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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

Fabric of the syntectonic emplaced Magba granite (Central Cameroon domain): constraints from anisotropy of magnetic susceptibility (AMS), microstructures and vorticity

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1. Introduction and geological settings

Over the last three decades, various methods have been provided to analyse the fabrics in plutonic rocks, including anisotropy of magnetic susceptibility (AMS) and vorticity data (e.g. Mamtani, 2014; Bella Nke et al., 2018). It is well established that AMS technique can be used to determine magnetic fabric or petrofabric in the rocks devoid of visible stretching lineation and/or foliation (Bella Nke et al, 2022; Mengou et al., 2025). In the present work, field, AMS, microstructures and vorticity data have been combined to decipher the fabrics development and the tectonic evolution of the Magba granite, located in the Central African Fold Belt (CAFB),central Cameroon domain (Fig. 1).

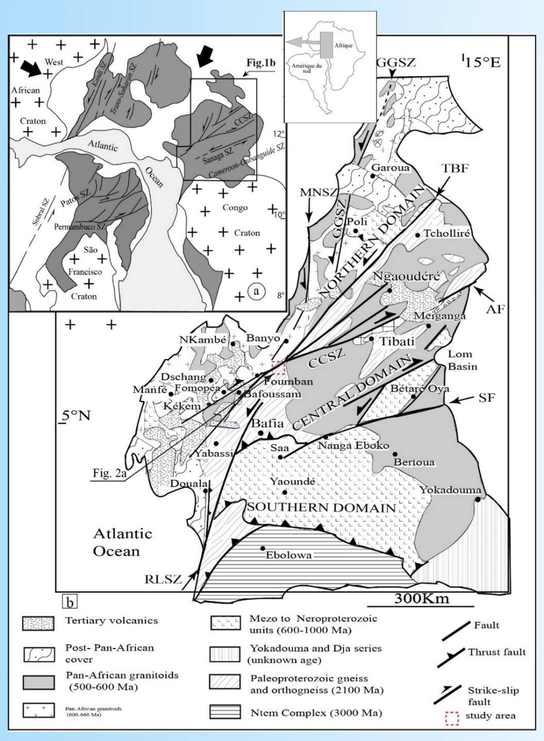

Fig. 1. (a) – Pan–African zone network in a pre–Mesozoic reconstruction (modified by Caby et al.. 1991) ; (b) – Lithotectonic map of Cameroon with the different domains (south, Central and NW) (from Toteu et al., 2001, and modified by Njanko et al., 2010) and the study area location : Central Cameroon Shear Zone (CCSZ) ; Tcholleré Banyo Fault (TBF) ; Sanaga Fault (SF) ; Mayo Nolti Shear Zone (MNSZ) ; Gode Gormaya Shear Zone (GGSZ) ; RLSZ : Rocher du Loup Shear Zone (RLSZ)

2. Materials and methods: AMS measurements

The AMS was measured on 105 oriented cylindrical cores of 25.4 mm diameter and 22 mm height in LGME (Ouagadougou, Burkina Faso) using a susceptibilimeter MFK1-FA (AGICO) to obtain scalar and directional parameters. Thermomagnetic and hysteresis analysis were carried out in CEREGE (Aix Marseille Université (AMU); France) using the CS3 furnace of the MFK1 (AGICO) and the VSM Micromag 3900 (PMC). Microstructural study was carried out on thin section oriented parallely to the magnetic lineation (K_1) and perpendicularly to the magnetic foliation (K_1K_3) plane. CPO analyses were acquired by EBSD technique in the CRF, (Central Research Facility), IIT Kharagpur, India.

3. Results

3.1. Petrography, structural analysis and microstructure

The Magba granite, elongated SW–NE (Fig. 2), is intruded in banded biotite gneiss. It is mainly composed of biotite granite and granodiorite (Fig. 2b). The biotite granite has a porphyric texture marked by megacrysts of alkali feldspar (Fig. 3a), protomylonitic (Fig. 3b) to porphyritic cataclastic textures. Granodiorite (Fig. 3c) has heterogranular microstructure (Fig. 3d).

