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Structural and geochronological investigations of (meta) granitoids of western Cameroon, central-Africa: implications on the evolution of the Pan-Africano/Brazilian belt

G. Njiekak*,
Institute for Geophysical Research, Department of Physics, University of Alberta, Edmonton, Alberta, T6G 2J1, Canada njiekak@ualberta.ca

A. Gerdes,
Institute of Geosciences, Frankfurt a. M. University, Altenhöferallee 1, D-60438 Frankfurt a.M., Germany

Jean-Pierre Tchouankoué,
Department of Earth Sciences, University of Yaoundé I, P.O. Box, 812 Yaoundé, Cameroon

and

G Zulauf,
Institute of Geosciences, Frankfurt a. M. University, Altenhöferallee 1, D-60438 Frankfurt a.M., Germany

Summary

Striking characteristics of the Pan-African belt of central Africa north of the Congo craton are the large volume of granitoids and crustal-scale shear zones. New structural and geochronological data from this area are provided to put constraints on the tectonic evolution of this segment of the belt and to make further correlations between major shear zones exposed on both sides of the Atlantic Ocean.

Field studies have revealed the presence of the following complexes: the migmatitic complex of Foumbot (MCF), the Bangwa complex (BC), the Chepang complex (CC), and the Batié pluton (BP). Combining (micro)structural patterns with the obtained geochronological data, three tectono-magmatic phases have been pointed out: The first phase was marked by the emplacement of (grano)dioritic rocks of the BC and protoliths of the migmatites of the MCF at ca. 640 Ma. The inferred BC and MCF granitoids emplaced before and/or during a regional SSE-directed thrusting event. The second phase led to the emplacement of syenogranitic rocks the BC and granite in the CC at ca. 607 Ma. The intrusion of the ca. 607 Ma old granitoids marked the change from nappe to (sinistral) transcurrent tectonics within the BC. The emplacement of the porphyritic syenogranite of Batié at ca. 600 Ma marked the third tectono-magmatic phase. Few inherited zircon cores of Paleoproterozoic age within granitic rocks of the BC suggest some inputs of Eburnean crust to the evolution of the Pan-African granitoids.

There are geochronological correlations between the (meta)granitoids of the study area and Brasiliano pre- to syn-transcurrent granitoids of the Borborema province. Some differences in shear kinematics between these two domains exist, especially in the late stage of the Pan-Africano/Brazilian event (since ca. 600 Ma).

Introduction

The Neoproterozoic fold belt of Cameroon (NFBC) is characterized by the presence of voluminous plutonic bodies that are surrounded and/or cut by a network of continental-scale shear zones. Available data on the NFBC suggest the belt to have been formed as the West African and the Congo/Saõ-Francisco cratons converged during the assembly of West Gondwana (e.g. Trompette, 1997).

The Borborema province (BOP) in NE-Brazil is recognized as an equivalent of the NFBC (Vauchez et al., 1995; Fig. 1a). Slip along shear zones in the BOP should have started around 590-570 Ma and continued under decreasing temperature to ca. 500 Ma (e.g., Neves et al., 2006 and references therein). The extension of the Borborema shear zone system in the NFBC is still a matter of debate. As structural, petrological and geochronological data are largely lacking from the NFBC, its tectonometamorphic and magmatic evolution remains only partially understood.

This study provides new structural and geochronological data (U-Pb on zircon and monazite) from the western part of the NFBC, puts constraints on the tectonic evolution of this segment of the belt, and makes correlations between the western NFBC and equivalent crustal parts in northeastern Brazil.

Methods

Detailed structural studies have been carried out in order to (i) describe the microstructures related to different deformation phases (magmatic, sub-magmatic, and non-magmatic), and (ii) estimate the temperature conditions and the deformation mechanisms governing each phase. An attempt has been made to characterize the three-dimensional geometry of the major shear zones cutting through the study area; metagranitoid samples have been selected for the application of the Rf/Ø method (e.g., Ramsay and Huber, 1983).

U-(Th)-Pb dating of zircon and monazite have been carried out to unravel the chronology of rock and mineral formation and thermal and metamorphic events in the study area. Different techniques have been used: the thermal ionization mass spectrometry, the laser ablation inductively coupled plasma mass spectrometry, and the electron microprobe.

