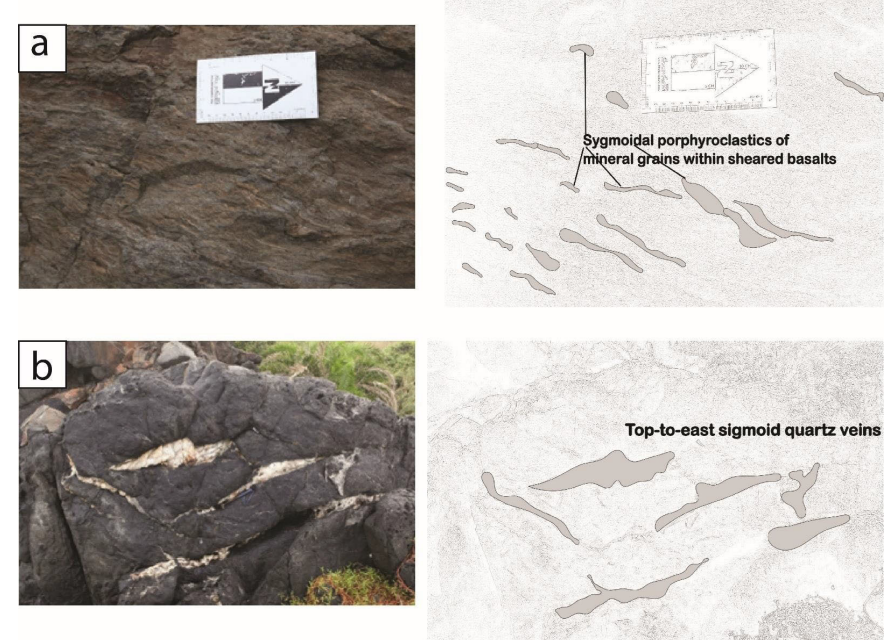


Figure B2: a) sigmoidal porphyroblasts of mineral grains within sheared basalts b) Top-to-east sigmoidal quartz veins observed in amphibolo-pyroxenites in the southern Kibi-Winneba belt (photo was taken facing the south)

Deformational History

Event	Structures	Trend
D1	Foliations	ESE-WNW
D2a	Isoclinal/open folds	SE-NW
D2b	Reverse faults	NW-SE
D3	Crenulations	NE-SW