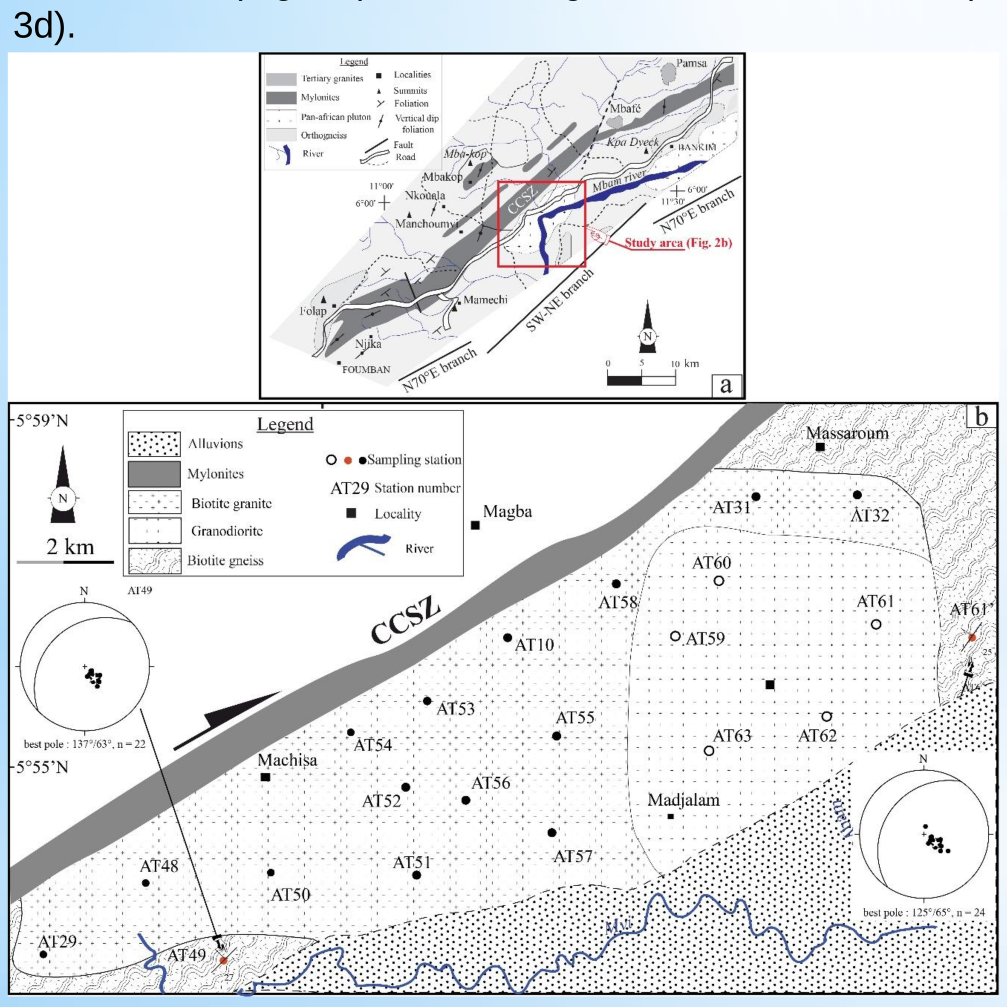

Fig. 2. (a) – Simplified lithotectonic map of the Central Cameroon Shear Zone (CCSZ) displaying its two directions branches (NE–SW and N70°E) in the Foumban–Bankim area in the Tikar plain (Njonfang et al., 2006) and the location of studied granite; (b) – Geological sampling map of the study area with AMS stations

