

PETRO-STRUCTURAL STUDY OF THE GEOLOGICAL FORMATIONS OF PR 807 AND PR 809 PERMITS, VAVOUA, CENTRAL-WESTERN COTE D'IVOIRE : TECTONIC IMPLICATIONS AND GOLD EXPLORATION POTENTIAL

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ABSTRACT

The Paleoproterozoic terranes of the Baoulé-Mossi domain of the West African Craton constitute a major province of crustal growth and metallogenesis, particularly gold mineralization. In this context, the PR 807 and PR 809 exploration permits, located in the Vavoua Department of central-western Côte d'Ivoire, are of particular interest for understanding the relationships between lithology, deformation, hydrothermal alteration, and metallogenic potential. This study aims to characterize the exposed geological formations, their mineralogical assemblages and metamorphic and hydrothermal transformations, define the main tectonic structures, and discuss their implications for gold exploration.

The methodology combines geological field observations, macroscopic and microscopic petrographic investigations, structural measurements, and remote-sensing analysis based on Landsat 8 imagery. Five main lithological units were identified: granite, granodiorite, diorite, amphibolite, and magnetite-bearing quartzite. Secondary mineral assemblages dominated by chlorite, epidote, and sericite indicate low-grade metamorphic and hydrothermal alteration processes compatible with predominantly greenschist-facies conditions. The main hydrothermal alteration types include sericitization, chloritization, epidotization, silicification, and sulfidation. Structural analysis of 396 lineaments reveals a predominance of E–W-trending structures, followed by NW–SE, NE–SW, and N–S orientations. Field observations document the coexistence of ductile structures, including foliation, stretching lineation, boudinage, and drag folds, with brittle structures such as fractures, faults, strike-slip structures, quartz veins. This structural association records a polyphase tectonic history characterized by a transition from ductile to brittle deformation. The coexistence of major structural corridors, quartz veins, and hydrothermal alteration provides favorable geological evidence for fluid circulation and the potential concentration of mineralization.

Keywords: *Wac; Birimian; tectonics; hydrothermal alteration; gold exploration*

1. INTRODUCTION

The West African Craton (WAC) represents a major continental domain composed of Archean nuclei and Paleoproterozoic terranes. In its southern part, the Baoulé-Mossi domain is mainly composed of Birimian terranes and Eburnean granitoids, whose evolution reflects a complex history of crustal accretion, collision, magmatism, metamorphism, and deformation. Recent geodynamic models favor a prolonged accretionary–collisional evolution rather than a simple monocyclic model of crustal growth (Grenholm *et al.*, 2019; Masurel *et al.*, 2022; Perret *et al.*, 2026).

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In Paleoproterozoic domains, gold mineralization is commonly associated with major tectonic structures, particularly shear corridors, fractures, and contacts between contrasting lithological units. Gold occurrences may also be related to contacts between metasedimentary and volcanic rocks, as well as to granitoid intrusions that affect Birimian formations (Feybesse, 2001; Assié, 2008; Houssou, 2013; Ouattara, 2015). Consequently, investigating the relationships between lithology, tectonic structures, magmatic intrusions, and potential alteration zones is essential for understanding the distribution of mineralization and for effectively guiding mineral exploration. The relationship between deformation and gold mineralization is therefore of particular significance within the WAC.

Paleoproterozoic gold systems are frequently associated with shear networks, subsidiary structures, lithological contacts, and quartz veins. However, spatial relationships between structures and gold mineralization should not be equated with demonstrated genetic relationships. Several deformation events may reactivate the same structural discontinuities, while hydrothermal alteration may extend considerably beyond the mineralized zones (Masurel *et al.*, 2022; Perret *et al.*, 2025). The Vavoua region remains comparatively less well documented than neighboring gold districts. This study therefore aims to improve the petrographic and structural understanding of the geological formations exposed in the area and to establish a preliminary geological framework that can contribute to the assessment of its structural and gold exploration potential.

2. GEOLOGICAL CONTEXT

The Baoulé-Mossi domain was formed during the Paleoproterozoic through successive episodes of crustal growth and reworking of pre-existing crustal material. U–Pb–Hf studies of detrital and magmatic zircons indicate that the Birimian crust resulted from a combination of juvenile crustal additions and crustal recycling within a diachronous accretionary–collisional system (Parra-Avila *et al.*, 2016; Satkoski *et al.*, 2017; Grenholm *et al.*, 2019). Recent geochronological and isotopic studies further indicate that Birimian granitoids do not represent a genetically homogeneous population. Depending on the geological setting, their sources may involve hydrated mafic crust, metasomatized mantle, and contributions from older continental crust (Amponsah *et al.*, 2023; Kwayisi *et al.*, 2025).

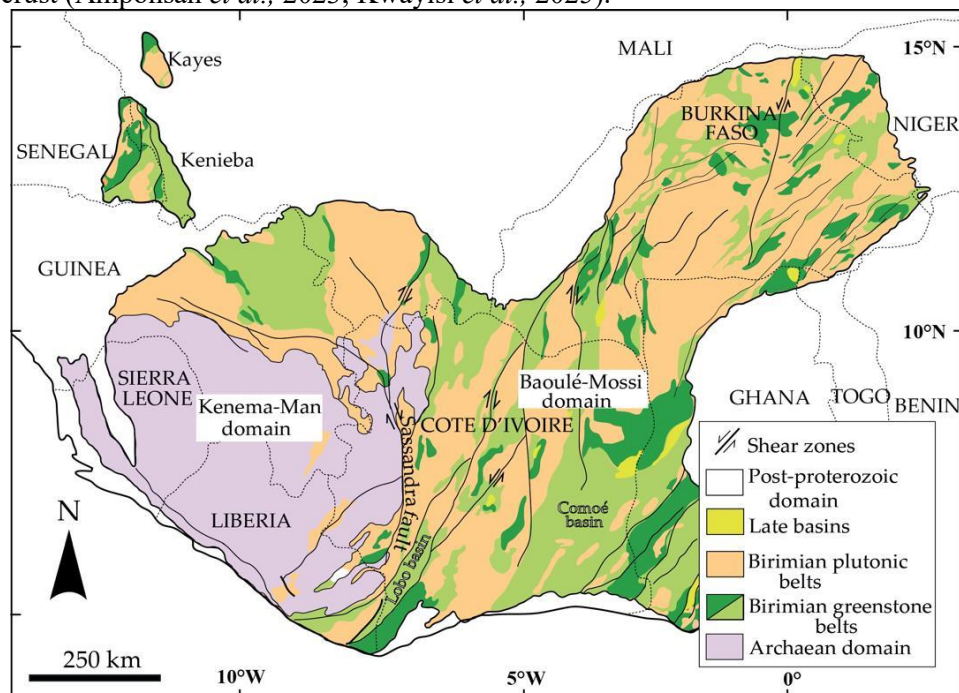


Figure 1 : Geological map of the West African Craton, modified after Block *et al.* (2015)

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At the scale of the Man-Léo Shield (Figure 1), recent studies emphasize widespread Eburnean deformation, characterized by strain partitioning among shortening structures, shear zones, and transcurrent structures. Accordingly, structural trends identified at the local scale should be considered in relation to their relative chronology and cross-cutting relationships in order to distinguish successive deformation phases and constrain the tectonic evolution of the studied area (Chardon *et al.*, 2020; Perret *et al.*, 2025; Perret *et al.*, 2026).