METAMORPHISM AND PETROGRAPHY

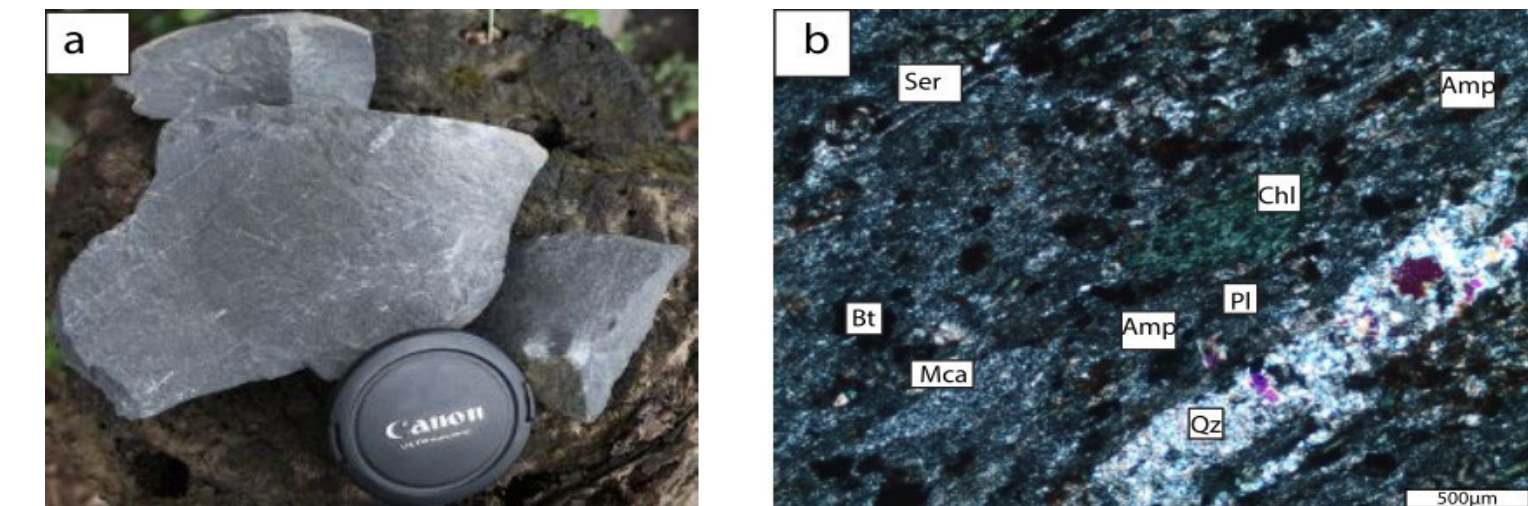


Figure C1: Basalt (KW020) showing Amp + Bt + Chl + Pl (greenschist facies).