Results

Field studies have revealed the presence of the following complexes: the migmatitic complex of Foumbot (MCF), the Bangwa complex (BC), the Chepang complex (CC), and the Batié pluton (BP). The complexes of Foumbot, Bangwa and Chepang are cut by the Batié pluton. The latter is intruded by the Cenozoic Batcha complex. The MCF is cut by an ENE-trending shear zone. NE-trending shear zones affect the BP margins, the BC, and the CC. (Fig. 1)

The MCF consists of diatexite, metatexite, and amphibolite. Features such as shear folding of rock fabrics along sets of ENE-trending shear planes and the accumulation of leucosome in hinge zones of folds, well documented in diatexite and in strongly deformed metatexite, suggest partial melting during increasing shearing. Characteristic patterns of foliation and lineations in high-strain domains suggest flattening to be the dominant coaxial component during deformation. Dextral kinematics prevails along the ENE-trending shear zone that affects the MCF but earlier sinistral movements cannot be ruled out.

The BC is composed of variably deformed quartz-diorite, granodiorite, syenogranite, leucogranite, and monzonite. Quartz-diorite and granodiorite occur as cm- to m-scale bodies and display subhorizontal fabric that is gradually transposed by NE-trending steep foliation when moving from eastern to western BC. Syenogranite and leucogranite are forming larger bodies and show NE-trending steep submagmatic foliation. Pervasive solid-state fabrics (crystal plastic deformation/recrystallization of feldspar, S-C structures) in syenogranitic and leucogranitic bodies reflect deformation during the cooling stage (T ≤ ca. 500°C) while deformation microfabrics in quartz-diorite and granodiorite are interpreted to reflect low- to high-grade metamorphism. S-C relationships suggest dextral shearing within NE-trending mylonitic zones along the BC-BP contact. Towards the internal BC margins, superimposition of small-scale sinistral shear zones by dextral ones is locally visible. A maximum pressure of ca. 4.5 kbar at T = ca. 500°C during shearing has been estimated using phengite barometry of deformed syenogranite. The eastern country rocks of the BC (Maham region) are migmatites displaying subhorizontal foliation, the foliation being (northwestward) progressively transposed by cm- to m- scale ENE-trending steep shear zones. As a whole, fabrics from migmatites of the Maham area, quartz-diorite and granodiorite of the BC are consistent with a regional SSE-directed nappe tectonics followed by the development of NE- to ENE-trending shear zones.

The CC consists of alternating steep m-scale bands of dioritic and granitic composition. The CC units display a NE- trending mylonitic foliation. Analyses of S-L patterns and quartz [c]-axes in the mylonitic granite reveal a dominant flattening component and a medium to high temperature conditions (up to ca. 650 °C) during shearing. Phengite barometry of mylonitic granite points to a maximum pressure of 6 kbar at T = ca. 500°C.

Medium to coarse-grained syenogranite forms the main unit of the BP. Towards the margins of the massif, magmatic fabrics (e.g. tiling of feldspar megacrysts, anhedral shape of quartz aggregates) are progressively superimposed by submagmatic fabrics (e.g. crystal plastic deformation/recrystallization of feldspar and quartz, myrmekite, S-C structures). The continuous deformation from magmatic to solid-state flow along the BP margins and the (sub)parallelism of the steep solid-state foliation in the BP margins with the foliation in the surrounding BC, CC and MCF suggest synkinematic emplacement of the BP along crustal-scale NNE- to ENE-trending strike-slip shear zones.

Zircon and monazite U-Pb isotope systematic indicate the presence of three groups of granitoids in the study area with different intrusion ages. The first group (ca. 640 Ma) consists of protoliths of the migmatites of the MCF and (grano)dioritic rocks of the BC, the second group (ca. 607 Ma) includes the syenogranite and leucogranite of the BC and the granite of the CC, and the third group (ca. 600 Ma) is made of the syenogranite of the BP. Moreover, xenocrystic cores and outer rims of zircons from the migmatites of the MCF have been dated at ca. 660-700 Ma and ca. 597 Ma, respectively. $^{206}Pb/^{238}U$ ages (ca. 650-720 Ma) have also been obtained from xenocrystic zircon cores from the granodiorite of the BC.

Discussion and Conclusions

Combining (micro)structural patterns with the obtained geochronological data, three tectono-magmatic phases have been pointed out: The first phase was marked by the emplacement of dioritic to granodioritic rocks of the BC and protoliths of the migmatites of the MCF at ca. 640 Ma. The inferred BC and MCF granitoids emplaced before and/or during a regional SSE-directed thrusting event. The second phase led to the emplacement of syenogranite and leucogranite in the BC and granite in the CC at ca. 607 Ma and was synchronous with metamorphic overprint of the 640 Ma old granitoids. The intrusion of the ca. 607 Ma old granitoids marked the change from nappe to (sinistral) transcurrent tectonics within the BC. The emplacement of the porphyritic syenogranite of Batié at ca. 600 Ma marked the third tectono-magmatic phase and likely triggered dextral kinematics at the BP borders and in the immediate surrounding rocks. Moreover, ages of 700-660 Ma obtained from xenocrystic zircon cores of migmatites of the MCF and granodiorite of the BC would reflect early-Pan-African basement into which the 640 Ma old granitoids intruded. Few inherited zircon cores of Paleoproterozoic age within leucogranite of the BC suggest some inputs of Eburnean crust to the evolution of the Pan-African granitoids.