The study area belongs to the Paleoproterozoic domain, which is mainly composed of Birimian formations. These formations occur within volcano-sedimentary belts generally trending NNE–SSW and bordered by, or enclosing, granitoid bodies. Seventeen Birimian belts have been identified in Côte d’Ivoire and are distributed along two major alignments: the Téhini–Dimbokro alignment in the east and the Ferké–Soubré alignment in the central part of the country (Tagini, 1971). These belts consist mainly of metavolcanic rocks, plutonic rocks, and metasedimentary formations.

The Vavoua area is located within the Bouaflé belt (Yacé, 2002). Dense vegetation cover and intense weathering significantly limit geological observations and account for the scarcity of exposed outcrops. The basement rocks have undergone extensive weathering and lateritization, characteristic of tropical regions with warm and humid climates. Eluvial deposits are widespread, together with lateritic duricrusts and their associated dismantling products, which are extensively developed throughout the area.

The geological evolution of the region has traditionally been interpreted to involve the stabilization and cratonization of an Archean basement, followed by extensive granitoid and granodioritic magmatism and deformation. These rocks were locally transformed into orthogneiss under conditions associated with high heat flow and the emplacement of mafic and/or ultramafic magmas. Relics of this older crust are represented by migmatitic gneiss panels and amphibolite enclaves (Ahimon, 1990). However, the precise nature and age of these basement components require careful consideration in light of more recent geochronological and isotopic constraints.

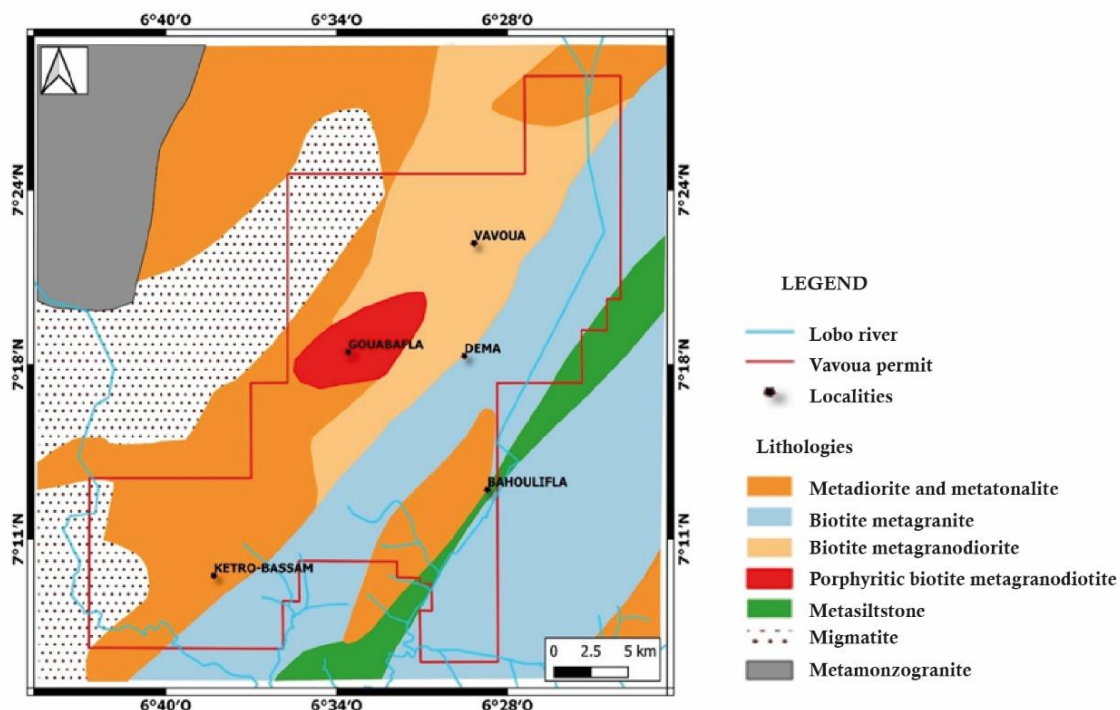


Figure 2 : Geological sketch map of the study area, digitized using QGIS from the 1:200,000-scale geological map of the Séguéla degree-square.

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a lithological perspective, the basement is dominated by granitoid rocks with relatively consistent mineralogical compositions. These include alkaline to subalkaline granites occurring within metamorphic formations, particularly gneisses and migmatites, which display broadly similar mineralogical characteristics. These formations are rarely exposed at the surface because they are largely concealed beneath a thick clayey-sandy weathering profile. In some areas, the weathering mantle may reach approximately 20 m in thickness, consisting predominantly of products derived from the alteration of the underlying bedrock. The study area is located in the western part of the Paleoproterozoic domain, within the transition zone of the central domain defined by Kouamelan (1996). It lies within the Bouaflé belt, more specifically in the Séguéla degree-square. The regional geology comprises several distinct lithological units, including porphyritic metagranodiorite containing biotite and/or hornblende, metasilstone with subordinate metasandstone, undifferentiated migmatites, metadiorite and metatonalite, as well as biotite–muscovite metagranite (Figure 2).

3. MATERIALS AND METHODS

3.1. Petrographic Study

The study area is located within a transitional humid tropical climatic zone characterized by dense vegetation cover and intense supergene weathering. These conditions result in a scarcity of exposed bedrock. The few accessible outcrops are mainly located on hills and within artisanal gold-mining pits that reach the underlying bedrock. Field investigations were conducted using standardized description sheets designed to systematically record geological observations. For each outcrop and sampling site, geographic coordinates and sampling locations were recorded. Particular attention was paid to rock texture, structure, color, degree of weathering, and mineralogical composition. Observations were conducted at both outcrop and hand-specimen scales with the objective of identifying and characterizing the different lithological units occurring within the study area. Representative rock samples were collected for petrographic analysis. Standard thin sections were prepared from selected samples and examined under a polarizing optical microscope. Microscopic observations focused on mineral assemblages, grain relationships, textures, microstructures, alteration features, and evidence of deformation. These observations were used to refine the lithological classification established from field observations and to characterize the metamorphic and hydrothermal modifications affecting the rocks.

3.2. Structural Analysis

A structural and kinematic analysis of the geological formations was conducted during field investigations. In addition to the petrographic characterization of the different lithologies, structural features were systematically identified, measured, and interpreted. Structural measurements included the orientations and dips of planar and linear features, particularly foliation, fractures, faults, quartz veins, and other observable deformation structures. The structural measurements were compiled into a dedicated database using Microsoft Excel and subsequently exported in text format for processing with the GEORient software. Directional data were represented using rose diagrams to characterize the main structural trends and their relative frequency. Structural observations were performed at both outcrop and thin-section scales, allowing field-scale structures to be compared with microscopic deformation features and mineral-scale fabrics. The integration of field structural measurements and petrographic observations was used to constrain the deformation history of the study area and to identify the principal structural trends and deformation mechanisms. Particular attention was given to cross-cutting relationships, structural overprinting, and the relationships between deformation, lithological contacts, veins, and alteration zones.