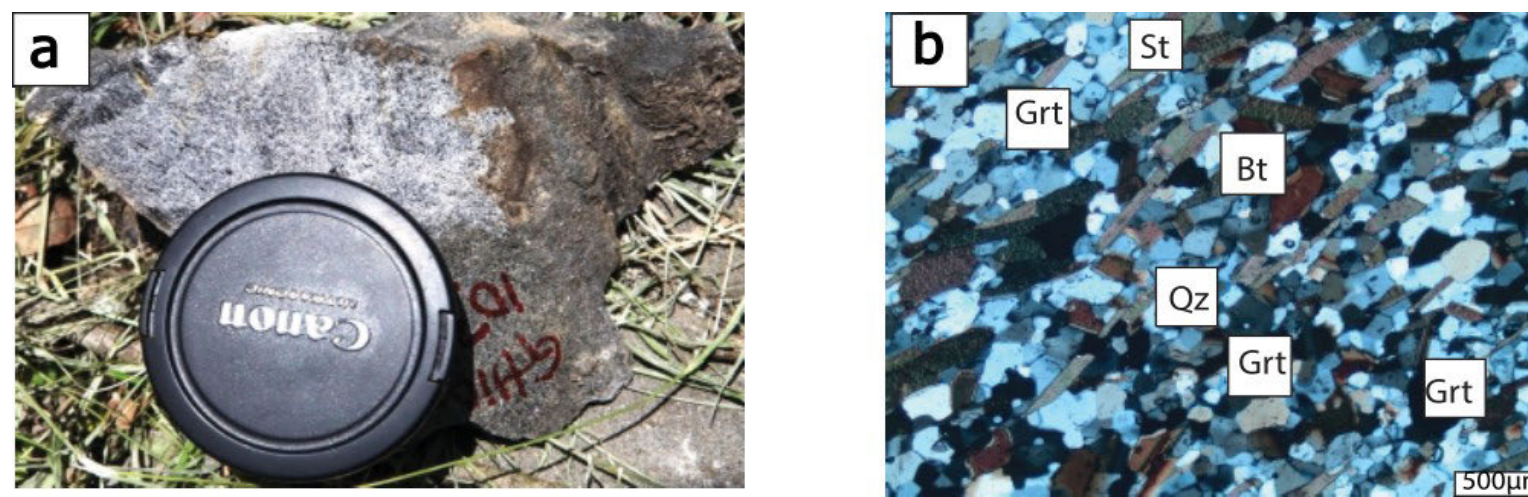


Figure C2: Garnet-staurolite schist (GH10-103) showing Grt+Bt+St

THERMODYNAMIC MODELLING OF P- T CONDITIONS

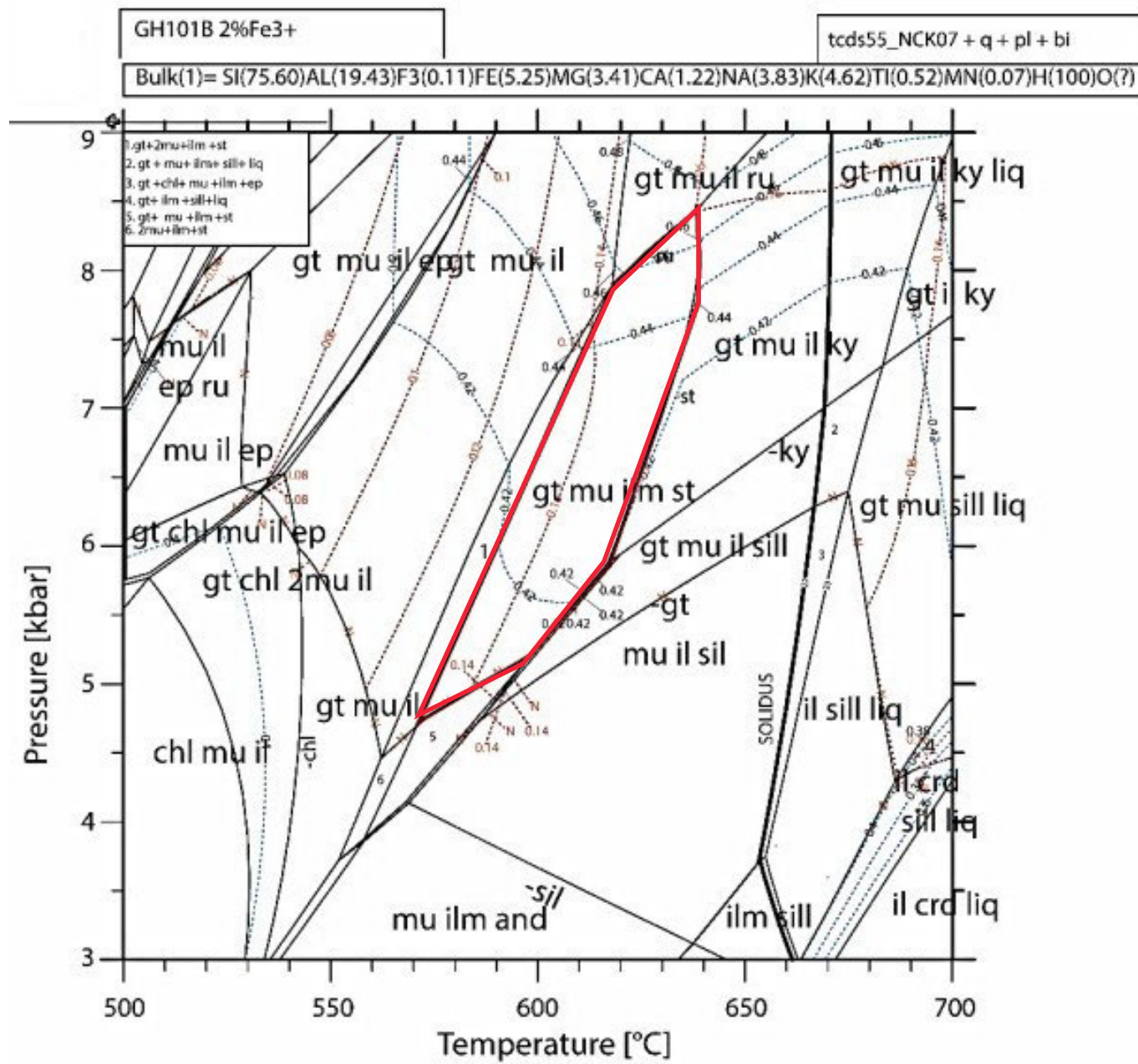


Figure D1: P-T pseudosection for sample GH09-101B showing isopleths for garnet and biotite with mineral composition expressed in mole %. Temperature constrained is ~590°C at a pressure of 5.8 kbar.