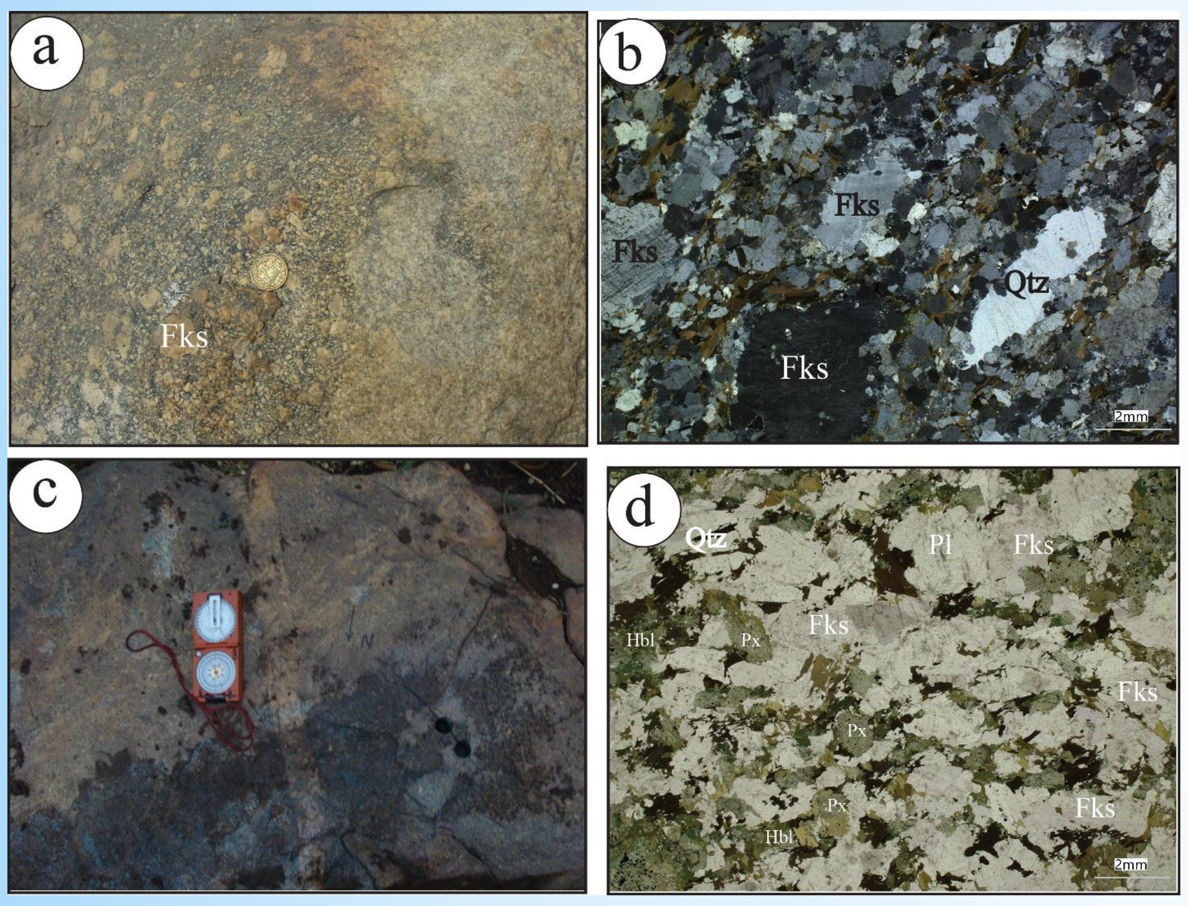

Fig. 3. Field photographs (a and c) and photomicrographs (under plane polarized ligth (b and e) of the Magba granite : (a) – Biotite phenocrysts K–feldspar granite outcrop, note the preferred orientation of alkali fledspar crystal; (b) – K–feldspars porphyroclasts and dynamic recrystallization of quartz in the preferred orientation expressing mylonitic deformation (station AT29) ; (c) – granodiorite outcrop in the field (station AT31); (d) – granodiorite showing mylonitic texture with clasts of pyroxene (Px), feldspars in preferred orientation (station AT59)

The Magba granite displays solid–state deformation microstructures such as kink–band, twins and bending recorded in feldspar and amphiboles crystals and quartz rubans (Fig. 4a–c) observed in the northwestern edge, at the vicinity of the shear zone. Syn–magmatic flow fabric (Fig. 4d) are observed at the southeastern part of the Magba granite.