3.3. Remote Sensing Analysis

Remote sensing was additionally employed to improve the identification and spatial characterization of geological structures in an area where bedrock exposure is limited. Satellite imagery can provide valuable information for geological mapping, particularly through the detection and analysis of linear features and

regional structural patterns (Toutin, 1996). Landsat 8 Operational Land Imager (OLI) optical imagery was used to identify and map major geological lineaments. Because of the limited number of exposed outcrops, the remote-sensing analysis was primarily used to obtain a regional overview of the structural framework and to complement the field-based structural observations rather than to replace them. The Landsat 8 OLI scene used in this study was obtained from the United States Geological Survey (USGS) EarthExplorer platform. The scene identifier is LC819805420201130, corresponding to Landsat 8 path 198, row 54, acquired on 30 November 2020. The imagery was subsequently processed using ENVI 5.2 through two main stages: image preprocessing and image enhancement/processing. The preprocessing stage was performed to prepare the imagery for subsequent structural interpretation, whereas the processing stage focused on enhancing linear features and improving the visual discrimination of geological structures. The resulting products were integrated with field observations to identify and characterize the principal lineament trends within the study area.

4. RESULTS

4.1. Petrography

The petrographic investigation identified two major groups of rocks in the study area: igneous rocks, represented by granite, granodiorite, and diorite, and metamorphic rocks, mainly amphibolite and magnetite-bearing quartzite. Their mineralogical and textural characteristics are described below.

4.1.1. Granite

Two main granite varieties were identified, including two-mica granite and biotite granite (Figure 3A et 3B). The two-mica granite is porphyritic and contains abundant quartz and plagioclase phenocrysts set in a medium- to coarse-grained matrix. Quartz commonly exhibits undulose extinction, indicating post-crystallization strain. The main mafic and mica phases consist of elongated biotite and muscovite. Secondary minerals, including epidote and sericite, occur locally and are interpreted as alteration products affecting biotite and plagioclase, respectively. Accessory opaque minerals are locally present.

The biotite granite displays a predominantly equigranular texture, with variable grain size. Quartz is abundant and occurs together with K-feldspar, mainly microcline, characterized by its diagnostic tartan twinning. Plagioclase is also present. Biotite occurs as elongated crystals and is locally altered to chlorite and epidote. Zircon inclusions are locally observed within biotite crystals. Minor iron oxides also occur as accessory phases.

4.1.2. Granodiorite

The granodiorite is a coarse-grained, mesocratic rock that commonly forms slab-like outcrops (Figure 3C). Microscopically, it displays a porphyritic, inequigranular texture (Figure 3D). Plagioclase is the dominant feldspar and locally forms phenocrysts. Some plagioclase crystals show partial alteration to sericite. Biotite occurs as brown, commonly elongated crystals and is locally affected by alteration to epidote. Microcline represents the main K-feldspar phase. Subhedral amphibole crystals are characterized by greenish to yellowish colors and locally show alteration to chlorite. Sericite, epidote, and chlorite constitute the principal secondary mineral phases.

4.1.3. Diorite

The diorite is a melanocratic, medium-grained rock that occurs locally as dome-shaped outcrops (Figure 3E, F). Its primary mineral assemblage consists mainly of amphibole, biotite, and plagioclase, with subordinate quartz occurring interstitially between the main crystals. Secondary chlorite, epidote, and sericite are locally observed and are associated with the alteration of amphibole, biotite, and feldspar, respectively. Zircon inclusions are locally observed within biotite crystals, particularly where they are highlighted by pleochroic halos. Minor opaque minerals are also present.

4.1.3. Amphibolite

Amphibolite occurs in the central part of the study area and was observed at the top of a hill. Locally, the rock is crosscut by quartz veins and veinlets. It is generally massive and compact, moderately weathered,

greenish in color, and fine-grained (Figure 3G et 3H). The main mineral assemblage consists of amphibole and plagioclase. Amphibole crystals locally show progressive alteration to epidote, whereas plagioclase commonly occurs in association with amphibole. In thin section, the rock displays a granoblastic to nematoblastic texture, reflecting the recrystallization and preferred orientation of its constituent minerals.