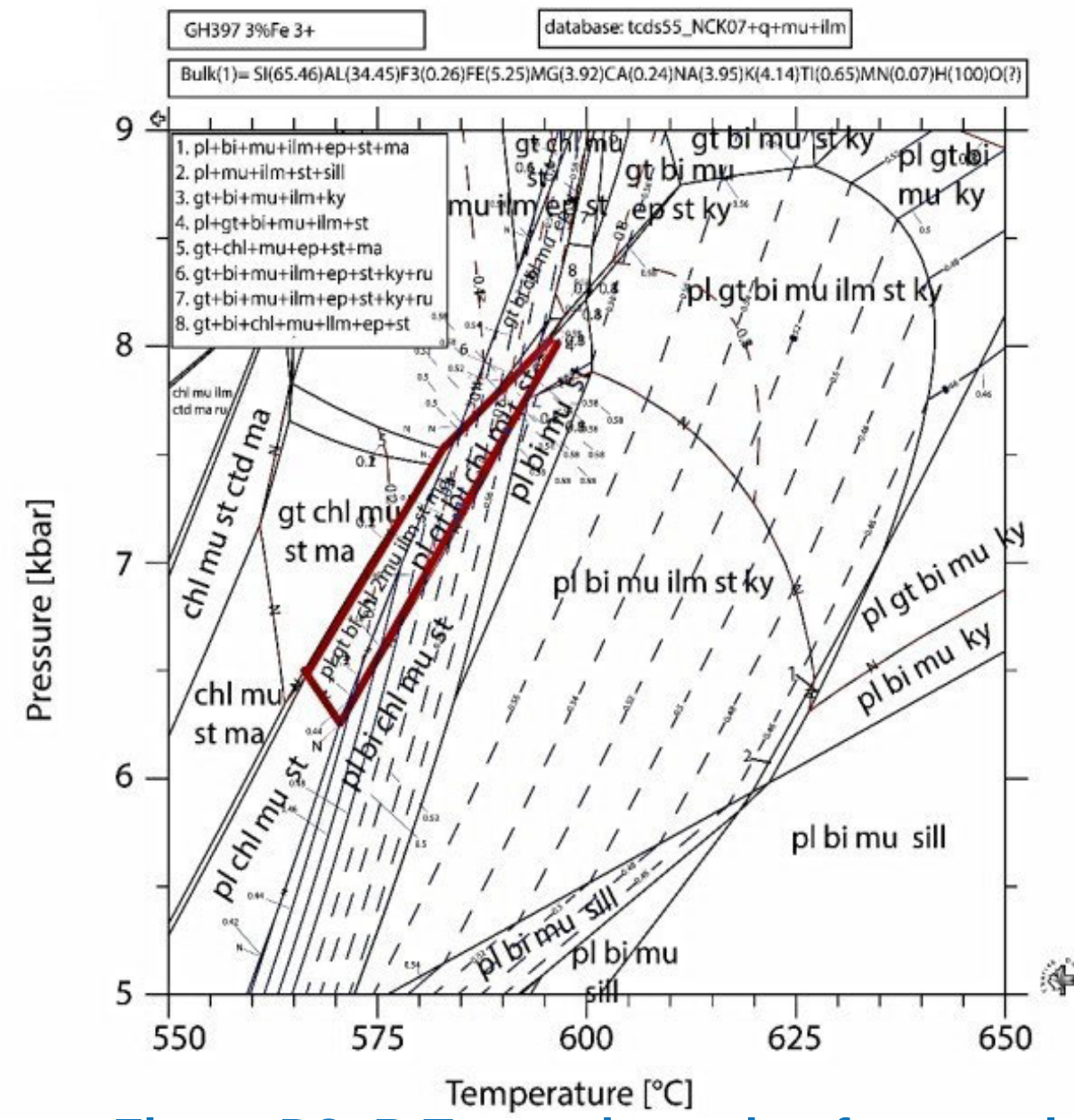


Figure D2: P-T pseudosection for sample GH397 showing isopleths for garnet and biotite with mineral composition expressed in mole %. Temperature constrained is ~ 570°C at a pressure of 6.9 kbar.

KEY P-T RESULTS

Cape Coast Basin (garnet-staurolite schist): 590°C @ 5.8 kbar (amphibolite facies, ~31°C/km)

Ashanti Belt (Tarkwaian metasandstone): 570°C @ 6.9 kbar (amphibolite facies, ~25°C/km)

Northern Kibi-Winneba belt: Greenschist facies (chlorite, sericite, carbonate)

Tectonic Interpretation

- Metavolcanics: Tholeiitic & calc-alkaline, MORB/OIB signatures
→ Island arc + active continental margin
- Granitoids: Volcanic arc, syn-collisional, I-type, adakitic (TTG-like)

Conclusion

Polyphase deformation and crustal thickening associated with a convergent-margin orogenic cycle—from subduction-related arc magmatism and diachronous Barrovian amphibolite-facies metamorphism, to final exhumation with greenschist-facies overprinting.

Selected References: Perrouty et al. (2012) | Block et al. (2015) | Klemd et al. (2002) | Feybesse et al. (2006) | Amponsah et al. (2023) Acknowledgements: West African Exploration Initiative (WAXI) | IRD | Goldfields Ghana Ltd. | University of Ghana | GET Toulouse



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