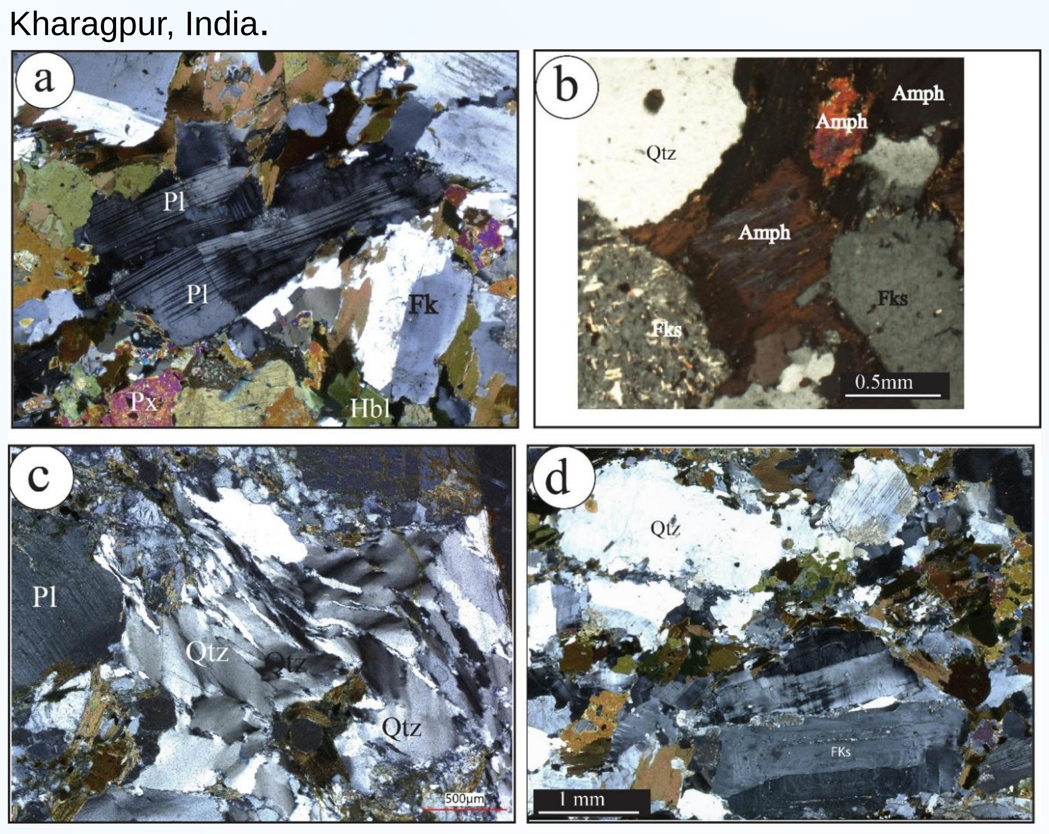

Fig. 4. Photomicrographs of Microstructures of magmatic and intra plastic deformation in the Magba granite : (a–b): Plagioclase and amphibole crystals affected by kink–band deformation characterizing plastic deformation at high– to moderate– temperature, (e) elongated quartz crystals and ribbons of recrystallized quartz showing dynamic recrystallization ; (d) – Preferred orientation of euhedral to subeuheral zoning feldspars crystals in diorite and quartz crystal without deformation indicating magmatic deformation.

Foliation in biotite gneiss strikes NE-SW with low dips towards NW (Fig. 2b). Kinematic markers (Figs. 5a –b) and asymmetric c–axis of quartz grains (Fig. 5c) indicate ubiquitous dextral, top to the NE sense of shear movement. Consistently, the quartz CPO suggest an association of basal <a> and prism <a> slip (Fig. 5c).