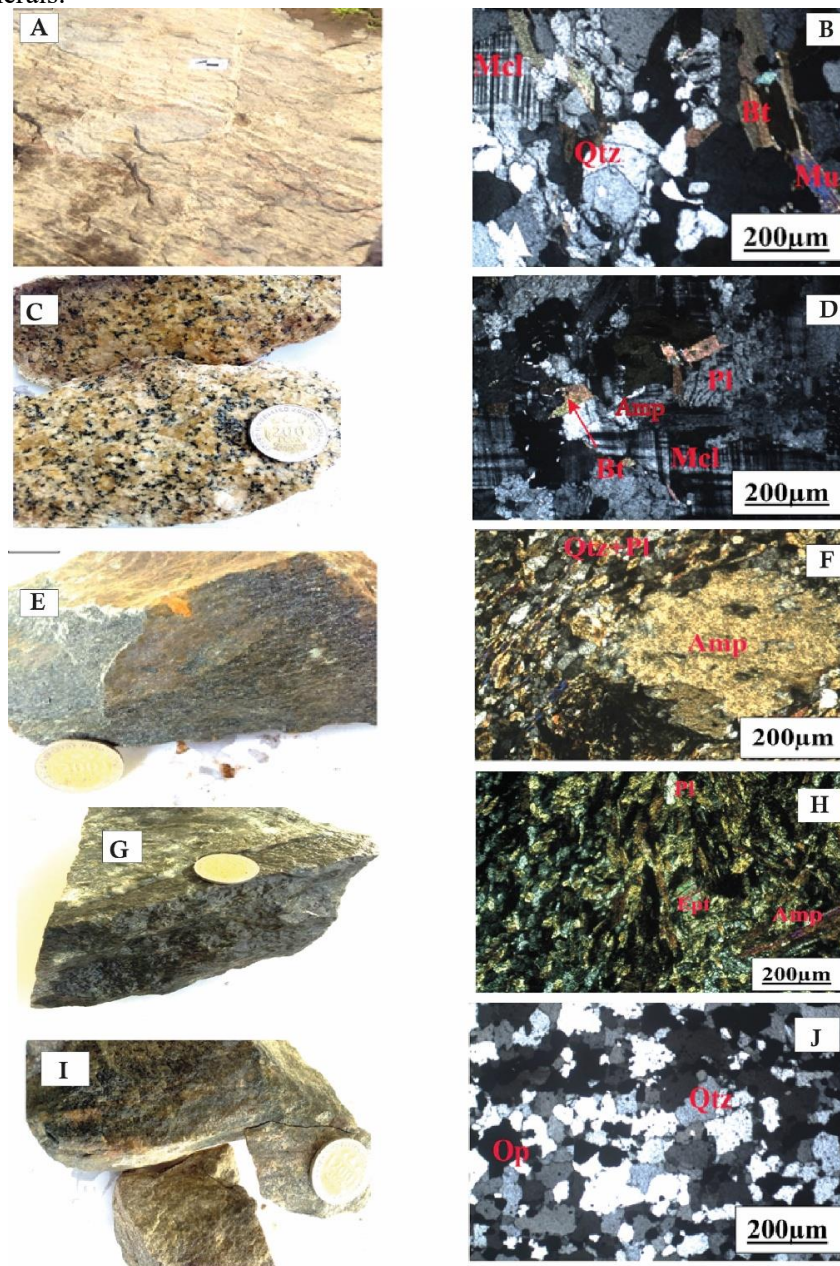


Figure 3 : Macroscopic and microscopic characteristics of the main lithologies identified in the study area. A, B: granite; C, D: granodiorite; E, F: microdiorite; G, H: amphibolite; I, J: magnetite-bearing quartzite. Abbreviations: Qtz = quartz; Pl = plagioclase; Bt = biotite; Mcl = microcline; Mus = muscovite; Op = opaque minerals; Ep = epidote; Amp = amphibole.

4.1.4. Magnetite-bearing Quartzite

Magnetite-bearing quartzite is not exposed in situ within the study area. It occurs mainly as eluvial and colluvial material approximately 300 m from the Gouabafla hill (Figure 3I et 3J). The material displays variable colors ranging from grayish to brownish and locally exhibits a distinct banded appearance characterized by centimeter-scale alternations of light and dark layers. The light bands are mainly composed of quartz and feldspar, whereas the darker bands contain abundant iron oxides, predominantly

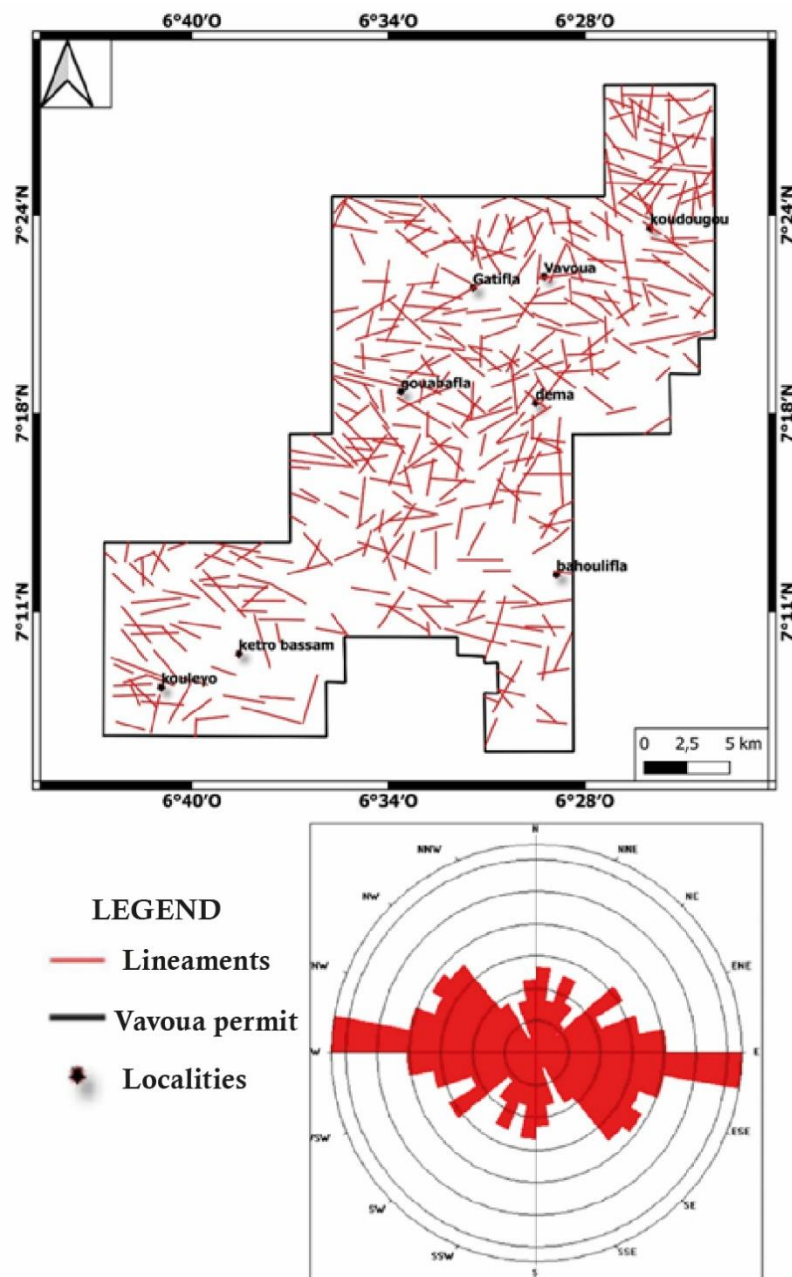


Figure 4 : Lineament map and associated directional rose diagram.

magnetite with possible subordinate ilmenite. The magnetic character of the material was confirmed in the field using a magnetic susceptibility pen. The banding is also evident in thin section, where the rock

displays a granoblastic texture and a mineral assemblage dominated by quartz and opaque minerals, mainly iron oxides. The mineralogical and textural characteristics of the magnetite-bearing quartzite indicate a strongly recrystallized quartz-rich lithology with compositional banding. However, because the unit is represented mainly by transported eluvial and colluvial material rather than by in-situ outcrops, its precise field relationships with the surrounding lithologies remain uncertain.