The new data confirm previous assumptions that the western NFBC is equivalent to parts of the Borborema province of Brazil. There are geochronological correlations between the (meta)granitoids of the study area and Brasiliano pre- to syn-transcurrent granitoids of the Borborema province. Some differences in shear kinematics between these two domains exist, especially in the late stage of the Pan-Africano/Brazilian event (since ca. 600 Ma). This might reflect local variations in the stressfield imposed by the emplacement of syn- to late transcurrent magmatic bodies. The orientation of transcurrent shear zones in the western NFBC could have been controlled by (1) the emplacement of large Pan-African plutons in this part of the belt and (2) the geometry of the Congo craton boundary (actually its Paleoproterozoic reworked northern part).

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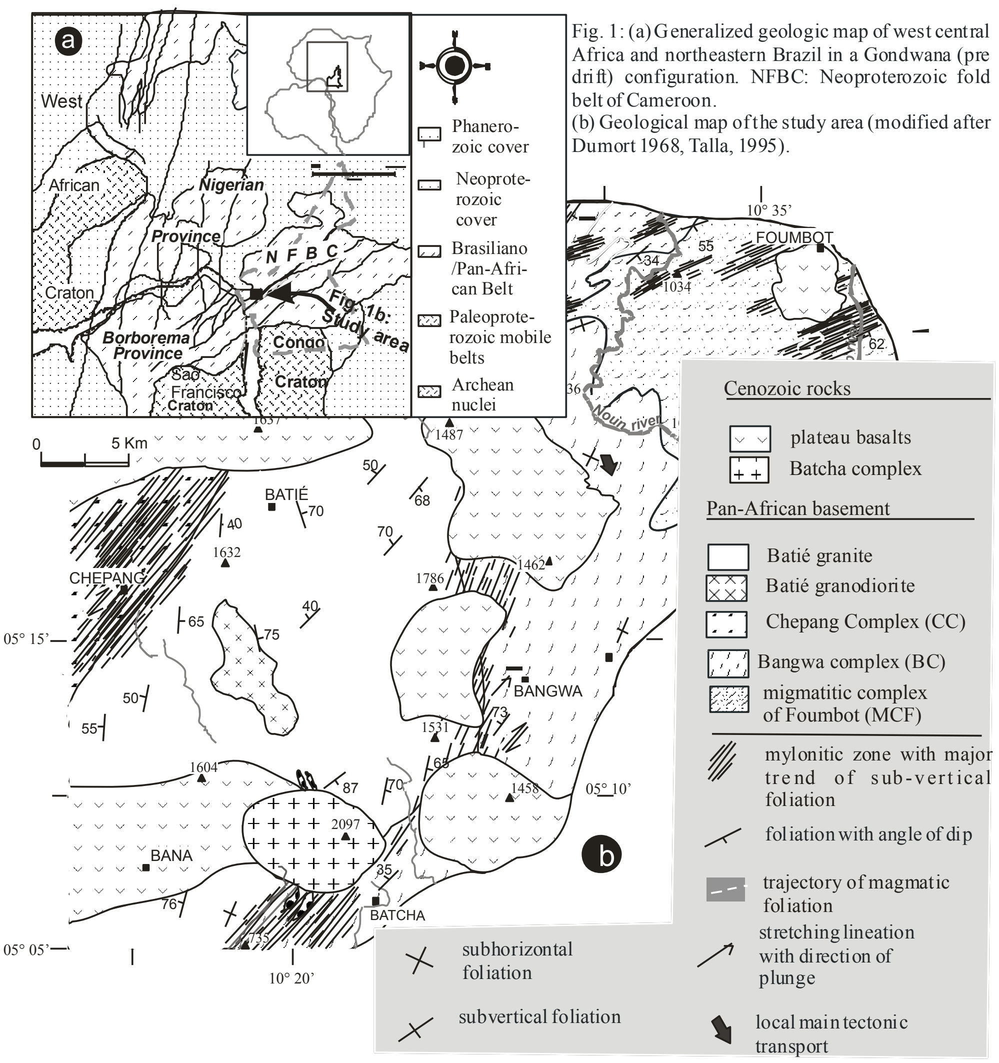

Fig. 1: (a) Generalized geologic map of west central Africa and northeastern Brazil in a Gondwana (pre drift) configuration. NFBC: Neoproterozoic fold belt of Cameroon.
(b) Geological map of the study area (modified after Dumort 1968, Talla, 1995).