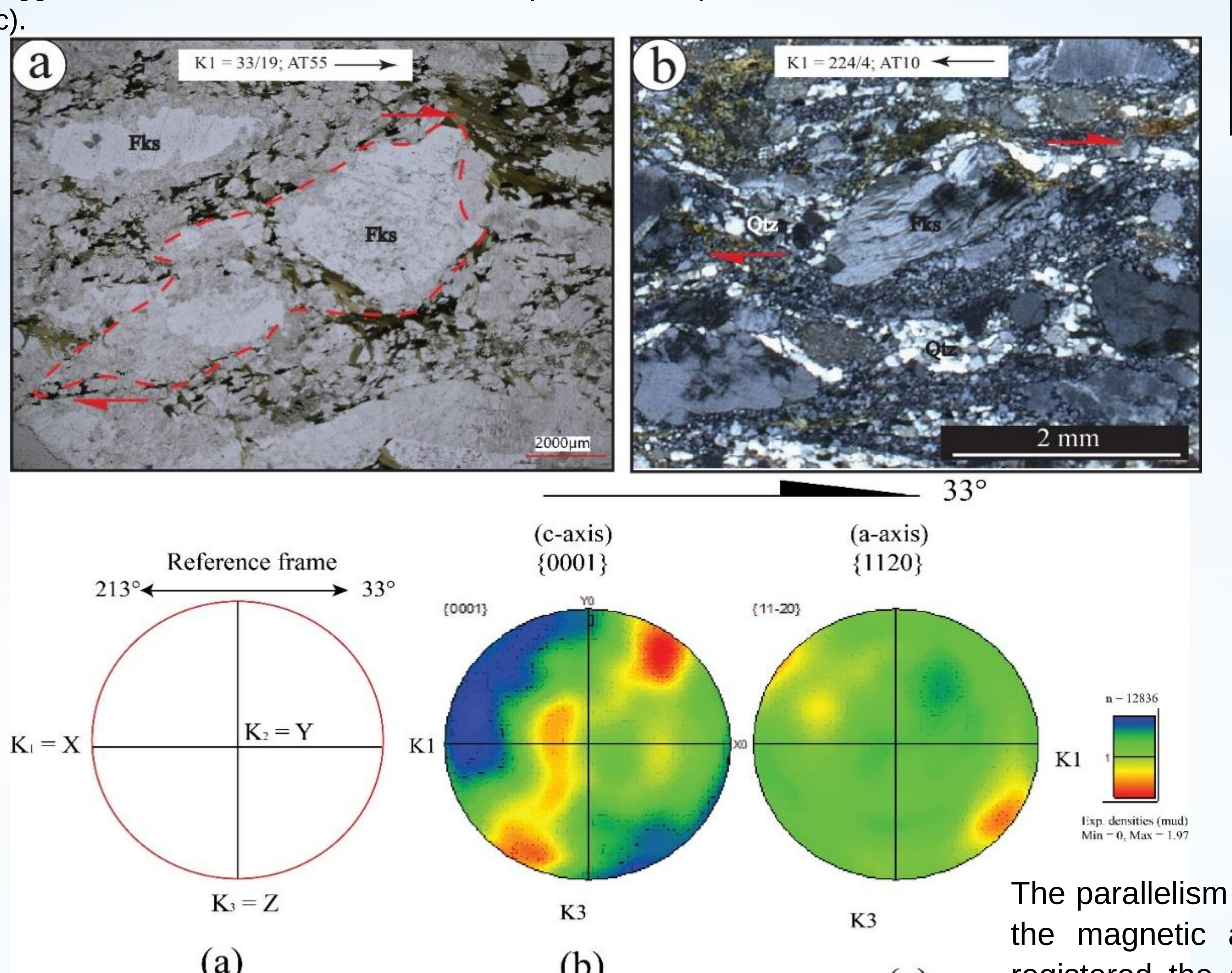

Fig.5 – Evidence of dextral sense of shear movement in Magba granite: a) σ– type markers of K–feldspar in dextral movement in biotite granite ; (b) asymmetric quartz pressure shadows around K–feldspar porphyroclast in dextral movement in biotite granite; (c) Quartz CPO analyses obtained through SEM-EBSD data indicated sense of shear top-towards 33° (the direction of K_1)