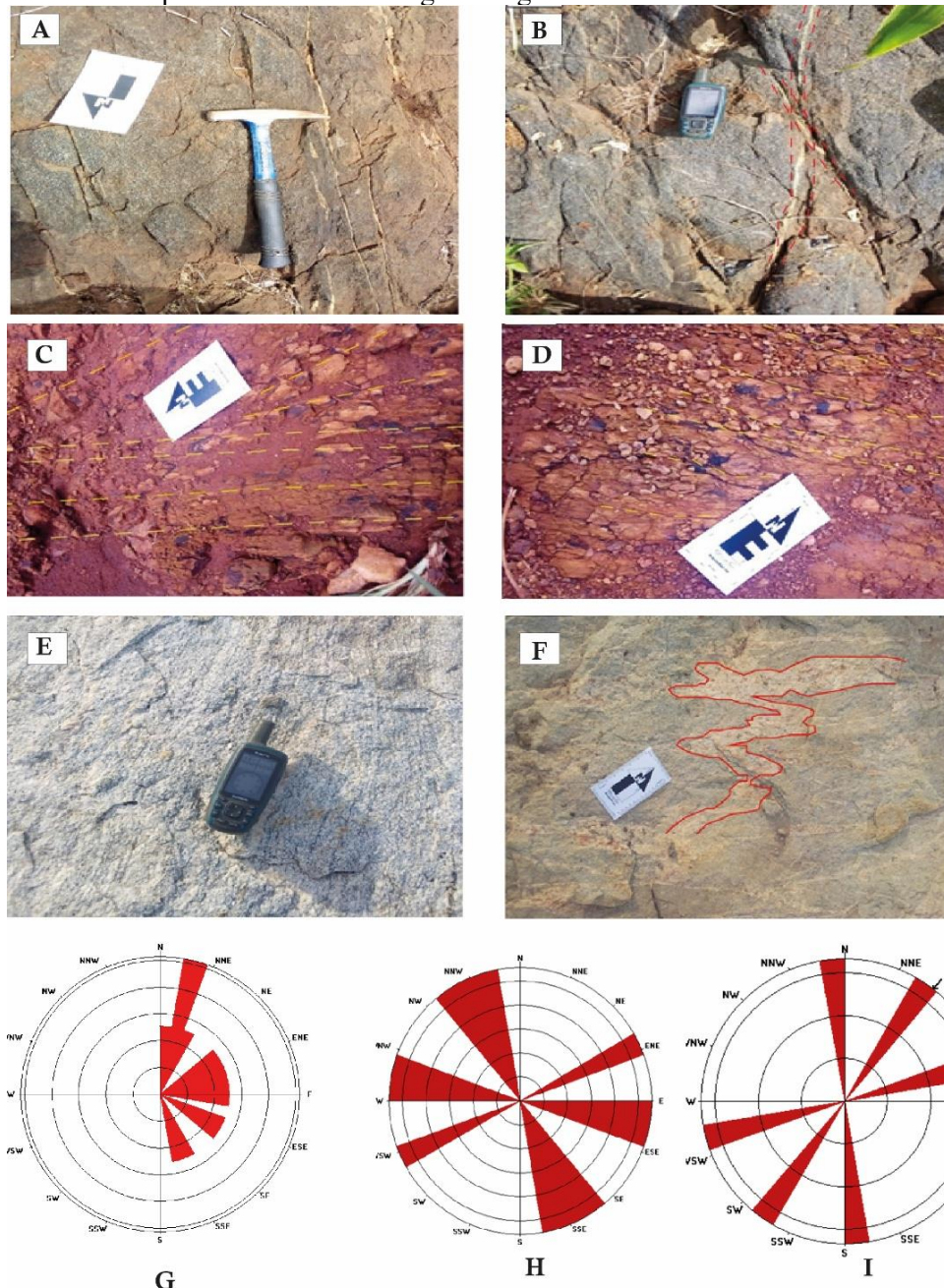


Figure 5 : Structural features observed within the study area. (A, B) Quartz veins and dykes observed within the exploration permit ; (C, D, E, F) Macroscopic features of fractures, faults, strike-slip structures, fracture cleavage, and foliation. (G) Directional rose diagram of veins and dykes ; (H) directional rose diagram of fractures ; (I) directional rose diagram of fracture cleavage.

4.2. Structural Analysis

4.2.1. Lineament Analysis

Processing and interpretation of Landsat 8 satellite imagery allowed the identification of 396 lineaments displaying variable orientations and lengths. A detailed lineament map of the study area was produced through the interpretation of images generated using different image-processing techniques (Fig. 4). The resulting map shows a relatively high density of lineaments with lengths ranging from several hundred meters to several kilometers. The lineaments were initially extracted from the processed imagery using ENVI and subsequently transferred to QGIS to produce the structural lineament map of the study area (Fig. 4). The combined interpretation of the enhanced satellite products facilitated the recognition and spatial mapping of linear features. The statistical analysis of the extracted lineaments indicates that the E–W trend is the dominant orientation, followed by NW–SE, NE–SW, and N–S trends (Fig. 4). These major lineament families are relatively homogeneously distributed throughout the study area. The lineaments identified from satellite imagery represent remotely sensed linear features and may reflect different geological or geomorphological discontinuities. Their precise nature cannot be established solely from remote sensing. However, field observations indicate that some of these lineaments correspond to fractures, faults, lithological contacts, quartz veins, foliation trends, and other linear geological structures. The integration of remote-sensing results with field measurements therefore provides a more robust basis for interpreting the structural framework of the study area.

4.2.2. Field Structural

Field investigations revealed a wide variety of structural features, reflecting the complex deformation history of the study area. These structures were classified into two broad groups according to their deformation style : brittle structures and ductile structures. Brittle structures include mainly fractures, fracture cleavages, quartz and pegmatite veins, faults, and strike-slip structures. Ductile structures include foliation, boudinage, and foliation deflections. Brittle deformation is characterized by discontinuities and openings within the rock, with or without displacement of the adjacent blocks. Some of these fractures are filled by hydrothermal or magmatic minerals, producing quartz or pegmatite veins. Brittle structures constitute the most frequently observed structural features in the study area. They occur discontinuously and display variable orientations and thicknesses (Figure 5A et 5B).

The observed quartz and pegmatite veins show several orientations, including approximately N120°, N90°, N95°, N100°, N160°, N165°, and N20°. On the Bahoulifla granite slab, quartz veins are commonly subparallel to pegmatite veins, many of which display boudinage. Dextral strike-slip structures with an approximately N80° orientation locally affect the pegmatite veins, indicating post-emplacement deformation of these structures. The directional rose diagrams constructed from the measured veins and dykes indicate a dominant NNE–SSW trend, with a secondary set ranging from ENE–WSW to E–W (Figure 5G et 5H). The coexistence of differently oriented vein sets and their cross-cutting and deformation relationships provides evidence for successive structural events affecting the study area.

Fracture cleavage is observed within the amphibolites and commonly occurs as regularly spaced, closely repeated fractures that are clearly visible at the outcrop scale (Figure 5C et 5D). The orientations and dips of the fracture cleavage planes are variable. Representative measurements include N180° with a dip of 62°, N40° with a dip of 60°, and N72° with a dip of 60°. The directional rose diagram of the measured fracture-cleavage orientations shows three main trends : NE–SW, ENE–WSW, and N–S (Figure 6I). Ductile deformation is expressed mainly by foliation, mineral lineation, folding, boudinage, and foliation deflection (Figure 6^E et 6F). The observed structures locally display evidence of rotational and non-coaxial deformation ; however, their kinematic significance is considered in relation to the geometry and cross-cutting relationships of the individual structures.

A weakly developed foliation is observed within the granite slab in the study area. It is expressed by alternating dark and light bands, reflecting compositional and/or mineralogical segregation. The measured

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foliation orientations range from approximately N10° to N40°, with dips of about 62°, generally toward the northwest. Folds observed in the study area mainly affect quartz and pegmatite veins, indicating that these veins were emplaced prior to, or during, at least part of the deformation responsible for their folding. A drag fold was identified within the granite (Figure 6F). Its general axial-plane orientation is NE–SW, providing an additional structural constraint on the deformation affecting the study area.

5. DISCUSSION

5.1. Lithological, Metamorphic and Hydrothermal Significance

The study area displays considerable lithological diversity. Macroscopic and microscopic investigations identified granite, granodiorite, microdiorite, amphibolite, and magnetite-bearing quartzite. These rocks exhibit variable degrees of metamorphic overprinting and alteration, as indicated by the partial destabilization of primary minerals and the development of secondary mineral assemblages. Both supergene and hydrothermal alteration are recognized, with hydrothermal alteration occurring as pervasive replacement and along veins and fractures. The main alteration assemblages identified include sericitization, epidotization, chloritization, sulfidation, and silicification. These alteration processes reflect the interaction between the host rocks and hydrothermal fluids, although some mineral transformations may also be related to metamorphic reactions. The widespread occurrence of chlorite, epidote, and sericite is broadly compatible with low-grade metamorphic conditions, particularly within the greenschist-facies range. However, the presence of amphibolite alone does not necessarily demonstrate that the entire study area experienced amphibolite-facies metamorphism. The coexistence of granitoids and metamorphic rocks is consistent with the geological architecture commonly documented in the Paleoproterozoic Baoulé-Mossi domain. However, lithological similarities with neighboring areas are insufficient to establish a reliable stratigraphic or tectonic correlation. Recent studies demonstrate that granitoids with broadly similar petrographic characteristics may have formed from different sources and through distinct magmatic processes (Parra-Avila *et al.*, 2016; Sakyi *et al.*, 2018; Sakyi *et al.*, 2020; Kwayisi *et al.*, 2025). The hydrothermal alteration identified in the study area is of particular interest from a metallogenic perspective. Silicification, sericitization, chloritization, epidotization, and sulfidation commonly accompany fluid–rock interaction in hydrothermal systems. Their spatial association with fractures, veins, and other structural discontinuities suggests that deformation may have provided pathways for hydrothermal fluid circulation.

5.2. Structural

The integration of remote-sensing and field structural data provides a comprehensive overview of the deformation affecting the study area. Analysis of the Landsat-derived lineaments shows that the E–W trend is dominant, followed by NW–SE, NE–SW, and N–S orientations. These regional lineament trends are complemented by field observations documenting fractures, fracture cleavage, faults, strike-slip structures, veins, foliation, mineral lineation, boudinage, drag folds, and foliation deflections. The coexistence of brittle and ductile structures indicates a polyphase deformation history involving both ductile and brittle deformation mechanisms. The principal structural trends identified in the field range from ENE–WSW to E–W, NNE–SSW, NW–SE, NE–SW, and N–S. The E–W trend identified from remote sensing is particularly prominent at the regional scale, whereas several N–S to NE–SW structures are also well represented among the field measurements. The observed structures indicate the operation of at least two broad deformation mechanisms: flattening, expressed mainly by foliation and mineral fabrics, and shearing, expressed by ductile and brittle shear-related structures. The occurrence of drag folds, boudinage, foliation deflections, mineral stretching lineation, and dextral strike-slip structures indicates that simple coaxial shortening alone cannot account for the observed structural architecture. The N–S and NE–SW trends identified in the field are associated locally with foliation, mineral stretching lineation, fracture cleavage, and quartz and pegmatite veins. In contrast, NW–SE and E–W structures commonly

correspond to fractures, faults, and quartz and pegmatite veins. Fracture cleavage measurements include approximately N180°, N40°, and N72°, corresponding broadly to N–S, NE–SW, and ENE–WSW trends.

5.3. Regional Tectonic Significance

The structural framework identified in the study area can be compared with regional structural trends previously documented in the Paleoproterozoic domains of Côte d'Ivoire. Tagini (1971) reported ESE–WNW-trending fractures associated with a major tectonic boundary and interpreted them in relation to thrusting of Paleoproterozoic rocks toward the south over the Archean basement. According to this regional model, the intensity of collision-related deformation decreases away from the Archean basement margin. The NNW-trending faults observed in the study area can also be compared with structures documented in the Agbahou and Bonikro gold districts (Houssou, 2013; Ouattara, 2015). Previous regional studies have associated NW-trending structures within Birimian terranes with strike-slip deformation and transcurrent tectonics (Milési *et al.*, 1992; Feybesse *et al.*, 2006; Lompo, 2010; Ouattara, 2015). These regional comparisons suggest that the structural architecture observed at Vavoua may reflect deformation processes that affected a broader part of the Paleoproterozoic domain.

5.4. Structural Implication for Gold Exploration

The relationship between major structures and hydrothermal fluid circulation is particularly relevant to gold exploration in Paleoproterozoic terranes. Previous studies from several Birimian gold districts, including Aféma, Agbahou, Bobosso, Bonikro, and Kalamon, have emphasized the importance of shear zones and associated structures in controlling the emplacement of gold mineralization (Assié, 2008 ; Houssou, 2013 ; Gnanzou, 2014 ; Ouattara, 2015). In these systems, faults and shear zones act as preferential pathways for hydrothermal fluids and may localize mineral precipitation where suitable physical and chemical conditions are developed. These structures, together with quartz veins and hydrothermal alteration, define zones that may be considered structurally favorable targets for further gold exploration. The integration of lithological, structural, and remote-sensing data ultimately allowed the construction of a lithostructural sketch map of the study area (Figure 6).