3.2. Magnetic susceptibility (Km), magnetic mineralogy, degree of magnetic anisotropy (Pj) and shape parameter (Tj)

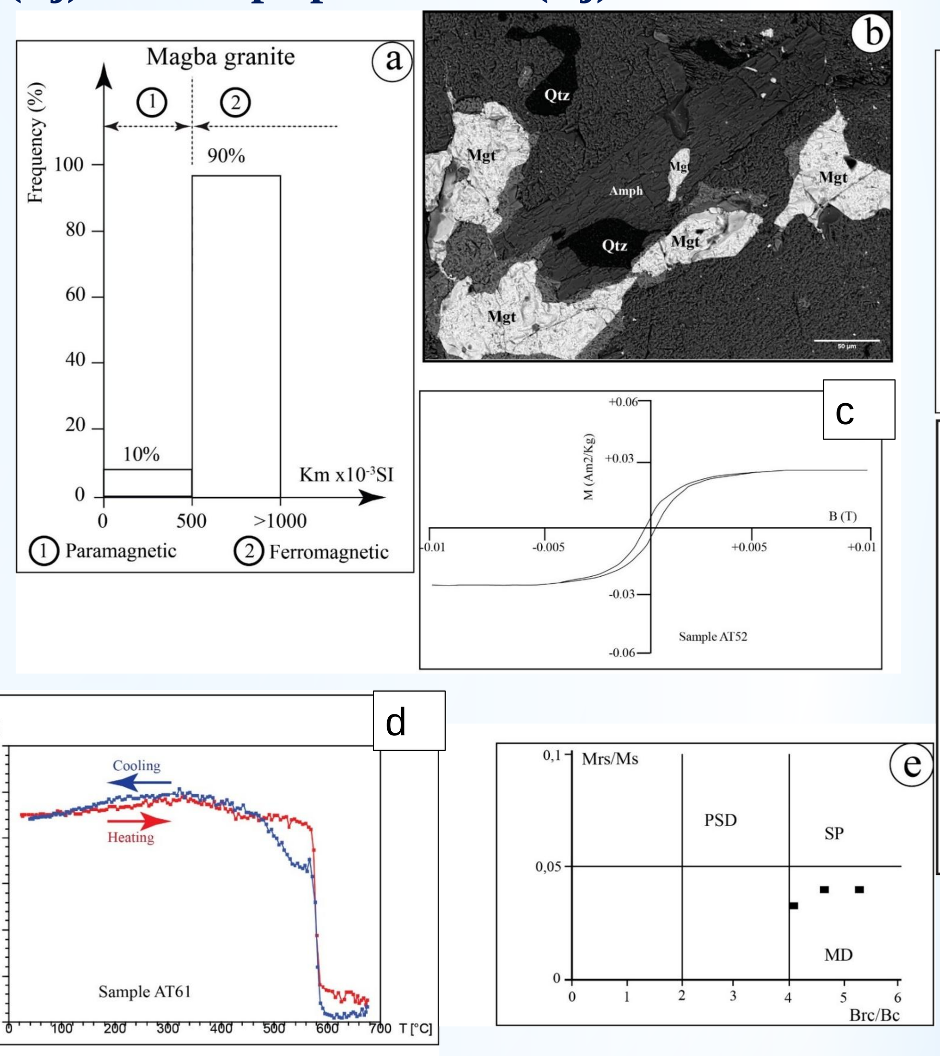

Fig. 6: (a) Histogram of Km values; b- SEM images of sub-euhedral magnetite grains;; c– Hysteresis loops of representative sample showing ferromagnetic features and day diagram, (d) KT curve (e) of Magba granite

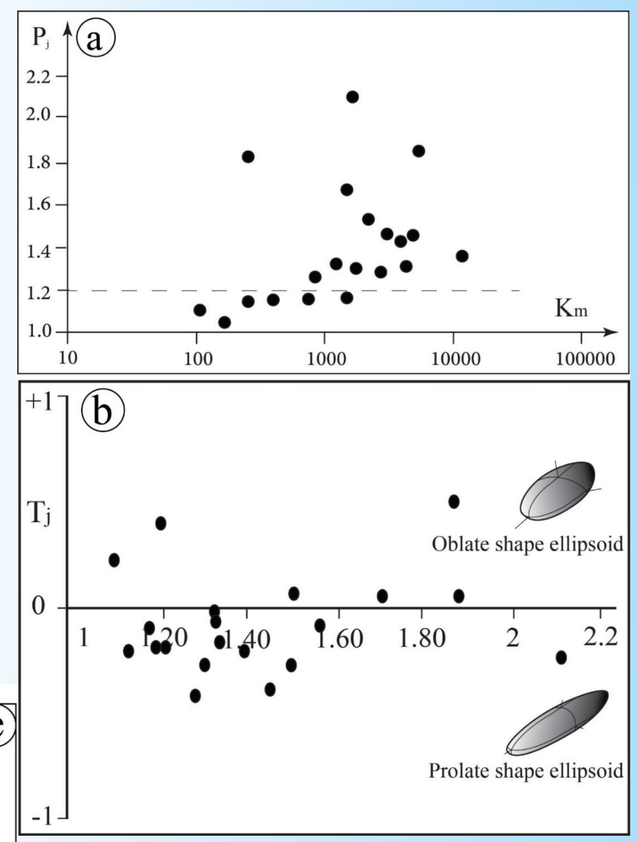

Fig. 7 : Pj vs Km semi-log plot diagram (a) and Tj vs Pj plot diagram (b) of Magba granite