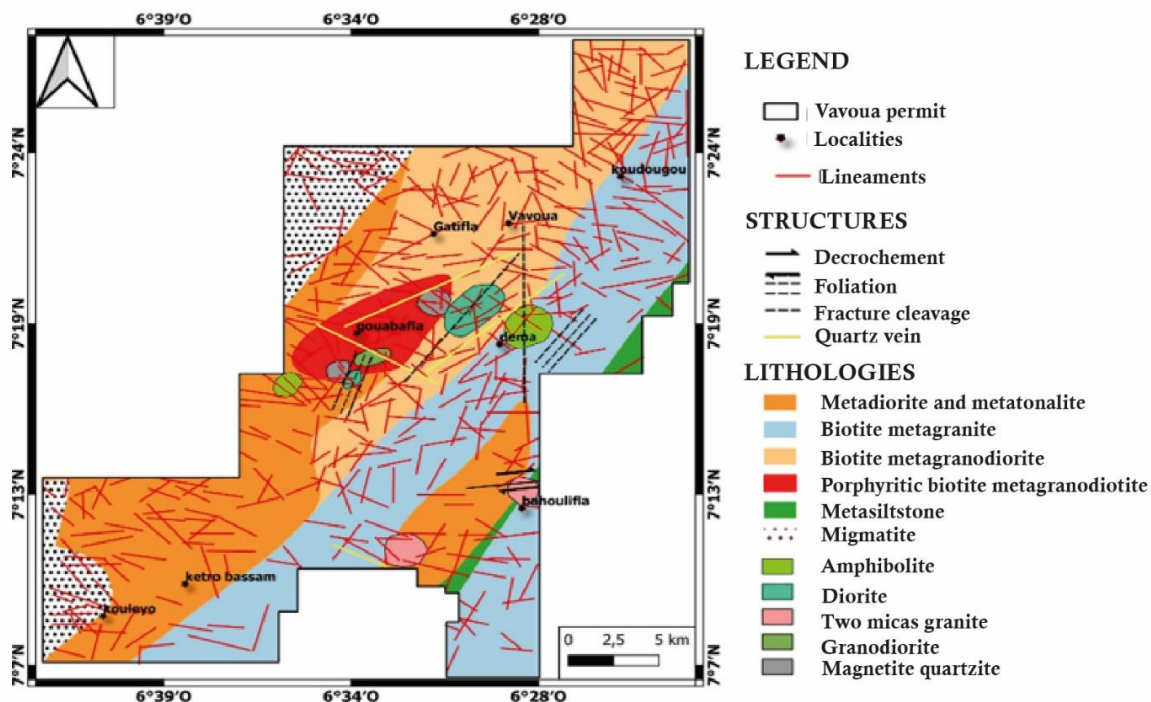


Figure 6 : Lithostructural sketch map of the study area

6. CONCLUSION

This study provides a petrographic and structural characterization of the Vavoua area within the Paleoproterozoic domain of the West African Craton. Petrographic investigations identified two-mica granite, granodiorite, microdiorite, amphibolite, and magnetite-bearing quartzite. The rocks have been affected by both intense meteoric weathering and hydrothermal alteration, occurring as pervasive alteration and as vein- and fracture-controlled alteration. The main hydrothermal alteration features include sericitization, silicification, sulfidation, epidotization, and chloritization. The mineral assemblages identified are broadly consistent with low-grade metamorphic conditions, predominantly within the greenschist-facies range. The integration of remote-sensing and field structural data revealed a complex deformation architecture characterized by both brittle and ductile structures. The main structural features include fractures, fracture cleavage, veins and dykes, dextral strike-slip faults, foliation, mineral stretching lineations, boudinage, foliation deflection, and drag folds. These structures record deformation involving both flattening and shearing mechanisms. The principal structural trends identified include ENE–WSW, E–W, NW–SE, and NE–SW orientations. The coexistence of deformation structures, quartz and pegmatite veins, and hydrothermal alteration indicates that the structural network may have provided pathways for hydrothermal fluid circulation. These relationships define structurally favorable zones that warrant further investigation in the context of gold exploration. However, the present dataset does not provide sufficient evidence to unequivocally demonstrate the existence of a major through-going shear zone or economically significant gold mineralization. The structural framework is therefore best regarded as a potentially favorable exploration setting rather than direct evidence of a mineralized shear zone.

REFERENCES

- Ahimon O. (1990).** Explanatory note to the geological map of Côte d'Ivoire at 1:200,000, Daloa sheet. *Memoir of the Directorate of Geology*, Abidjan, Côte d'Ivoire, No. 1, 28 p.
- Amponsah P. O., Kwayisi D., Awunyo E. K., Sapah M. S., Sakyi P. A., Su B.-X., Lu Y., Nude P. M. (2023).** New evidence for crustal reworking and juvenile arc magmatism during the Paleoproterozoic Eburnean events in the Suhum Basin, south-eastern Ghana. *Geological Journal*, 58, 3734–3755. <https://doi.org/10.1002/gj.4790>
- Assie K. E. (2008).** Lode gold mineralization in the Paleoproterozoic (Birimian) volcano-sedimentary sequence of the Afema gold district, south-eastern Côte d'Ivoire. Thesis, Faculty of Energy and Economic Sciences, Technical University of Clausthal, Germany, 198 p.
- Baratoux L., Metelka V., Naba S., Jessell M. W., Grégoire M., Ganne J. (2011).** Juvenile Paleoproterozoic crust evolution during the Eburnean orogeny: a case study of the Kédougou-Kéniéba inlier, eastern Senegal. *Precambrian Research*.
- Block S., Ganne J., Baratoux L., Zeh A., Parra-Avila L. A., Jessell M. W., Ailleres L., Siebenaller L. (2015).** Petrological and geochronological constraints on lower crust exhumation during the Paleoproterozoic Eburnean orogeny, north-western Ghana. *Journal of Metamorphic Geology*, 33, 463–494.
- Chardon D., Bamba O., Traoré K. (2020).** Eburnean deformation pattern of Burkina Faso and the tectonic significance of shear zones in the West African Craton. *BSGF – Earth Sciences Bulletin*, 191, 2. <https://doi.org/10.1051/bsgf/2020001>
- Chardon D., Berger J., Martellozzo F. (2024).** Archean craton assembly and Paleoproterozoic accretion-collision tectonics in the Reguibat Shield, West African Craton. *Precambrian Research*, 413, 107570. <https://doi.org/10.1016/j.precamres.2024.107570>

- Eglinger A., Thébaud N., Baratoux L., Davis J., Miller J., Jessell M. (2017).** Petrology and geochemistry of Paleoproterozoic granitoids of the southern West African Craton.
- Feybesse J.-L. (2001).** Geometry and kinematics of fractures controlling the emplacement of quartz veins and veinlets at the Angovia gold mine (Yaouré, Côte d'Ivoire). Compagnie Minière d'Afrique, Internal unpublished report, pp. 94–100.
- Feybesse J.-L., Billa M., Guerrot C., Duguey E., Lescuyer J.-L., Milési J.-P., Bouchot V. (2006).** The Paleoproterozoic Ghanaian province: geodynamic model and ore controls, including regional stress modeling. *Precambrian Research*, **149**, 149–196.
- Feybesse J.-L., Milési J.-P. (1994).** The Archean/Paleoproterozoic contact zone in West Africa: a major crustal boundary.
- Ganne J., De Andrade V., Weinberg R. F., Vidal O., Dubacq B., Kagambega N., Naba S., Baratoux L., Jessell M., Allibone A. (2012).** Modern-style plate subduction preserved in the Palaeoproterozoic West African Craton. *Nature Geoscience*, **5**, 60–65.
- Gnanzou A. (2014).** Study of the volcano-sedimentary sequences of the Dabakala region (north-eastern Côte d'Ivoire): genesis and magmatic evolution. Contribution to the knowledge of the Bobosso gold mineralization in the Haute-Comoé sequence. Scientific Doctorate, Université Paris-Sud Orsay, 229 p.
- Goldfarb R. J., Groves D. I., Gardoll S. (2001).** Orogenic gold and geologic time: a global synthesis. *Ore Geology Reviews*, **18**, 1–75.
- Grenholm M., Jessell M., Thébaud N. (2019).** A geodynamic model for the Paleoproterozoic (ca. 2.27–1.96 Ga) Birimian Orogen of the southern West African Craton. *Earth-Science Reviews*, **192**, 138–193. <https://doi.org/10.1016/j.earscirev.2019.02.006>
- Houssou N. N. (2013).** Petrological, structural and metallogenic study of the Agbahou gold deposit, Divo, Côte d'Ivoire. Doctoral thesis, Université Félix Houphouët-Boigny, 177 p.
- John T., Schenk V., Haase K., Scherer E. (1999).** Evidence for a Paleoproterozoic high-pressure metamorphic event in the West African Craton.
- Kouamelan A. N. (1996).** Geochronology and geochemistry of the Archean and Proterozoic formations of the Man Ridge, Côte d'Ivoire. Doctoral thesis, Université de Rennes.
- Kwayisi D., Amponsah P. O., Awunyo E. K., Sapah M. S., Sakyi P. A., Su B. X., et al. (2025).** Petrology and geochemistry of the Suhum Basin granitoid complex, Ghana: implications for crustal growth during the Rhyacian orogeny of the West African Craton. *Journal of African Earth Sciences*, **222**, 105475. <https://doi.org/10.1016/j.jafrearsci.2024.105475>
- Ledru P., Ponsard J.-L., Clauer N. (1991).** The Birimian orogeny in West Africa.
- Lompo M. (2010).** Structural evolution of the Paleoproterozoic belts (Eburnean event) in the Man-Leo Shield, West African Craton. *Journal of African Earth Sciences*, **58**, 231–254.
- Masurel Q., Eglinger A., Thébaud N., Allibone A., André-Mayer A.-S., McFarlane H., Miller J., Jessell M., Aillères L., Vanderhaeghe O., Salvi S., Baratoux L., Perrouty S., Begg G., Fougereuse D., Hayman P., Wane O., Tshibubudze A., Parra-Avila L., Kouamélan A., Amponsah P. O. (2022).** Paleoproterozoic gold events in the southern West African Craton: review and synopsis. *Mineralium Deposita*, **57**, 513–537. <https://doi.org/10.1007/s00126-021-01052-5>
- Milési J.-P., Feybesse J.-L., Ledru P., Dommanget A., Ouedraogo M.-F., Marcoux E., et al. (1989).** Gold mineralizations of West Africa. *Chronique de la Recherche Minière*, 497.