3.3. Magnetic foliation (K_3) and lineation (K_1)

The magnetic fabric in the Magba granite mainly strikes N–S to NE–SW (60% of the stations). The NE–SW direction is observed in the SW and the top parts of the pluton (Fig.8). In the central part of the pluton, the various directions of both magnetic foliation and lineation display concentric fabric. The directions of the magnetic fabric seem to display concentric fabric centered on a virtual station located at the east of Madjalam locality.

In the country rocks, the magnetic fabric displays NE–SW direction parallel with the field fabric, with moderate dips and low plunges towards SW.

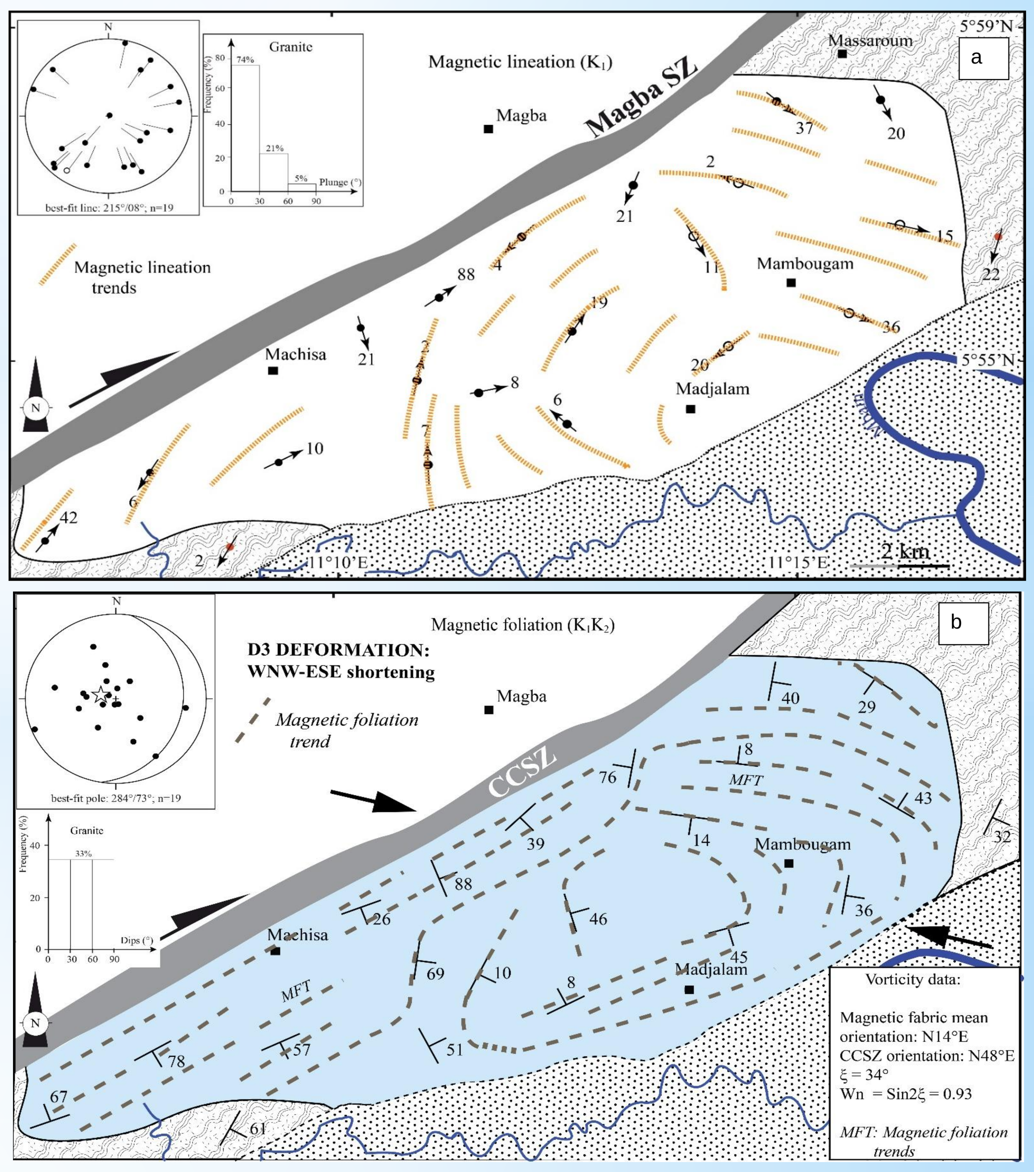

Fig. 8: Magnetic fabric maps: lineation (a) and foliation (b) associated with their lower hemisphere equal area projection diagrams and histograms; Lower hemisphere equal area projection diagram of AMS orientations (K1 > K2 > K3) of mean data obtained from 25 samples from Magba granite.

4. Discussion and conclusion

The parallelism existing between the magnetic fabric of the studied granite, the magnetic and field fabrics of its country rock indicate that both registered the same phase of deformation during dextral top to the NE shear movement. The Magba granite displays fabric emplace syn–tectonically with it country rock, at temperatures above 670°C.

Moreover, the dextral shear movement is pervasive in the CAFB in Cameroon and mainly recorded in the CCSZ during D_3 tectonic event, dated at 585–540 Ma (Ngako and Njonfang, 2011). Thus, it can then be concluded that the magnetic fabric in the Magba granite is coeval to the D_3 tectonic event of the regional deformation.

The kinematic vorticity number Wn, with Wn = (Sin2ξ), gives Wn = 0.93 (Fig. 8b), implying emplacement of the granite under simple shear.

The CCSZ then played a role in the migration of the granitic magma through pathway in dextral transpressive regime. Then, throughout a depth crustal opening, in relation with the functioning of the CCSZ, there was a dilatation that provided space to allow the ascension of the melt (Fig. 9a and b). This enabled the magma to ascend towards the upper crustal level during D_3 deformation (Fig. 9b and c).

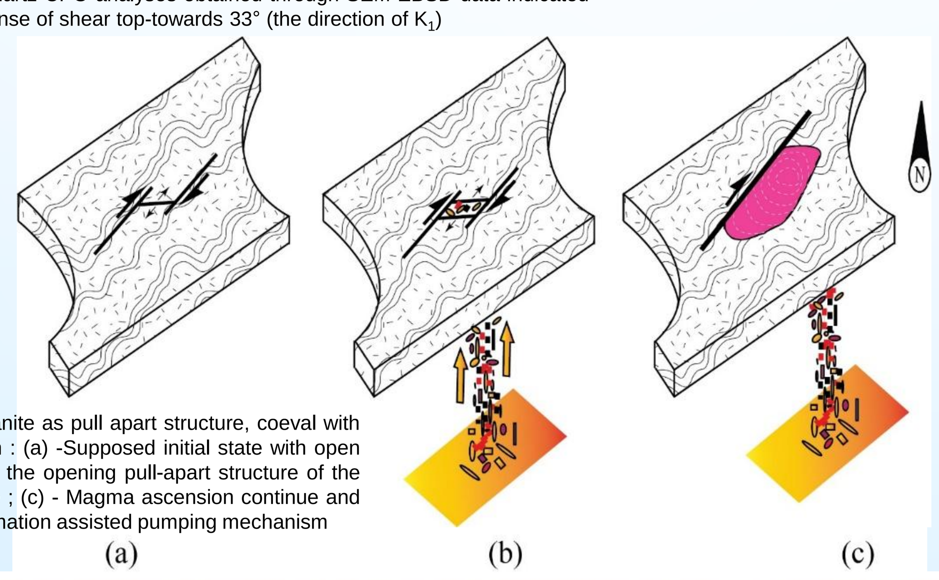

Fig. 9. Emplacement model of the Magba granite as pull apart structure, coeval with the regional transpressive dextral deformation : (a) -Supposed initial state with open crack ; (b) -Progressive magma ascension in the opening pull-apart structure of the magma to the emplacement of Magba granite ; (c) - Magma ascension continue and the final state of the Magba granite with deformation assisted pumping mechanism

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