- Milési J.-P., Ledru P., Feybesse J.-L., Dommange A., Marcoux E. (1992).** Early Proterozoic ore deposits and tectonics of the Birimian orogenic belt, West Africa. *Precambrian Research*, **58**, 305–344.
- Mortimer J. (2016).** Paleoproterozoic geology of the Toumodi area, Ivory Coast, 1:100,000. *Journal of Maps*, **12**, 392–400. <https://doi.org/10.1080/17445647.2016.1227732>
- Ouattara Z. (2015).** Lithostratigraphic, structural, geochemical and metallogenic characteristics of the Bonikro deposit, Fettekro Birimian belt, central-southern Côte d'Ivoire. Doctoral thesis in Science, Université Félix Houphouët-Boigny, Côte d'Ivoire, 275 p.
- Parra-Avila L. A., Belousova E., Fiorentini M. L., Baratoux L., Davis J., Miller J., McCuaig T. C. (2016).** Crustal evolution of the Paleoproterozoic Birimian terranes of the Baoulé-Mossi domain, southern West African Craton: U–Pb and Hf-isotope studies of detrital zircons. *Precambrian Research*, **274**, 25–60. <https://doi.org/10.1016/j.precamres.2015.09.005>
- Passchier W., Trouw R. A. J. (1998).** Microtectonics. Springer, Berlin, Heidelberg, New York, 289 p.
- Perret J., Thébaud N., Fougrouse D., Brochard C., Hayman P. C., Jessell M. W. (2025).** Crustal to microscale strain partitioning during transpression and control on ore formation: insights from the Paleoproterozoic Séguéla Shear Zone, southern West African Craton. *tektonika*, **3**, 127–154. <https://doi.org/10.55575/tektonika2025.3.2.108>
- Perret J., Thébaud N., Fougrouse D., Brochard C., Hayman P. C., Jessell M. W. (2026).** Transpressional flow and escape of orogens: the Paleoproterozoic Eburnean accretionary orogen of West Africa. *Journal of Structural Geology*, **210**, 105742. <https://doi.org/10.1016/j.jsg.2026.105742>
- Pitra P., Kouamelan A. N., Ballèvre M., Peucat J.-J. (2010).** Palaeoproterozoic high-pressure granulite overprint of Archean continental crust: evidence for homogeneous crustal thickening, Man Rise, Ivory Coast. *Journal of Metamorphic Geology*, **28**, 41–58.
- Salvi S., Baratoux L., et al. (2015).** Gold deposits and tectonic evolution of the Paleoproterozoic West African Craton.
- Sakyi P. A., Nude P. M., Su B.-X., et al. (2018).** Geochemical and Sr–Nd isotopic records of Paleoproterozoic metavolcanics and mafic intrusive rocks from the West African Craton: evidence for petrogenesis and tectonic setting. *Geological Journal*. <https://doi.org/10.1002/gj.2923>
- Sakyi P. A., Addae R. A., Su B.-X., Dampare S. B., Abitty E., Su B.-C., Liu B., Asiedu D. K. (2020).** Petrology and geochemistry of TTG and K-rich Paleoproterozoic Birimian granitoids of the West African Craton (Ghana): petrogenesis and tectonic implications. *Precambrian Research*, **336**, 105492. <https://doi.org/10.1016/j.precamres.2019.105492>
- Satkoski A. M., et al. (2017).** Birimian crustal growth in the West African Craton: U–Pb, O and Lu–Hf isotope constraints from detrital zircon in major rivers. *Chemical Geology*, **479**, 259–271. <https://doi.org/10.1016/j.chemgeo.2018.01.021>
- Tagini B. (1971).** Structural sketch of Côte d'Ivoire: an attempt at regional geotectonics. Doctoral thesis, Université de Lausanne, Côte d'Ivoire (SODEMI), Bulletin No. 5, 302 p.
- Thébaud N., et al. (2023).** The metasedimentary-hosted Nyangoubé gold prospect, north-western Côte d'Ivoire: geochemical and mineralogical characterization of associated hydrothermal alteration. *Heliyon*, **9**, e20227. <https://doi.org/10.1016/j.heliyon.2023.e20227>
- Toutin T. (1996).** Opposite-side ERS-1 SAR stereo mapping over rolling topography. *IEEE Transactions on Geoscience and Remote Sensing*, **34**(2), 543–549.

- Traoré K., Chardon D., Naba S., Wane O., Bouaré M. L. (2022).** Paleoproterozoic collision tectonics in West Africa: insights into the geodynamics of continental growth. *Precambrian Research*, 376, 106692.
- Vernon N. J., et al. (2008).** Fluid immiscibility and gold deposition in the Birimian quartz veins of the Angovia deposit (Yaouré, Ivory Coast). *Journal of African Earth Sciences*, **50**, 234–254. <https://doi.org/10.1016/j.jafrearsci.2007.09.014>
- Yacé I. (2002).** Introduction to geology: the example of Côte d'Ivoire and West Africa. CEDA, Abidjan, Côte d'Ivoire, 183 p.
- Yésou P., et al. (1993).** Geological and geophysical data on the Precambrian formations of Côte d'Ivoire.